



**UNIVERSITÀ DEGLI STUDI DI MILANO**

FACOLTÀ DI SCIENZE POLITICHE,  
ECONOMICHE E SOCIALI

**MASTER'S DEGREE COURSE IN  
ADMINISTRATION AND PUBLIC POLICIES**

**The democratization of science  
Analysis of the voluntary distributed  
computing platform BOINC**

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**Academic Year** 2021 /2022



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## **Abstract**

The goal of this thesis is to analyze the relationship between computational volunteers distributed of the BOINC platform and the researchers. BOINC is a platform of distributed computing that falls within the complex of activities defined as citizen science. I have determined the scientific output of BOINC in 20 years of proving business how BOINC is a great tool for scientific research. The analysis continues with the description of the central role of the virtual communities born around the platform. The complexity of these communities was not foreseen in 1999. The volunteers they are not passive users but rather they are a very important player in the network of BOINC and in particular help researchers in their activities. The elaborate also has the aim of demonstrating how BOINC is a very economical alternative to the centres of data processing of the hi-tech giants. BOINC, for its multidisciplinary and for the its way of aggregating communities is unique in the panorama of citizen projects science. The structure of the Italian community "BOINC.Italy" will also be explored. The analysis also takes into consideration researchers, those who ask for power computing power offered by volunteers, and companies that can donate computing power or propose distributed computing projects. Special emphasis will be placed on communication between researchers and volunteers as a fundamental pivot for a relationship of mutual and loyal cooperation.

## **Methodological note**

The thesis is mainly a qualitative analysis but with elements of quantitative analysis. As regards the qualitative part of the research, interviews were carried out speeches to the volunteers of BOINC.Italy and to the administrator of the Tn-Grid project, per the free and open source software "Open Broadcaster Software"<sup>1</sup> was used for the recording of the interviews, while the interviews were conducted with the free teleconferencing service "Google Meet"<sup>2</sup> ; has been used

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<sup>1</sup> <https://obsproject.com> site visited on 28/10/2022

<sup>2</sup> <https://meet.google.com> site visited on 28/10/2022

non-participant observation to analyze user comments at some virtual community forums and project sites. For the quantitative analysis it was used secondary analysis to determine, for example, the number of publications or costs of distributed computing projects; to learn more about the report between volunteers and researchers a sample survey was formulated, with sample non-probabilistic, through a questionnaire that was administered to the community virtual BOINC.Italy. The thesis was written using free and open software source LibreOffice<sup>3</sup> . The files are available through the Google Drive<sup>4</sup> web service .

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<sup>3</sup> <https://it.libreoffice.org> site visited on 04/11/2022

<sup>4</sup> [https://www.google.com/intl/it\\_it/drive/](https://www.google.com/intl/it_it/drive/) site visited on 04/11/2022

## **Chapter 1 The concept of citizen science, what is distributed computing, the functioning of the BOINC structure and scientific production**

### **1.1 Citizen science, definition and advantages**

Citizen science is the involvement of people, especially without details scientific knowledge or analysis, in research projects. The participation of persons concerns the collection, analysis and processing of data on a voluntary basis. Research projects are often limited in terms of budget and resources humanities, but citizen science, or the democratization of science, allows the researchers to obtain much more data than could be collected with the normal human and material resources made available to the researcher<sup>5</sup> .

Researchers have different tasks and can delegate simpler tasks as well repetitive to the volunteers while they can deal with more complex tasks that they cannot be carried out by volunteers.

Simplifying, if a free volunteer analyzes 1 hour a week of the images of galaxies to classify them means that the researcher, in 1 month, has obtained 4 hours of analysis of galaxies without cost and being able to devote himself to other activities. In the cost benefit analysis, this should be part of the opportunity cost of the researcher<sup>6</sup> .

There are also strong cost reductions with regard to hardware (eg. acquisition and maintenance of servers for processing). Projects like Einstein@Home and Rosetta@Home have a power approaching 2 PetaFLOPS per project, this power is provided by Amazon EC2, a virtual machine rental service, at a cost of \$43,520.00 in 2019<sup>7</sup> . Savings in terms of

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<sup>5</sup> Pierangelo Crucitti, (2016), Citizen Science. Participatory science. Principles, examples and perspectives of a growing phenomenon constant, p. 1

<sup>6</sup> Massimo Florio, (2019), Investing in Science, p. 239

<sup>7</sup> David P. Anderson, (2019), BOINC: A Platform for Volunteer Computing, p. 1



resources is significant given that the cost of CPU and GPU (purchase, maintenance, electricity) is translated almost entirely on volunteers.

Citizen science is not only about hard sciences, but also about soft sciences such as archeology. An interesting example is that of the Archaeological Area of Poggio del Molino, near Populonia, where volunteers can help archaeologists digging, cataloging artifacts and mapping the site, among the activities we find for example the cleaning of individual mosaic tiles, which we can define as a repetitive activity e that can be performed by anyone, which allows professionals to devote themselves to more complex tasks or supervising more people, speeding up restoration<sup>8</sup> .

The participation of citizens also allows them to get closer to the themes of scientific research, decreasing the distance between researchers and citizens by providing scientific insights as well as making people aware of the importance of investment in scientific research.

## 1.2 Distributed computing

According to Wikipedia “ distributed computing is a field of computer science that studies i distributed systems, i.e. systems that consist of many self-contained computers interact/communicate with each other through a network in order to achieve a common goal (software running in a distributed system is called a program distributed, and distributed programming is the process of writing such software)”<sup>9</sup> .

Then, unlike supercomputers, a complex problem is worked out and solved not from a single very powerful electronic device but from a network of devices. There are numerous distributed computing projects (BOINC, DreamLab della Vodafone foundation, Folding@home etc.) who use smartphones, tablets but especially personal computers of people who install the related software

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<sup>8</sup> <https://earthwatch.org/expeditions/unearthing-ancient-history-in-tuscany> site visited on 15/09/2022

<sup>9</sup> [https://it.wikipedia.org/wiki/Calcolo\\_distribuito#:~:text=Il%20computing%20distributed%20is%20a,system%20distributed%20is%20said%20program](https://it.wikipedia.org/wiki/Calcolo_distribuito#:~:text=Il%20computing%20distributed%20is%20a,system%20distributed%20is%20said%20program) site visited on 09/15/2022

computational project to solve complex problems (e.g. find a cure for a determined type of cancer by simulating protein folding).

BOINC is definitely the most complex distributed computing project in terms of number of scientific projects and sectors, 96 projects in 2022 in about 20 years of activity.

Folding is a distributed computing project that focuses on protein folding and became the first supercomputer to break the exascale barrier, plus it is became, for a time, the most powerful supercomputer in the globe by beating any previous record and surpassing the top supercomputer per hour in the charts, i.e. IBM Summit (148.6 petaFLOPS)<sup>10</sup>. Folding was recently surpassed by the Frontier supercomputer (1,102 exaFLOPS)<sup>11</sup>, but it undoubtedly makes

reflect that the first supercomputer to achieve exascale computing power was not a supercomputer but the set of thousands of computers of a project by distributed computing. During the COVID-19 pandemic, Folding@Home reached a peak computing power of 2.4 exaFLOPS<sup>12</sup> or twice the power of calculation by Frontier (first position in the top 500 supercomputers by power of calculation)<sup>13</sup>.

One of the limitations of distributed computing is the variability of computing power, users they can suspend processing or uninstall BOINC. The computing power of a voluntary computational design therefore is not constant and is not programmable as per i supercomputer.

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10 <https://www.anandtech.com/show/15661/folding-at-home-reaches-exascale-10000000000000000000-operations-per-second-for-covid-19> site visited 09/16/2022

11 [https://www.hwupgrade.it/news/server-workstation/frontier-inaugura-l-era-exascale-e-il-supercomputer-piu-veloce-al-mondo-grazie-ai-chip-amd\\_107576.html](https://www.hwupgrade.it/news/server-workstation/frontier-inaugura-l-era-exascale-e-il-supercomputer-piu-veloce-al-mondo-grazie-ai-chip-amd_107576.html) site visited on 17/09/2022

12 [https://www.hwupgrade.it/news/sistemi/folding-home- Potenza-superiore-ai-primi-500-supercomputer-al-mondo-messi-insieme- passed-the-2-4-exaflops\\_88543.html](https://www.hwupgrade.it/news/sistemi/folding-home- Potenza-superiore-ai-primi-500-supercomputer-al-mondo-messi-insieme- passed-the-2-4-exaflops_88543.html) site visited on 17/09/2022

13 <https://www.top500.org/lists/top500/2022/06/> 17/09/2022

The computing power is based on the unit of measurement of FLOPS (FLoating point Operations Per Second ) or the number of operations that are performed in 1 second from CPU<sup>14</sup> .

At each clock cycle a certain number of operations (Nop) are performed this value must be multiplied by the clock frequency (fclock) to get the number of FLOPS (FLOPS= Nop x fclock ).

Is. Nop = 10;                fclock = 2GHz;  
FLOPS = Nop x fclock = 2GHz x 10 = 20 GigaFLOPS

This is true if the CPU has only 1 core, so let's add one more into the formula multiplication, i.e. the number of cores (Ncore).

So if we have a processor with 4 cores we must add x4 to the formula<sup>15</sup> .

es. CPU quadcore

Nop = 16;                fclock = 2GHz;                no. processors = 4  
Nop x fclock x Ncore= 2GHz x 16 x 4 = 128 GigaFLOPS

The main concept of distributed computing projects is that many computers (even underperformers), united in a network, can equal or exceed the supercomputer in fact the computing power also depends on the number of processors and not only by the power of the single processor (number of operations and frequency of clock).

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<sup>14</sup> <https://it.wikipedia.org/wiki/FLOPS> site visited on 16/09/2022 site visited on 16/09/2022

<sup>15</sup> <http://www.programmiamo.altervista.org/hsw/hsw11.html> site visited on 09/16/2022

### 1.3 The operation of BOINC

The user downloads the software<sup>16</sup> from the BOINC official site, after which he installs it and choose a project to support (Figure 1) through the "BOINC Manager" or the control panel (Figures 2 and 3).

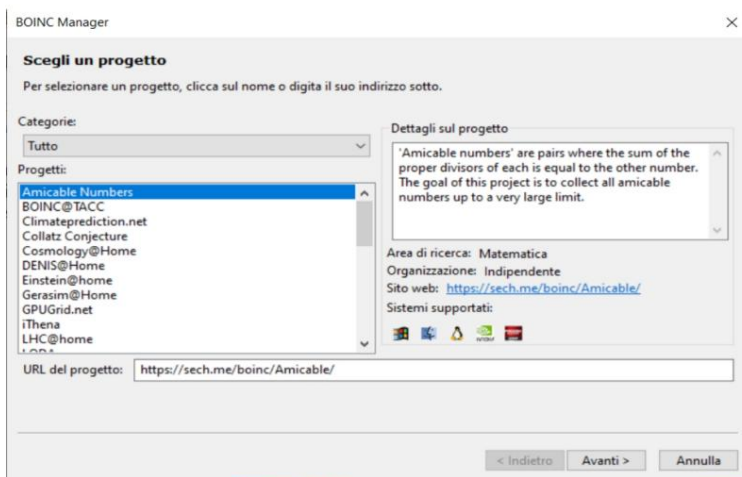


Figura 1: Connessione ad un progetto, Antonio Cerrato, 2022, fonte: BOINC Manager

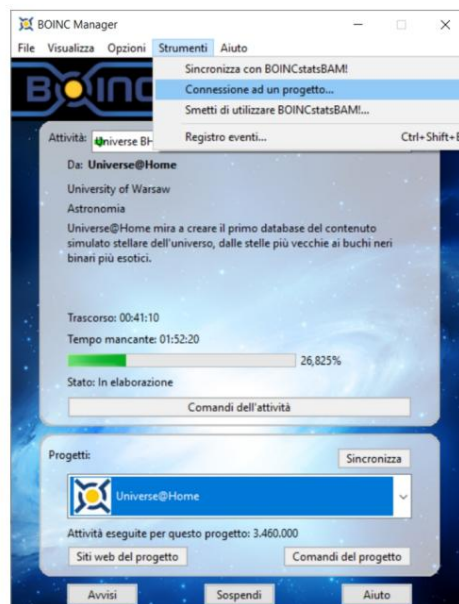


Figura 2: BOINC Manager, pannello di controllo semplificato con percorso per connettersi a un progetto, Antonio Cerrato, 2022, fonte: BOINC Manager

Progetto	Account	Team	Crediti totali	Media dei crediti	Allocazione ris...	Stato
Einstein@Home	Antonio Cerrato [CAMP]	BOINC.Italy	1.862.389	861,28	100 (14,29%)	Non richiedere nuove attività
LHC@home	Antonio	BOINC.Italy	0	0,00	100 (14,29%)	Non richiedere nuove attività
Milkyway@Home	Antonio Cerrato [CAMP]	BOINC.Italy	63.127	365,22	100 (14,29%)	Non richiedere nuove attività
Rosetta@home	Antonio Cerrato [CAMP]	BOINC.Italy	576.407	870,32	100 (14,29%)	Non richiedere nuove attività
TN-Grid Platform	Antonio Cerrato [CAMP]	BOINC.Italy	2.253.083	4.770,34	100 (14,29%)	Non richiedere nuove attività
Universe@Home	Antonio Cerrato [CAMP]	BOINC.Italy	3.460.000	2.773,66	100 (14,29%)	Non richiedere nuove attività
World Community Grid	Antonio Cerrato [CAMP]	BOINC.Italy	850.351	0,01	100 (14,29%)	Non richiedere nuove attività

Figura 3: BOINC Manager, pannello di controllo con visualizzazione avanzata, Antonio Cerrato, 2022, fonte: BOINC Manager

<sup>16</sup> <https://boinc.berkeley.edu/download.php> site visited on 09/17/2022

The user must subscribe to the individual BOINC projects by choosing a username, a password and email. Each email is associated with the CPID (Cross-project identification) which is used to connect the BOINC Manager to an account manager. The CPID is useful for statistics external to BOINC<sup>17</sup>, for example to compare the credits between two teams, during a challenge, on sites external to that of BOINC.

Using two different emails means having two different CPIDs and therefore the user will have two separate accounts. The user, if he used the same username, will appear as two times in the stats (the credits will stay the same because they are based on the power of calculation so they will not duplicate).

Account managers are sites, external to the official BOINC site, which help the user manage and view the statistics of their account<sup>18</sup>

moreover, many challenges between teams are based precisely on the scores recorded by some accounts manager (e.g. "BOINC Account Manager (BAM!)"). The user can then, optionally, create an account on an account manager and connect via the "Tools" section of the BOINC control panel similarly as for a project.

Moving on to how BOINC actually works, the user's PC requires some task to the project server which in turn will send the requested tasks to the user's PC, in based on the characteristics of the PC. After downloading the tasks, also called "work units" or "wu", the PC will start to process them and once processed it will send them to the server project. After which the user's PC will request new processing by repeating the ciclo<sup>19</sup>.

The same work unit is sent to two different users who then process the same task.

This is to minimize processing errors. In case the results of the

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<sup>17</sup> [https://boinc.berkeley.edu/wiki/Cross-project\\_identification](https://boinc.berkeley.edu/wiki/Cross-project_identification) site visited 09/20/2022

<sup>18</sup> [https://boinc.berkeley.edu/wiki/Account\\_managers](https://boinc.berkeley.edu/wiki/Account_managers) site visited 09/20/2022

<sup>19</sup> [https://boinc.berkeley.edu/wiki/How\\_BOINC\\_works](https://boinc.berkeley.edu/wiki/How_BOINC_works) site visited 09/20/2022

same elaboration are different, the two elaborations are compared with a third one (processed by a third user).

The user receives a score, called credit, when the project server compares and validates the two elaborations coming from different PCs and users<sup>20</sup>.

Double processing is also to prevent a user from spoofing results for get an altered score to climb the leaderboards. Plus the double processing is needed so that at least one result is actually returned to the server. The wus have time limits, this way you are sure not to miss a certain work package which will be returned to the server and sent to a new user for processing (this leads to inefficiencies with respect to the calculation run by supercomputers in fact not meeting deadlines means that the server he will have to cancel some wu, perhaps already partly elaborated, and reassign them to another user lengthening processing times and therefore scientific research).

The unit of measurement of the score is the credit which is 1/200 of the CPU time. Initially, a 1 GigaFLOPS electronic device produced 200 credit units in one day<sup>21</sup>. The production of the credits was subsequently changed, the value given by an elaboration is determined by the project administrators. The credit has no monetary value but is used by researchers as a tool of gamification to increase user engagement in the processing of work unit.

Another quantity is the RAC (Recent Average Credit) which measures the average credit of all machines associated with a user in a week.

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<sup>20</sup> [https://boinc.berkeley.edu/wiki/How\\_BOINC\\_works](https://boinc.berkeley.edu/wiki/How_BOINC_works) site visited 09/20/2022

<sup>21</sup> [https://boinc.berkeley.edu/wiki/Computation\\_credit](https://boinc.berkeley.edu/wiki/Computation_credit) site visited 09/20/2022

The RAC, in case of failure to grant credit in 7 days, decreases by 50%<sup>22</sup> .

It basically serves to see if a user is active.

**1.4 BOINC Terms of Use, Source Code and Privacy Policy** The software is free to use and is distributed under the terms of the GNU Lesser General Public License<sup>23</sup>. The source code of BOINC is open source and available on GitHub<sup>24</sup>

As far as the individual applications of the projects are concerned, this depends on the project a project, for example Einstein@Home is in turn free software distributed under the GNU Lesser General Public License<sup>25</sup> and the source code is open source<sup>26</sup> as is the application for searching for binary pulsars<sup>27</sup> .

BOINC.Italy compiled a list of open source projects. 43 out of 96 projects have made their source code available<sup>28</sup>, in some cases the projects have not made it open source the source code because, in part, it is based on paid licenses.

As far as user data is concerned, the individual user can choose a username that may not coincide with his name and surname thus making it anonymous. The email used for registration to individual projects is not shown in any site or forum, it is not shown to the organizers but can be used to receive newsletters (the option can be deactivated). If you participate in a project, the individual project registers information such as processor type, graphics card, ram etc.. The hardware information can be shown to other users with consent of the single user (Figure 4). In the absence of the individual user's consent to a

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<sup>22</sup> [https://boinc.berkeley.edu/boinc\\_papers/credit/text.php](https://boinc.berkeley.edu/boinc_papers/credit/text.php) site visited 09/20/2022

<sup>23</sup> University of California, (2022), License Agreement <sup>24</sup>

<https://github.com/BOINC/boinc/> site visited on 21/09/2022 <sup>25</sup>

<https://einsteinathome.org/it-it/application-source-code-and-license> site visited on 21/09/2022

<sup>26</sup> <https://wiki.ligo.org/Computing/LALSuite> site visited on 21/09/2022

<sup>27</sup> <https://einsteinathome.org/it-it/application-source-code-and-license> site visited on 21/09/2022

<sup>28</sup> <https://www.boincitaly.org/projects/sources-projects.html> site visited on 06/10/2022

project, the credits of that project will not be recorded by the account manager and will not they will appear on third-party statistics sites<sup>29</sup> .

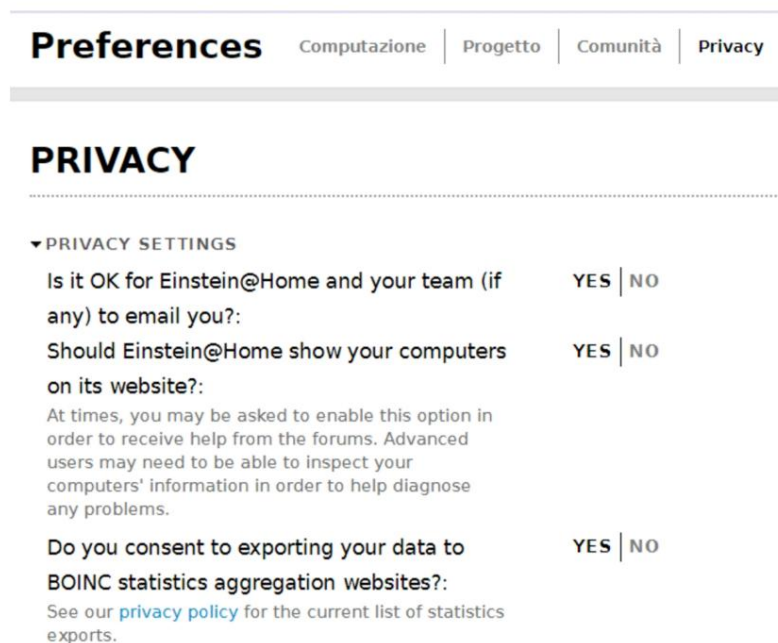


Figura 4, Impostazioni privacy del progetto Einstein@Home quando l'utente decide di acconsentire al trattamento dei dati, Antonio Cerrato, 2022, fonte: <https://einsteinathome.org/it-it>

In no case will the location of the electronic device be shown the user's IP address<sup>30</sup> .

Each individual project has its own privacy policy (e.g. Einstein@Home<sup>31</sup>).

<sup>29</sup> <https://boinc.berkeley.edu/info.php> site visited on 09/21/2022

<sup>30</sup> <https://boinc.berkeley.edu/info.php> site visited on 09/21/2022

<sup>31</sup> <https://einsteinathome.org/it-it/privacy> site visited on 09/21/2022



## 1.5 Historical notes on the birth of BOINC

BOINC was developed between 2001 and 2002 to then actually be released in February 2002. BOINC is however the second stage of a first project that had discovered potential in voluntary computation.

In 1995 David Pope Anderson (the originator of BOINC) was contacted by David Gedye, his former teaching assistant for teaching operating systems, to create a voluntary computing project for SETI (Search for Extra-Terrestrial Intelligence) e then to analyze SETI radio telescope data to search for radio signals synthetics. SETI@home was officially launched in May 1999. The program was a success, in the first year the peak of 1000 years of calculation was reached several times per day. The main problem with SETI@home is that it included both the of part infrastructure (server-client communication) and scientific analysis. So every time the scientific part changed, a new one had to be released updating of the entire program forcing continuous installations by of user-volunteers. From this experience, Anderson decided to split the infrastructure from the scientific part of the project and to combine everything with the more complex concept of big science<sup>32</sup> .

While working at BOINC, Anderson applied to the National Science Foundation (NSF, the independent federal research support agency<sup>33</sup>) to subsidize the development of the distributed computing platform. So he got the position of Research Scientist at the University of California, Berkeley<sup>34</sup>. TO Due to some legal wrangling, Anderson decided that the source code of BOINC it was supposed to belong to the University of California and it was supposed to be open source. Being a professor in that university and having regard to his decision to make the open source distributed computing platform decided to call the platform with the name of "BOINC" which is none other than the acronym of "Berkeley Open Infrastructure

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32 [https://continuum-hypothesis.com/boinc\\_history.php#origins](https://continuum-hypothesis.com/boinc_history.php#origins) site visited 09/22/2022

33 <https://www.nsf.gov/about/> site visited 09/22/2022

34 [https://continuum-hypothesis.com/boinc\\_history.php#funding](https://continuum-hypothesis.com/boinc_history.php#funding) site visited on 09/22/2022

for Network Computing”, he was also looking for an onomatopoeic word compared to the classics names from Greek mythology given to academic software projects<sup>35</sup> .

SETI@home was included in BOINC and new scientific projects began to be born (Predictor@home to predict protein structures<sup>36</sup> , Climateprediction.net for the development of climatological models<sup>37</sup> etc.)

## 1.6 BOINC's projects

In the more than 20 years since the platform, a number of projects have opened and closed. We can divide projects into monothematic and multidisciplinary. The projects monothematic focused on solving a single problem while inside the multidisciplinary projects we find some sub-projects also from different areas scientific.

An example of a monothematic project is Einstein@Home, whose research area is that of physics. It is a project conceived by the University of Wisconsin-Milwaukee e has as its objective “the search for weak astrophysical signals from stars of rotating neutrons (often called pulsars) using data from the LIGO gravitational wave detector, the Arecibo radio telescope and the Fermi gamma-ray satellite”<sup>38</sup> .

Instead a multidisciplinary project is made up of several sub-projects. For example World Community Grid has many different projects within it, such as "FightAIDS@Home" which had as its objective the analysis of the reaction of the compounds chemicals with the HIV virus or “The Clean Energy Project” it was targeting that of "finding new materials useful for new generation organic solar cells"<sup>39</sup>. Multidisciplinary projects allow users to receive in continuation of processing but also to choose which sub-projects to process e which ones not. Multidisciplinary projects, therefore, attract more users by allowing one certain stability of computing power to researchers.

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35 [https://continuum-hypothesis.com/boinc\\_history.php#origins](https://continuum-hypothesis.com/boinc_history.php#origins) site visited on 22/09/2022

36 <https://en.wikipedia.org/wiki/Predictor@home> site visited on 22/09/2022

37 <https://en.wikipedia.org/wiki/Climateprediction.net> site visited on 09/22/2022

38 <https://einsteinathome.org/it-it/about> site visited on 09/05/2022

39 [https://it.wikipedia.org/wiki/World\\_Community\\_Grid](https://it.wikipedia.org/wiki/World_Community_Grid) site visited on 05/09/2022

## 1.7 The scientific production of BOINC

### 1.7.1 Methodology for collecting scientific publications

There is no complete and official list of scientific publications obtained thanks to the BOINC platform. There is an official list but it is incomplete, in fact the list contains 420 publications<sup>40</sup> while I registered 994 publications (more than double the list of official publications).

Projects are not required to draw up a list of publications, but independently they release news about publications or have dedicated sections on project websites. For example Einstein@Home has a very up-to-date section of the site dedicated to scientific publications obtained with the help of volunteers<sup>41</sup>.

The virtual communities, which have arisen around the platform, have tried to draw up some lists of scientific publications. The German virtual community Rechenkraft.net has identified 187 scientific publications, or about half of the official number of publications.

The Italian virtual community BOINC.Italy has identified a high number of scientific publications, documents from conferences, workshops and reports of projects. The BOINC.Italy list was obtained by checking the sites and forums of individual projects and by searching for the name of the projects on Google Scholar. From this list already existing, I developed a spreadsheet file containing the publications obtained thanks to BOINC volunteers. I then deleted from the list of BOINC.Italy all those documents that have not had a peer evaluation reviews (for example the power points of workshops or scientific conferences). I have reclassified the projects into 7 scientific areas: astronomy and physics; chemistry and energy renewable; biology and medicine; climatology, earth study and ecology; mathematics; cognitive and social sciences and computer science. With each publication I have

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<sup>40</sup> [https://boinc.berkeley.edu/wiki/Publications\\_by\\_BOINC\\_projects](https://boinc.berkeley.edu/wiki/Publications_by_BOINC_projects) site checked 05/10/2022

<sup>41</sup> <https://einsteinathome.org/it-it/science/publications> site checked 05/10/2022

associated with the number of citations and the date when the citations were checked quotations, i.e. between 11 July and 4 October.

I have updated, as far as possible, the number of publications above all to 2021 for projects still open through Google Scholar. Searching for publications is very difficult because often researchers do not include in the keywords articles words like “BOINC” or “volunteer computing”. The sections of the official sites of the projects, dedicated to scientific publications, are not very up-to-date or totally non-existent.

### **1.7.2 Statistics of scientific production**

In about 20 years BOINC has produced at least 994 scientific publications<sup>42</sup> we can define this number as the minimum number of publications science actually obtained from distributed computing. Most likely this number is higher but no further items could be traced.

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<sup>42</sup> The BOINC official list of scientific publications has been updated after the publication of this thesis (December 19, 2022) also thanks to the documents elaborated with this thesis. Comparing the official list and the publications list of this thesis, after two rounds of checks, one carried out by Alex Piskun and a second carried out by me, the official publications are 915 (as regards publications up to 2022). As of 08/07/2023 there are 921 publications in the official list. Below is the final file of the two rounds of checks: [https://docs.google.com/spreadsheets/d/1iAlZjKrExWMGMVhm78yWsgQ6d4PTlusXoi4K\\_kFKze0/edit?usp=drive\\_link](https://docs.google.com/spreadsheets/d/1iAlZjKrExWMGMVhm78yWsgQ6d4PTlusXoi4K_kFKze0/edit?usp=drive_link)

Table 1: Number of scientific publications by sector, Antonio Cerrato, 2022, source: elaborations by Cerrato with partial extraction of information from the BOINC.Italy forum

<b>Number of publications by scientific area</b>	
Astronomy and Physics	200
Chemistry and renewable energies	36
Biology and Medicine	486
Climatology, study of the earth and ecology	135
Mathematics	47
Cognitive and social sciences	13
Informatica	77

The scientific area with the most scientific publications (Table 1) is the medical sector e of biology with 486 articles, then we have the area of astronomy and physics with 200 publications. The sector with the fewest scientific publications is that of the sciences cognitive and social. From here we can understand that most publications it comes above all from the hard sciences and purely quantitative research.

Table 2: Average citations of scientific articles divided by sector, Antonio Cerrato, 2022, source: Cerrato elaborations with partial extraction of information from the BOINC.Italy forum

<b>Average number of citations by scientific area</b>	
Astronomy and Physics	51
Chemistry and renewable energies	94
Biology and Medicine	168
Climatology, study of the earth and ecology	105
Mathematics	10
Cognitive and social sciences	21
Informatica	16

I calculated the average number of citations by scientific area (Table 2), the sector with the highest average citations per publication is medical and biology with an average of 168 citations per publication. The lowest averages belong to the following areas: mathematics, cognitive and social sciences e informatica.

These averages are in line with worldwide data by research area<sup>43</sup> (Figure 5).

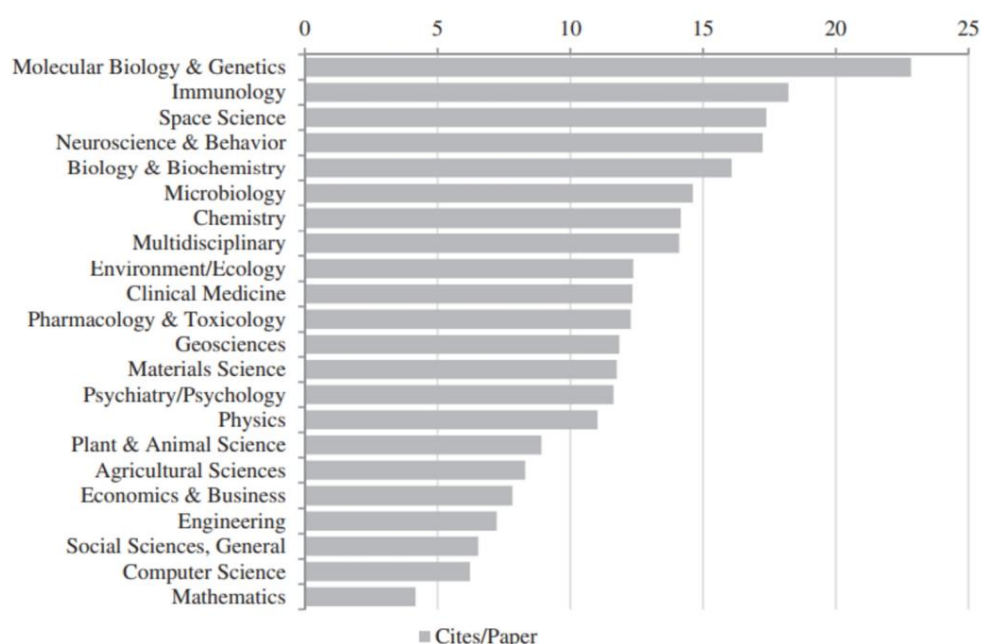


Figura 5: Numero medio di citazioni per articolo in più campi (Essential Science Indicators), Massimo Florio, 2018, fonte: elaborazioni di Massimo Florio basate sui dati di Clarivate Analytics.

The projects with the most scientific publications are: Rosetta@Home with 223 scientific publications in 16 years of activity, ClimatePrediction.Net with 103 scientific publications in 18 years of activity and World Community Grid with 80 scientific publications in 17 years of activity.

The averages of the number of citations are as follows: 284 (World Community Grid), 237 (Rosetta@Home) and 129 (ClimatePrediction.Net).

<sup>43</sup> Massimo Florio, (2019), Investing in Science, pp. 94-95

The most cited article is "AutoDock4 and AutoDockTools4: Automated docking with selective receptor flexibility" of the seventh project "FightAIDS@Home" of World Community Grid with 15,848 citations.

Most likely without BOINC these publications would hardly be able to exist, in fact the researchers did not have to ask for any permission for access to supercomputers and have therefore not submitted any requests to consortia and/or commissions to obtain computing power that was provided, however, by volunteers.

The file containing the scientific publications can be downloaded at the following link<sup>44</sup>:

<https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxceP5c2sq8S6kx3TftZGII91oSxqk/edit?usp=sharing>

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<sup>44</sup> <https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxceP5c2sq8S6kx3TftZGII91oSxqk/edit?usp=sharing>

## **Chapter 2 The virtual communities of BOINC**

The actors that revolve around the world of BOINC are a fundamental part of the success of distributed computing. The increasing complexity of organizations, that have arisen around BOINC, has determined the growth not only of total computing power but also the level of socialization and growth cultural and scientific volunteers. Furthermore, distributed computing was fundamental for the creation of the concept of "volunteering 2.0", that is an evolution of concept of volunteering declined in the improvement of support activities and scientific research. Certainly virtual communities (and teams) are an important one part of the BOINC network that has not only embraced distributed computing but has it incorporated in various ways.

Interviews were conducted with community administrators BOINC.Italy.

N.b:

\*Full interviews are available via the section "Text files, video files ed audio, data and processing" at the end of the report or through the link in the following note<sup>45</sup>

### **2.1 I Team**

Each user can create or join a single team for each project. Each team has a founder and in case of inactivity by the founder the role can be transferred to another user of the same team.

There are also statistics for teams or total credits (the sum of credits of each user in the team) and the RAC which is calculated based on the average of the users.

By default, each project has 12 team types: company (for entrepreneurs and employees), primary school, secondary school, junior college, university or department, public body, NGO, national, local/regional, type of computer (e.g example a team dedicated to enthusiasts and owners of electronic devices

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<sup>45</sup> <https://drive.google.com/drive/folders/1QQuGK7dle8aEI9Dg9uBIPz3aWqGcsvru?usp=sharing>



Mac), charity/political/religious and none (residual category or for teams international).

The predominant category, or certainly the most active, is the national and international one based on the participation in the challenges between teams<sup>46</sup>.

A state can be associated with each team (even if not national).

The country category should cover the territory of the country in the name of the team, but the user does not have any special requirements to access the team, so essentially anyone can join any national team in

based on one's own sense of belonging to this or that nation. There may be

teams that, in their description, call themselves a national team (or that speak

mainly the language of the State reported) but which fall into the "none" category<sup>47</sup> or in any

case there may be more than one national team belonging to the same

nation, for example if we select the State among the Rosetta@Home project teams

"Germany" we will find several teams including SETI.Germany, Rosetta@Germany and

Rechenkraft.net (the latter is also present in the legal form of association no

profit in the Federal Republic of Germany). The same description as

Rechenkraft.net invites users "from all over the world" to join the team anyway

having a section of their site entirely in English as well as pointing out that many of them know

English<sup>48</sup>. As well as the calculation of BOINC is distributed and

decentralized, there is no single national team that has some sort of

representativeness of a nation but more teams of the category can coexist

"national" and of the State itself but which they have decided for interests, projects or objectives to create different teams.

## 2.2 Virtual communities

In addition to team building based on BOINC projects some teams have gods

external sites, compared to BOINC, where they manage their goals and interests in a manner

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<sup>46</sup> <https://www.boincstats.com/stats/challenge/team/overview> site visited on 09/28/2022

<sup>47</sup> [https://boinc.bakerlab.org/rosetta/team\\_display.php?teamid=26](https://boinc.bakerlab.org/rosetta/team_display.php?teamid=26) site visited on 28/09/2022

<sup>48</sup> [https://boinc.bakerlab.org/rosetta/team\\_display.php?teamid=31](https://boinc.bakerlab.org/rosetta/team_display.php?teamid=31) site visited on 28/09/2022

independent from the official forums of the various projects. For example Rechenkraft.net has one own wiki distinct from the official BOINC<sup>49</sup> one, it has its own site<sup>50</sup> and a forum<sup>51</sup> . The forum is certainly one of the most important areas of a virtual community where various discussions take place according to the topic of the topic. Always taking for example Rechenkraft.net, the forum is divided into several sections which in turn are divided into more specific subsections. The first section is dedicated to the rules of the forum (it is any unlawful activity such as copyright infringement is prohibited; it is not prohibited political activity but must not lead to racist, homophobic or sexist<sup>52</sup>), 3 sections are dedicated to BOINC projects according to the subject science (medicine, physics and mathematics), a section is dedicated to other projects (this section is very varied including: animation, finance, chess etc.), others two sections are dedicated to the two distributed computing projects created on BOINC right from Rechenkraft.net (yoyo@home and RNA World), then there's a whole section dedicated to "citizen science", one of the last sections has a generic content e encompasses several subsections not always related to distributed computing but more to the sphere of socialization with informal discussions ("small talk", science, hardware, video games, etc.). The last 3 sections are dedicated to: the team (preparation of challenges, podcasts), to the public part of the association, while the last section is dedicated to the management of the site, the wiki and the forum through feedback<sup>53</sup> . The forums of various communities have more or less the same structure: a part dedicated to regulation and functioning of BOINC, one dedicated to the various projects and one to hobbies or in any case to topics of various kinds not always related to distributed computing (SETI.USA<sup>54</sup>, L'Alliance Francophone<sup>55</sup>, BOINC.Italy<sup>56</sup> are some of them example).

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49 [https://www.rechenkraft.net/wiki/Willkommen\\_beim\\_Verein\\_Rechenkraft.net\\_e.V.](https://www.rechenkraft.net/wiki/Willkommen_beim_Verein_Rechenkraft.net_e.V.) site visited on 28/09/2022

50 <https://www.rechenkraft.net> site visited on 28/09/2022

51 <https://www.rechenkraft.net/forum/> site visited on 28/09/2022

52 <https://www.rechenkraft.net/forum/viewtopic.php?f=50&t=6469> 29/09/2022

53 <https://www.rechenkraft.net/forum/> site visited on 28/09/2022

54 <https://www.setiusa.us/forum.php> site visited on 28/09/2022

55 <https://www.boinc-af.org> site visited on 28/09/2022

56 <https://www.boincitaly.org/forum.html> site visited on 09/28/2022

Anderson underlines how effectively teams, through their virtual communities, have played an important role above all for the improvement and for the increase of the computing power of BOINC<sup>57</sup>.

## **2.3 The challenges, the Pentathlon and the BOINC Formula**

### **2.3.1 The challenge**

Challenges are certainly one of the most competitive tools, between teams important.

Essentially the team that gets the most credits on a given project, in a given time window, gets the first position and wins the challenge.

For the challenges, mainly external sites such as BoincStats or in are used in some cases there is the possibility of creating challenges within the project sites as in the case of World Community Grid<sup>58</sup>.

The team creates the challenge by determining the project, the start date (based on the time UTC) and the end date of the challenge<sup>59</sup>. The team that created the challenge can decide if the other teams can register for the competition before the date start of the challenge or if they can also register during the race.

Individual projects therefore get a real boost, for a short period of time time, by the participating teams. Plus challenges are a great way to introduce new projects to users. The organization of the challenges allows also to decrease the repetitiveness of the users' routines or in any case to limit the passive activities of users, in fact there are strategies, refined over time, for face competitions.

One of these is the so-called "bunker". The wu generator server (wu diminutive of work unit = processing), of each project, generates a certain number of wu per day therefore there is a limited number of elaborations to be sent to users. This is a

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<sup>57</sup> [https://continuum-hypothesis.com/boinc\\_history.php#volunteer](https://continuum-hypothesis.com/boinc_history.php#volunteer) site visited on 09/28/2022

<sup>58</sup> <https://www.worldcommunitygrid.org/help/topic.s?shortName=tmch> site visited on 09/29 /2022

<sup>59</sup> <https://www.boincstats.com/stats/challenge/team/overview> site visited on 09/29/2022

problem especially in test projects or in any case generate few wu, in fact the users will tend to hoard the few wu available to gain an advantage in challenges. Users, within each virtual community, will download into days before the challenge a certain number of wu to take advantage of the first ones hours / days of the race. Once a large amount of processing has been downloaded, the user, through the BOINC control panel on his pc, will decide to disconnect the software from the internet (this will prevent the work units from being shipped before the start of the challenge) and then have your BOINC manager reconnect once the challenge has started. In this way the single user (for micromanagement) it will "drop" its "bunker" (massive set of elaborate wu) in the first few hours of the race; an organized team can therefore easily place itself in the top positions at the start of the challenge. But BOINC, by default, sets a certain number of wu da send to users, this limit can be brought, via BOINC manager, up to 20 days of work (i.e. calculation).

The allocation of wu to users' electronic devices depends on the power of calculation (number of cpu) of the single device.

Users have come up with a way to circumvent the wu assignment system.

In fact, it will be enough to modify one of the files, of the installed software, to make the server believe of the project of having a much more powerful pc in order to obtain more work units for the bunker and then for the challenge<sup>60</sup> .

One of the administrators of BOINC.Italy has also created a guide for creating multiple clients and increasing the number of work units available to the user<sup>61</sup> .

For the creation of the bunkers, the expiry date of the singles must be taken into account work unit. It is possible to create a bunker with hundreds of elaborations but what they will be invalidated on the day of the challenge, because in the meantime they will all be expired due to expiration dates.

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<sup>60</sup> <https://www.boincitaly.org/forum/statistiche-sfide-e-traguardi/102820-come-organizzarsi-per-i-challenges.html> site visited on 29/09/2022

<sup>61</sup> <https://www.boincitaly.org/supporto/multisessionioni-boinc.html> site visited on 09/29/2022

Users of a team can be divided into groups, for example who makes the bunker and who no, who participates from the beginning and who enters the race in the challenge; strategic approaches they are therefore part of the organization of a challenge (the topic “World Gene Expansion Challenge 2021” is a good example<sup>62</sup>).

### 2.3.2 He Pentathlon

Another type of competition, created by the SETI.Germany virtual community, is the Pentathlon now in its thirteenth edition in 2022 and organized annually from the German team. Just as the Pentathlon has 5 disciplines, the BOINC version has 5 disciplines: obstacle course, sprint, city run, cross country and javelin throw. Each discipline corresponds to a different BOINC project.

Each discipline has its own rules and duration. For example the obstacle course it lasts for the duration of this particular challenge (14 days) and is randomly awarded a bonus score to credits processed on 3 different days to simulate the jumping over obstacles (score boosts are 100%, 150% and 200%). In based on the ranking, each team gets points for each discipline<sup>63</sup>.

A project is chosen by the organizers, for a single discipline, a few days before the start of the single race, this involves considerable complexity and capacity of adaptation by the teams. Since there are therefore different rules and projects, the teams they must develop strategies and possibly divide into groups in order to cover the different disciplines and therefore the different projects<sup>64</sup>.

Statistics are then generated from day to day until the end of the competition and to reward, symbolically, the first 3 teams at the end of Pentathlon<sup>65</sup>.

We can define the Pentathlon as a more articulated version of a challenge. Self in a classic challenge, the computing power of the team counts mainly, in the Pentathlon this is not enough; in fact, the different teams must and must organize themselves

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62 <https://www.boincitaly.org/forum/statistiche-sfide-e-traguardi/115182-world-gene-expansion-challenge-2021.html?start=0>

63 [https://www.seti-germany.de/boinc\\_pentathlon/15\\_en\\_Rules.html](https://www.seti-germany.de/boinc_pentathlon/15_en_Rules.html) site visited on 29/09/2022

64 [https://www.seti-germany.de/boinc\\_pentathlon/statistiken/pentathlon.php](https://www.seti-germany.de/boinc_pentathlon/statistiken/pentathlon.php) site visited on 29/09/2022

65 [https://www.seti-germany.de/boinc\\_pentathlon/statistiken/pentathlon.php](https://www.seti-germany.de/boinc_pentathlon/statistiken/pentathlon.php) site visited on 09/29/2022

adopt strategies based on the characteristics of the project (processing time of work units, processing based on cpu or even gpu, expiration of wu) and alle characteristics of the disciplines.

The Pentathlon is yet another event to increase team engagement, and by the way of its complexity, this engagement falls, cascading, on the individual users of the various team.

### **2.3.3 The BOINC Formula**

Always to keep the interest and participation in BOINC active, it was created in 2007 another type of race between teams or the Formula BOINC. There competition was created by user Otax of the L'Alliance Francophone team.

The competition lasts from January 1st to December 31st, thus covering the whole calendar year. There are two disciplines: marathon and sprint. The marathon lasts annual and all projects fall within the discipline (scores are therefore calculated in based on the performance of the teams in the single project), the sprints have a duration of 3 days and their functioning is similar to that of the challenges. Similarly to Formula, we have 3 categories: "League 1", "League 2", and "League 3". The teams more performing will find themselves in the first category, those less performing in the last. At the end of the year the top 3 teams from league 2 and league 3 will be promoted in category, while the 3 worst teams will be relegated in category (similarly as happens for football series)<sup>66</sup> .

**2.3.4 Competitions for Scientific Research and User Conflict** There are no real winners in these competitions, nothing material is won in fact there are no gold medals or cash prizes, the only prize is progress scientific.

Challenge, pentathlon and Formula BOINC had not been considered at all initially by the creator of BOINC, they are inventions of the users and teams who are

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<sup>66</sup> [https://formula-boinc.org/index\\_v2.py?year=2022&lang=it&team=&thx=](https://formula-boinc.org/index_v2.py?year=2022&lang=it&team=&thx=) site visited on 09/29/2022

they are formed and aggregated over time. The credit system has therefore been used by the users and amplified by the different types of challenges. Competitions are great example of technology-in-practice, or a different or alternative use of the technological structure that is available<sup>67</sup> .

Obviously these challenges are still competitions, in fact there may be gods conflicts before or during a challenge. For example, during the “World Gene Expansion Challenge 2021” challenge (beginning March 8th, ending March 15th 2021<sup>68</sup>), on the project Italian Tn-Grid, some users have shown some perplexity: the user “Magiceye04” (team: Planet 3DNow!) is concerned about the very limited number of the elaborations comparing them to the number of doses of the vaccine against the covid "(are) very rare"; user “Aurum” (team: Planet 3DNow!) seems very against ai “bunkers” because they limit the participation of users (and therefore of teams) in the competition; the user “Michael HW Weber” (team: Rechenkraft.net) points out that, during the challenge, they were left without processing and that they are “still doing nothing”<sup>69</sup> .

Choosing certain projects for challenges can therefore lead to conflicts between users and teams.

An initiative very similar to the BOINC Formula including marathons and sprints<sup>70</sup> has recently appeared. Some users, not satisfied with some decisions of the Formula BOINC staff, would have decided to create a parallel competition<sup>71</sup> . As reported by a user, some teams are telling other teams to unsubscribe from the BOINC<sup>72</sup> Formula .

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<sup>67</sup> Hatch, Cunliffe, (2013), Organization Theory, p. 180 <sup>68</sup>

<https://www.boincstats.com/stats/challenge/team/chat/1089> site visited on 01/10/2022

<sup>69</sup> [http://gene.disi.unitn.it/test/forum\\_thread.php?id=307](http://gene.disi.unitn.it/test/forum_thread.php?id=307)

<sup>70</sup> <https://www.boincgames.com> site visited on 17/10/2022

<sup>71</sup> <https://forums.anandtech.com/threads/boinc-games-live-for-alpha-testing.2597113/> site visited on 17 /

10/2022 <sup>72</sup> <https://www.boincitaly.org/forum/statistiche-sfide-e-traguardi/115251-boincgames-cos-è.html> site visited on 17/10/2022

## **2.4 Administrative subdivision, regionalism, localism and increase in computing power**

As was analyzed in paragraph 2.1, users belonging to the same country they can join a single team but have a wide choice. Some teams, for decrease the fragmentation of national groups, have engulfed within the their community own the concept of team divisions, that is, they have adopted the creation of internal groups and an internal ranking. This is mainly for not disperse the computing power during the challenges and to be attractive to the eyes of newbies who want to join a team.

### **2.4.1 The Francophone case**

Concentration towards a team mainly depends on the characteristics sociocultural aspects of a team, for example The Francophone Alliance is not the team of French but francophones and this allows the team to go beyond territorial borders e administrative French to attract users of different nationalities but that for reasons historical, social or political mainly speak the French language. The vision and advantages are well explained by the same team on their site ("Pourquoi L'Alliance Francophone ?"): the grouping of francophones makes it possible to have a mass greater results, therefore greater computing power allows you to scale easily world rankings to the whole team; The Alliance is one of the most visited sites this means that there is a high circulation of information and more information means better coordination and the ability to teach optimization (e.g for challenges) to new members; therefore more information means recruiting new members and therefore increasing computing power<sup>73</sup> .

How did the admins of the Alliance absorb smaller French-speaking teams?

On the site of the L'Alliance Francophone team we can see the subdivision made by team admins. Among the main mini-teams we find: a group of

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<sup>73</sup> <https://www.boinc-af.org/faq-alliance-francophone/pourquoi-lalliance-francophone.html> site visited on 01/10/2022



Quebec<sup>74</sup>, a group of members of the French-speaking maritime community<sup>75</sup>, a group dedicated to the Belgians (Wallonians, Flemings and even German speakers of the are allowed Belgium)<sup>76</sup> and so on<sup>77</sup> in a sort of new French empire but of distributed computing. An important aspect of the division into mini-teams is certainly that of credits. The Alliance, always internally, has precisely created internal statistics between mini-teams<sup>78</sup>. The goal is to incorporate the external teams but without depriving them of the sense of competitiveness, plus internal competitiveness (on computing power) definitely benefits the Alliance (in fact otherwise these teams would be outside the international statistics of the Alliance). To enter one of these mini-teams the individual user must add a tag within his own nickname (for example if a user wants to join the Belgian group: “nickname”y “[AF>Belgique] nickname”)<sup>79</sup>. The division into mini-teams does not have effects on external statistics sites, where only the wording “L'Alliance Francophone” and not that of the mini teams. Each group also has sections of the forum dedicated to its own mini-team (eg. forum dei Belgi<sup>80</sup>)

### 2.4.2 The Italian case

Similar to the French-speaking team, BOINC.Italy has also adopted a similar approach<sup>81</sup> .

To avoid the fragmentation of the Italian teams, internal groups have been created a BOINC.Italy. The main groups are based on the Italian division into regions, in fact we have the group of Emilia Romagna, Lombardia, Veneto, della Campania etc. then there are more local groups such as citizen teams including the group of Brescia, Belluno and Naples. Within the Italian team there are also some

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74 <https://www.boinc-af.org/liste-equipres/af-quebec.html> site visited on 01/10/2022

75 <https://www.boinc-af.org/af-amis-de-la-mer.html> site visited on 01/10/2022

76 <https://www.boinc-af.org/af-belgique.html> site visited on 01/10/2022

77 <https://www.boinc-af.org/liste-equipres.html> site visited on 01/10/2022

78 [https://statseb.boinc-af.org/classement\\_mt\\_v2.py?projet=0&niveau=1&sort=total](https://statseb.boinc-af.org/classement_mt_v2.py?projet=0&niveau=1&sort=total) site visited on 01/10/2022

79 <https://www.boinc-af.org/faq-alliance-francophone/comment-rejoindre-une-miniteam.html> site visited on 01/10/2022

80 <https://forum.boinc-af.org/index.php/topic,2140.0.html> site visited on 01/10/2022

81 <https://www.boincitaly.org/community/gruppi-interni.html> site visited on 01/10/2022

universities whose members are students or former students, among the various universities we find the Polytechnic of Turin, the University of Rome, the University of Pavia, the University of Eastern Piedmont and the Milan Polytechnic. The only group actually not belonging to the Italian territory is the group of Canton Ticino<sup>82</sup>.

BOINC.Italy's approach is more marked by the grouping of Italian citizens that of Italian-speakers, for example there are no internal groups of Italian-speaking Croatians, Greeks or Albanians.

BOINC.Italy also has its own ranking among internal groups<sup>83</sup> and has sections of the forum dedicated to internal groups<sup>84</sup>.

## **2.5 The organization of virtual communities and the network: a brief analysis of the organization and the new economy**

We can define the actors and levels of organization of BOINC based on the studies of de Vita, Mercury and Testa. We classify users as individual individual units, the virtual communities/teams as company level and project and challenge sites as a meeting place between different communities, businesses and universities and therefore as a meeting place for the network<sup>85</sup>. It is difficult to identify real groups within individual communities; groups can be defined for example those members who come together with face-to-face meetings and then cross over, such as group, all those characterizing phases (orientation, redefinition, coordination, implementation, conclusion)<sup>86</sup>.

Another example, much more frequent in virtual communities, can be the institution of a group for the challenges.

A user informs the others, with a thread on the forum of the virtual community, of one challenge. Users begin to see that he spontaneously participates in the challenge; through the comments you can easily identify the members with the most experience. There is not

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<sup>82</sup> <https://www.boincitaly.org/statistiche.html?show=listcommunity> site visited on 01/10/2022

<sup>83</sup> <https://www.boincitaly.org/statistiche.html?show=listcommunity> site visited on 01/10 /2022

<sup>84</sup> <https://www.boincitaly.org/forum/spazio-gruppi-e-community.html> site visited on 01/10/2022

<sup>85</sup> de Vita, Mercurio, Testa, (2007), pp.

<sup>86</sup> de Vita, Mercurio, Testa, (2007), pp. 104-107

a specific assignment of roles. There is an assignment if a member of the community organizes the challenge or if it has created internal or external statistics for the challenge (orientation stage).

In the next phase, any problems emerge: newbies ask how to create it a bunker or it emerges that there is low participation so you try to increase engagement to the challenge by involving and informing users of outside the specific thread/topic, for example with an ad hoc graphic on the homepage e announcing the team's participation in the challenge on social media or in the live chat of the community forum (redefinition stage).

The community is about to enter the real challenge phase, therefore other users have joined the challenge or are considering strategies for the pentathlon. It defines who has prepared the bunker and who has not and who will enter once challenge started (coordination stage).

The challenge begins, in the first hours the bunkers are released, any problems are resolved stats issues if the team organized the challenge. Any conflicts have a low priority compared to climbing the ladder (stadium of the implementation).

In the last phase the members prepare for the dissolution of the challenge group.

We sum up, we try to understand the strengths and weaknesses of the team during the challenge, the reasons for the lack of participation, a critical analysis of the strategies is carried out adopted etc. (conclusion stage).

BOINC's virtual communities fall under the classification of virtual community described by Hatch.

In fact, most of the interactions on the network take place through the media electronic (forums, sites, social networks, youtube, etc.). The communities of BOINC and the BOINC platform itself arise during a strong technological change in the our society, namely the widespread access of the internet to the masses. It is difficult to locate individually, those who offer computing power (in general they are volunteers) because the

choice on which project to develop is purely individual and therefore highly decentralized; instead it is well defined who requires computing power (i.e. researchers), "there is therefore not a single organization that produces goods or services (or offers computing power) within it, but the manufacturer or supplier is the network in its entirety" .

The advantages of the network are many<sup>88</sup>: there is the promotion and sharing of information that involves the release of decision-making power, in fact the allocation of computing power by the individual volunteer depends on his ethics (the volunteer can choose a project on the discovery of prime numbers or a project on cancer cure) and from the availability of work by projects, there is no mediation with teams. Virtual communities can incentivize projects with more effects on the quality of life, for example the administrators of a community can report more information and news on Rosetta@Home (folding of proteins) and on Minecraft@Home (which analyzes the seeds of the videogame maps Minecraft).

The decentralized network of BOINC allows for a lot of information exchange quickly and in multiple directions at the same time. Forum discussions are almost all fully accessible (for example, those for the internal communication between administrators and moderators), this allows a quick learning not only of the people who are part of the network but also of the external actors who can decide whether or not to join the network (e.g. neophyte who reads a guide on BOINC.Italy) or in any case to obtain explanations or learn complex information from guides.

If we consider Google and Amazon Web Services as traditional organizations and incumbent, we can define BOINC as a real competitor that has brought innovation in the field of data processing by creating an almost delocalized all decentralized unlike the big giants. BOINC is ultra-flexible and has

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<sup>87</sup> Cunliffe, Hatch, (2013), p. 316

<sup>88</sup> Cunliffe, Hatch, (2013), p. 317

created a new concept of organization by unhinging the corporate one and centralized by Google and Amazon. We cannot know the effects of this change in the new economy, for the long run on organizations, but, how affirmed and lived by Anderson, there can hardly be collaborations with BOINC<sup>89</sup> precisely because BOINC is an alternative to paid platforms. The data processing giants probably won't disappear, but they could undertake citizen science projects similar to BOINC.

## **2.6 La gamification**

Gamification (or gamification) is “the use of elements borrowed from games and of game creation techniques in non-playful contexts”<sup>90</sup>. They essentially come inserted characteristic elements of video games, such as points, level up, prizes, rankings etc., in contexts other than that of the video game.

As for the challenges (official and unofficial) gamification also does not exist only as part of the structure of BOINC but there are also features of gamefication created by virtual communities.

### **2.6.1 The gamification of projects**

For example, the Tn-Grid project administrator created a series of badges on the based on the total credits produced by the individual user. The scale is based on the materials and stones prezione, the higher the score the more the material is precious in fact at the first levels we find bronze, silver and gold (Figure 5) instead the maximum level is the pink diamond.

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<sup>89</sup> [https://continuum-hypothesis.com/boinc\\_history.php#vision](https://continuum-hypothesis.com/boinc_history.php#vision) site visited 10/10/2022

<sup>90</sup> <https://it.wikipedia.org/wiki/Gamification> site visited 10/01/2022



Figura 5: classifica dei primi 4 livelli della scala di badge adottata da Tn-Grid, Antonio cerrado, 2022 fonte: [http://gene.disi.unitn.it/test/forum\\_thread.php?id=130#608](http://gene.disi.unitn.it/test/forum_thread.php?id=130#608)

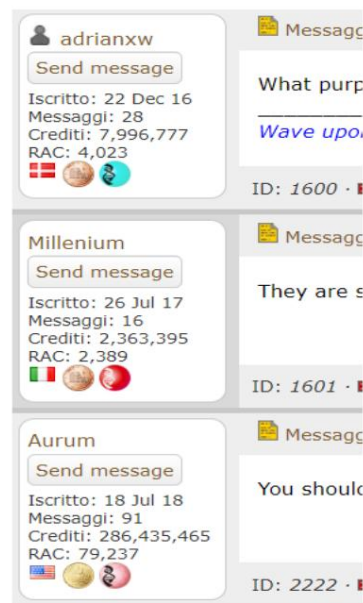


Figure 6: points system visible in the official project forum, Antonio Cerrato, 2022,

source: [http://gene.disi.unitn.it/test/forum\\_thread.php?id=130#608](http://gene.disi.unitn.it/test/forum_thread.php?id=130#608)

The badges are therefore a sort of visual classification and not just a numerical one. Visually users, with the badge system, can immediately know if a user has many or few credits on a given project (Figure 6).

Each project can decide to implement badges that do not depend on the level of the total credits. For example World Community Grid has introduced badges, for each sub-project, based on processing time. You get a badge, for each sub project, if a user processed for 14, 45, 90, 180 days and for 1 and 2 years. For the

first 14 days you will get a bronze badge while 2 years of processing yes will get the sapphire badge (Figure7) <sup>91</sup>



Figura 7: badge dei sotto-progetti World Community Grid, Didactylos, 2022, fonte: World Community Grid Wiki

## 2.6.2 Gamification and signatures on virtual community forums

Users can add a signature, a sort of personal bulletin board, under the replies in discussions on virtual community forums similar to email signatures e-mail. Within these signatures, users can collect statistics or badges accumulated over time also from different projects. Conceptually badges are not very different from military medals and decorations, from badges we can understand the experience gained over time by the user in a single project and how many projects the user participates (Figure 8) or even which challenges he has participated in and how he is ranked in internal community statistics (Figure 9). As well as medals and decorations show the experience of the military and its participation in precise

<sup>91</sup> [https://wcg.fandom.com/wiki/Project\\_badges](https://wcg.fandom.com/wiki/Project_badges) site visited 11/10/2022

military campaigns, badges show user experience and participation (and computing power) during a challenge. For example, the user zioriga has participated in a series of challenges and in some of them he placed, on the podium, al third or second place in the internal rankings (therefore not in those between teams) of BOINC.Italy, the total number of credits generated on BOINC is also shown.



Figura 8: la firma dell'utente "Kolossus" (parte inferiore) nel forum della comunità virtuale di Rechenkraft.net, ci sono per esempio i badge sia di WCG che di Tn-Grid, Antonio Cerrato, 2022, fonte: forum Rechenkraft.net, thread GPUGRID



Figura 9: firma (in basso al centro) dell'utente zioriga della comunità italiana BOINC.Italy, Antonio Cerrato, 2022, fonte: forum BOINC.Italy, thread [Thread Ufficiale] World Community Grid



## 2.7 Analysis of the BOINC.Italy virtual community

In this paragraph, the structure of the main virtual community will be explored Italian, i.e. that of BOINC.Italy.

The portal (site and forum) of BOINC.Italy officially opens on 22 December 2007<sup>92</sup>, but one of the first BOINC.Italy teams was created through the SETI@Home project il March 1, 1999, therefore between the foundation of the first teams on the various projects and the birth of the virtual community portal about 8 years pass.

The portal is made up of 8 main sections.

The first section is the home where the portal is presented and the main news (for example the conclusion of the server migration or the participation in a challenge)<sup>93</sup>.

In the second section we find articles of various kinds (scientific news, presentation articles of BOINC projects, news from BOINC workshops, etc.) written mainly by administrators, there are also more technical guides (e.g. BOINC server implementation for researchers)<sup>94</sup>.

The third section is dedicated to distributed thinking projects and distributed computing (not just by BOINC). Here we find all the useful information for: knowing the scientific objectives of BOINC projects and to access related discussions on forum, access the source codes of the various projects and scientific publications, powerpoints, reports and other documents of distributed computing projects<sup>95</sup>.

The fourth section is mainly dedicated to community<sup>96</sup> and from here you can access different social networks of the community (Facebook, Twitter, Telegram) or a messaging/communication platforms (Freenode, Liberachat). A

subsection is dedicated to initiatives outside the portal, there are for example descriptions on the improvement activities of the distributed computing pages on Wikipedia Italy, advertising campaigns or literary competitions or information on

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<sup>92</sup> <https://www.boincitaly.org/blog/annunci/15-apertura-portale-boincitaly.html> site visited on 12/10/2022

<sup>93</sup> <https://www.boincitaly.org> site visited on 12/10/2022

<sup>94</sup> <https://www.boincitaly.org/articoli.html> site visited on 12/10/2022

<sup>95</sup> <https://www.boincitaly.org/progetti/progetti-boinc.html> site visited on 12/10/2022

<sup>96</sup> <https://www.boincitaly.org/community/iniziativa.html> site visited on 10/12/2022

BOINC conferences; however, this section is not very updated and the related information on the initiatives is mainly communicated on the forum. The logos (Figure 10) and banners of BOINC.Italy97 are available in the community section (always made by volunteers) to be included in the signatures of any forum internet (to attract the attention of any new members to be recruited) and a series of prints and flyers to raise awareness of BOINC and BOINC.Italy in case of leafleting or live events98 .



Figura 10: Logo di BOINC.Italy con uomo vitruviano su chiocciola, Tommy.73, 2008, fonte: Sezione community, loghi e banner del portale di BOINC.Italy

The fifth section is dedicated to the forum. We can define this section as the beating heart of the community. The forum is structured in a similar way to the Rechenkraft.net forum, as explained in the paragraph “2.2 The virtual communities”99 . The forum is certainly an important section but, as explained precisely by the administrator Stefano Bologna (nickname "boboviz") social networks, facebook in particular, they are useful for possibly conveying people to the forum:

*“(people ed) They make requests for support on the facebook account and write posts private on the facebook account to which I reply directly saying “this thing the I know” or maybe “try to ask it on the forum that there are others” I don't know about linux I know a little bit. sabayonino (another director of BOINC.Italy ed) of work ago*

97 <https://www.boincitaly.org/community/loghi-e-banner.html> site visited on 12/10/2022

98 <https://www.boincitaly.org/community/facciamoci-conoscere.html> site visited on 12 /10/2022

99 <https://www.boincitaly.org/forum.html> site visited on 12/10/2022

*linux programmer. When there is a linux problem I say “look jump on the forum that someone replies to you”. Let's say that the forum is the nucleus, it is the heart. After there is everything that goes around (social channels, messaging, etc. ed.).”*

- Conversational interview of 04/10/2022 with Stefano Bologna, director of BOINC.Italy

The sixth section is dedicated to statistics, both worldwide and interna<sup>100</sup>. There is a list of BOINC project servers, this way users can know (with a traffic light system) which projects are active and which are not<sup>101</sup> .

The seventh section is dedicated to less technical guides, in fact they are very useful for a first approach to the BOINC<sup>102</sup> platform. In this section you can request also direct technical support via Skype or messaging channels.

The eighth section is dedicated to announcements and articles on BOINC.Italy<sup>103</sup>

### **2.7.1 The roles**

Within the BOINC.Italy community there is a minimal hierarchy to manage the portal and its activities. There are currently 3 administrators and 2 moderators.

The management is therefore entrusted to the administrators who implement certain decisions often in concert with forum users or during face-to-face meetings. To the moderators is entrusted with the task of managing discussions on the forum especially for avoid provocative topics or disputes between users.

Then there are the contacts of the individual projects. Referrers update the individual's thread project on the forum, therefore they report news regarding scientific news, news applications or solutions to problems related to the project. Currently the majority part of the referrers does not seem to be active, the role of referrers has been replaced mainly by that of administrators or general users.

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<sup>100</sup> <https://www.boincitaly.org/statistiche.html> site visited on 12/10/2022

<sup>101</sup> <https://www.boincitaly.org/statistiche/stato-dei-server.html> site visited on 12/10/2022

<sup>102</sup> <https://www.boincitaly.org/supporto.html> site visited on 12/10/2022

<sup>103</sup> <https://www.boincitaly.org/blog/annunci.html> site visited on 12/10/2022

Below each nickname, you can view the relative referent badge

(Figure 11).

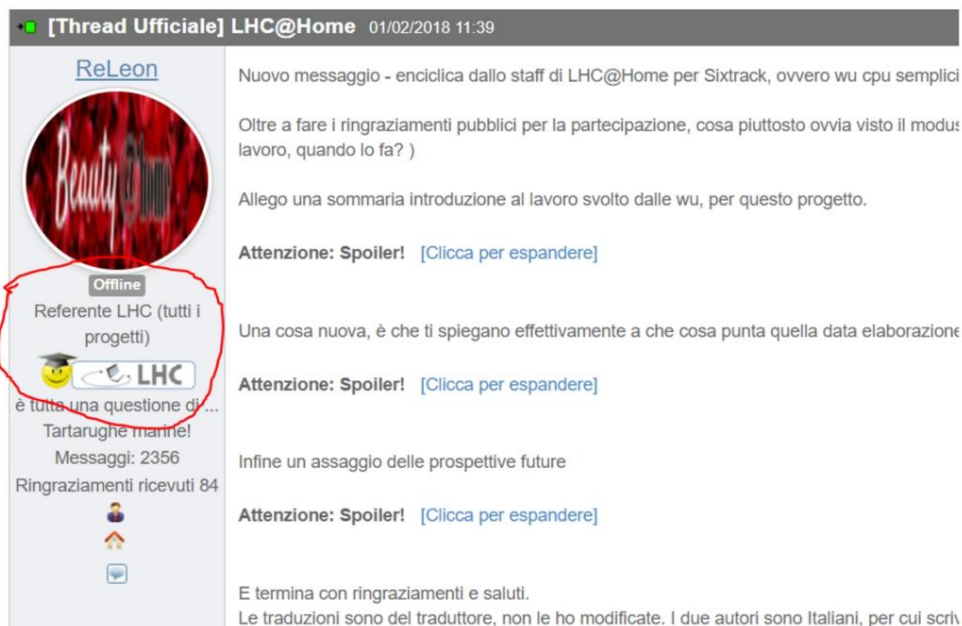


Figura 11: il referente ReLeon del progetto LHC, con relativo badge, informa gli utenti, Antonio Cerrato, 2022, fonte: forum BOINC.Italy, [Thread Ufficiale] LHC@Home

We have other portal support figures such as the glossary operator (they exist as we have seen specific terms, bunker tops, in the language of the volunteers of BOINC) or FAQs<sup>104</sup> .

## 2.7.2 The activities of the volunteers

One of the main activities of the volunteers is certainly that of donating power calculation to the various BOINC projects but it is purely a passive and almost carried out activity solely from electronic devices. Computing power donation is not the only activity.

First, the volunteers update the hardware of electronic devices, fixed PCs mainly. So there is a significant investment in hardware, in fact means buying new heatsinks, cpu, gpu, power supplies etc. Some users have

<sup>104</sup> <https://www.boincitaly.org/community/badge.html> site visited on 10/12/2022

dozens of active cpu, so it means updating, over time, PCs for hundreds if not thousands of euros.

Passive activities include participation in beta projects, therefore users (betatester) make their PCs available for projects that can cause wu invalid or in any case errors in processing but which are useful in the early stages of a project or for the implementation of a new application before distributing it to all users. Active tasks are of various nature. The simplest are the participation in virtual community forums based on your native language, if the user who knows the English language can participate in the discussions on the official forums of projects.

Among the more complex activities we have programming, for example the improve the code of a project. The boboviz admin talks about a real e own volunteering 2.0:

*“We define ourselves as volunteers. A form of volunteering 2.0, we define it like this. From an almost passive form of volunteering, which is the passive one: I install the client, I hook into a project and have the computer do everything and that's it. It has forms of more active volunteering. There are many types of holdings in the BOINC world. From the participate in the forum on BOINC.Italy, therefore in Italian. For those who know a little English, like me, participate in forums also projects. Propose yourself as a beta-tester of projects, therefore also making a car available even without having a Immediate return because often the projects test, the failure of the job is the order of the day rightly, it's beginning. So many helped, even as it happened on TnGrid, they made the source code public and a volunteer helped them optimize your code.*

*Participation is really active as the projects evolve.*

*[...] I make translations available if I know a little English. There are now volunteer programmers who are joining to improve the android app of*

*BOINC. There are many ways to participate based on your own experiences, ability, will and time.”*

- Conversational interview of 04/10/2022 with Stefano Bologna, director of BOINC.Italy

Among the other activities we therefore find the translation of texts from English to Italian for increase people engagement in Italy or localization in language

of the BOINC Manager<sup>105</sup>. Many Wikipedia entries have been created or expanded by BOINC.Italy to increase knowledge of the phenomenon also from an encyclopaedic point of view<sup>106</sup>.

The activities of the volunteers, therefore, are projected not only within the community virtual but also externally to make the world of BOINC known, for example BOINC.Italy was present with a station at the 2019 Researchers' Night at MUSE, the science museum of Trento (Figure 12).



Figura 12: partecipazione di BOINC.Italy alla notte dei ricercatori, BOINC.Italy, 2019, fonte: pagina Facebook di BOINC.Italy

<sup>105</sup> <https://explore.transifex.com/boinc/boinc/> site visited on 14/10/2022

<sup>106</sup> [https://it.wikipedia.org/w/index.php?title=Berkeley\\_Open\\_Infrastructure\\_for\\_Network\\_Computing&action=history](https://it.wikipedia.org/w/index.php?title=Berkeley_Open_Infrastructure_for_Network_Computing&action=history) site visited on 14/ 10/2022

### 2.7.3 Ranks and gamification

Gamification has been adopted not only by researchers but also by communities virtual. BOINC.Italy, in addition to the signature system, has adopted two other systems gamification: one for credits and one for the number of replies given on the forum.

The rank system is based on the number of total credits generated, the following exist gradi107:

- yes 0 to 1,000 CREDITS - Adept
- from 1,000 to 3,000 CREDITS - Runner
- from 3,000 to 10,000 CREDITS - Harvester
- from 10,000 to 25,000 CREDITS - GaussianRider
- from 25,000 to 50,000 CREDITS - WUDestroyer
- from 50,000 to 500,000 CREDITS - xth level Warrior starting from 1st and moving up level every 50,000 credits
- from 500,000 to 1,000,000 CREDITS - xth level Knight starting from the 1st and continuing level up every 100,000 credits
- from 1.000.000 to 10.000.000 CREDITS - x<sup>o</sup>level Emperor starting from the 1st and level up every 1,000,000 credits
- from 10,000,000 to 100,000,000 CREDITS - xth level God starting from the 1st and continuing level up every 10,000,000 credits
- from 100,000,000 to 1,000,000,000 CREDITS - xth level Master starting from 1st and level up every 100,000,000 credits
- from 1,000,000,000 to 10,000,000,000 CREDITS - xth level Evangelist yes starts at 1st and levels up every billion credits

The rank system has been implemented both for individual projects and for the number total credits (Figure 13). Each rank is associated with a tag that becomes of an increasingly valuable material based on increasing level.

The rank system has also been implemented for the forum based on the number of answers given in discussions.

The first levels are witty titles like “abacus” or “calculator”, while for i higher grades we have titles that rely on RAM (RAM 128 KB; RAM 256



KB; RAM >4GB etc.). There is currently no updated grade legend of the forum108 but are visible in the discussions on the forum (Figure 14).

In addition, there is also a system of thanks: if an answer was satisfactory or an intervention was particularly appreciated for its completeness, the single user can click the word "Thank you" below the signature to raise the single user's thanks counter (Figure 14).

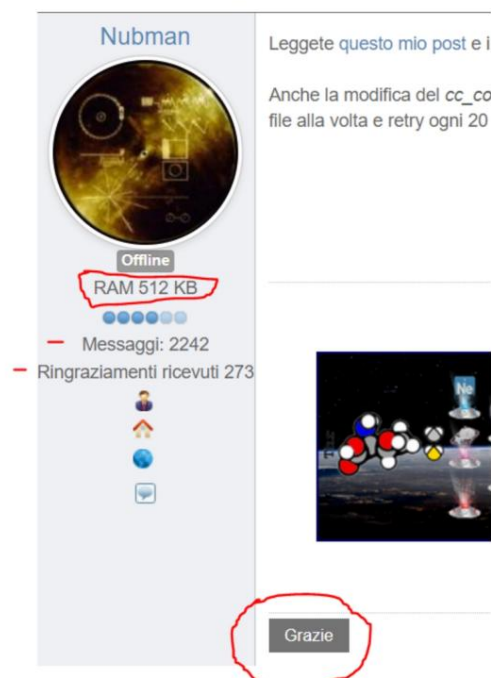


Figura 14: dettaglio del sistema dei gradi e del contatore dei ringraziamenti del forum, Antonio Cerrato, 2022, fonte: forum BOINC.Italy

#### 2.7.4 Gatherings

Among the various activities we also find the meetings of BOINC.Italy in presence. The rallies are not only a moment to address important discussions such as the

108 <https://www.boincitaly.org/boincitaly-rss/20-faq/boincitaly7/2443-i-gradi-del-forum.html> site visited on 10/14/2022

portal management, new recruitment methods, creation of gadgets etc. but also to create a moment of socialization to strengthen the ties of the group, especially if the major interdependencies happen digitally.

The first gathering, which was held in Bologna, began with a lunch<sup>109</sup> <sup>110</sup>and then continue with the actual meeting with the discussions on the activities of BOINC.Italy<sup>111</sup> .

There is a complete report of the meeting on the BOINC.Italy<sup>112</sup> forum. There participation in face-to-face rallies has decreased over time, we have gone from a first gathering with about twenty people to gatherings with less than ten participants. There Furthermore, the Covid-19 pandemic did not allow further physical meetings after 2017.

As explained by the Sabayonino administrator, both the geographical fragmentation and personal commitments have reduced the number of face-to-face gatherings, plus it gives us a rallies overview:

*“Now the events are sporadic, whether due to work or personal commitments, it's not easy coordinate and organize meetings with people who come from different parts of the peninsula, however, there are local micro-meetings with geographically close users easier to organise. Every once in a while it happens to make some. What was talked about? Among "NERD" users we talk about hardware, software and anything else accompanied by a good healthy lunch-meeting.*

*Among the site managers we mainly discuss technical problems and updates precisely the server that keeps up the forum, the donations of the volunteers who allow to stay "on", gadgets for the participants.*

*The last event organized was a visit to the Medicine Radio Telescope*

*“Marcello Ceccarelli”, in 2017 (<https://www.boincitaly.org/forum/spazio-gruppi-e-community/114373-meeting-nord-est-2017.html?start=0#123844>)”*

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<sup>109</sup> <https://www.youtube.com/watch?v=2uai9GJVrKo&t=1s> site visited on 14/10/2022

<sup>110</sup> [https://www.youtube.com/watch?v=\\_ohzBXai74](https://www.youtube.com/watch?v=_ohzBXai74) site visited on 14/10 /2022

<sup>111</sup> <https://www.boincitaly.org/blog/annunci/152-meetingitaly-tutti-i-dettagli.html> site visited on 14/10/2022

<sup>112</sup> <https://www.boincitaly.org/forum/boincitaly /29952-resoconto-discussione-meeting-bologna.html> site visited on 10/14/2022

- Email interview dated 10/13/2022 with sabayonino, administrator of BOINC.Italy

In addition to face-to-face rallies, the virtual community also organized online rallies to implement the ideas and activities of BOINC.Italy<sup>113</sup>. Communications today take place mainly through the forum, WhatsApp and Telegram.

### **2.7.5 The BOINC.Italy Challenges It**

should be highlighted how the challenges can celebrate or commemorate events or scientists who have played an important role in the scientific area of the project choice.

For example, the Italian community created, in 2013, the “Rita Levi-Montalcini memorial” to honor the important Italian scientist<sup>114</sup>. The initiative arrived at its sixth edition. The projects chosen for the challenge have a medical theme.

This is how the community explains the motivation for naming a challenge after Rita Levi-Montalcini:

*“We passionate about Distributed Computing, who voluntarily dedicate time and resources to scientific research, we believe that there is no better way to inaugurate the first BOINC.Italy Challenge, dedicating it to one of the most great scientists of our time. This great researcher has often opened the road to decisive discoveries and, thanks to its authority, it was always present in Italian public life, giving his contribution to the country in many ways e receiving in return the sincere affection and gratitude of the citizens. [...]”*

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<sup>113</sup> <https://www.boincitaly.org/blog/annunci/208-3d-meeting-online.html> site visited on 10/14/2022

<sup>114</sup> <https://www.boincitaly.org/137-uncategorised/2727-ritalevi-montalcini2013.html> site visited on 10/17/2022

The challenge also aims to make the scientist's discoveries known to the whole BOINC community, not only the Italian one, in fact the article, which celebrates the initiative, has been translated into English<sup>115</sup> and German<sup>116</sup> .

In addition to the commemorative challenges that are regularly repeated over the years, vi they can be unique challenges celebrating discoveries and anniversaries very precise. On the occasion of the 400th anniversary of the discovery of Kepler's third law, BOINC.Italy paid homage to this important scientific discovery by naming a challenge, on the Asteroids@home project, to the famous astronomer: "400 years from Kepler's Harmonic Law"<sup>117</sup>. Furthermore, in the Italian thread, a user recommended readings on the laws discovered by Kepler<sup>118</sup> .

### **2.7.6 The language of the community**

Many words used by both the international and Italian communities of BOINC are part of the lexicon of the computer science field (linux, drivers, calculus distributed, etc.) so there is not much difference between the computer lexicon used in and out of the world of BOINC.

Particular terms have appeared several times, even in this paper (such as "bunker") to describe an event, function, strategy, object, etc. for what concern BOINC world. Actually there are some terms that can have a certain valence in everyday language (or none) but have a different meaning in the world of BOINC. The bunker, for example, is a type of fortification, but in the world of BOINC it is the accumulation and release of large numbers of elaborations in a short time, a sort of insurmountable wall which, however, is of no use for defend but rather to have an advantage over the other teams in the challenges (the bunker from a means of defense it becomes a sort of means of attack). The Italian community has

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<sup>115</sup> <https://www.boincitaly.org/137-uncategorised/2737-rita-levi-montalcinieng.html> site visited on 10/17/2022

<sup>116</sup> <https://www.boincitaly.org/staff/137-uncategorised/2736--challenge-levi-montalcini-deu.html?showall=1&limitstart=> site visited on 17/10/2022

<sup>117</sup> <https://www.boincstats.com/stats/challenge/team/chat/992> site visited on 17/10/

<sup>2022</sup> <sup>118</sup> <https://www.boincitaly.org/forum/statistiche-sfide-e-traguardi/114722-challenge-keplero-asteroids-8-3-8-00-15-3-8-00.html?start=0> site visited on 10/17/2022

acquired and adapted the language, especially slang terms, from English in Italian. Many of these terms are part of BOINC's own culture.

Currently the glossary page on the BOINC.Italy portal cannot be visited<sup>119</sup> so I used "Way Back Machine" to recover some terms. The lexicon, shown below, it is still widely used by the community.

Here are some examples:

- Scaccolare<sup>120</sup>: slang for "Elaborare", "Calculate". In English, the is often used word "Crunching" which stands for "to crunch".
- Criceto<sup>121</sup>: slang and joking term for "Computer". In English it comes sometimes used the literal translation "Hamster".
- Joinare<sup>122</sup>: slang for "Join" or join a team.
- Uppare<sup>123</sup>: Jargon for "Do the upload" or send the data to the server.

Also using the Way Back Machine it is possible to recover the lexicon of the field computer science and distributed computing<sup>124</sup>, there are, for example, terms that have already been analysed such as "BOINC Manager" and "Account Manager" or basic IT terms such as graphics card, operating system, etc.

Both computer and slang terms have also been translated or adapted in other communities such as the German one<sup>125</sup>

## 2.7.7 The costs of maintaining the BOINC.Italy portal

The maintenance of the portal has a series of costs which are borne by the community BOINC.Italy.

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<sup>119</sup> <https://www.boincitaly.org/supporto/glossario.html> site visited on 10/17/2022

<sup>120</sup> <https://web.archive.org/web/20110526120656/http://www.boincitaly.org/supporto/glossario/Gergo-2/S/> site visited on 10/17/2022

<sup>121</sup> <https://web.archive.org/web/20110526120708/http://www.boincitaly.org/supporto/glossario/Gergo-2/C/> site visited on 17/10/2022

<sup>122</sup> <https://web.archive.org/web/20110526122437/http://www.boincitaly.org/supporto/glossario/Gergo-2/J/> site visited on 17/10/2022

<sup>123</sup> <https://web.archive.org/web/20110526120646/http://www.boincitaly.org/supporto/glossario/Gergo-2/U/> site visited on 10/17/2022

<sup>124</sup> <https://web.archive.org/web/20110722143428/http://www.boincitaly.org/supporto/glossario/Termini-tecnici-1/all/> site visited on 17/10/2022

<sup>125</sup> <https://www.rechenkraft.net/wiki/index.php?title=Kategorie:Technik> site visited 17/10/2022

Let's take for example the year 2021:

Cost of purchase and renewal of server + services (email, domain, etc.): €90.10

Template: € 10

TOTAL: €100.10

The costs of the portal are borne by the volunteers through the donations page<sup>126</sup>, i

There are many methods to donate (bank transfer, PayPal, PostePay, etc.).

it is also possible to donate using cryptocurrency (Bitcoin, Bitcoin Cash, Monero, Ethereum, Litecoin).

There are ad hoc fundraising campaigns to stimulate donations (eg.

“Donation campaign 2020”<sup>127</sup>

All income and expenses are collected in a single online spreadsheet accessible from the donation page<sup>128</sup>. The respective invoice.

From 2007 to 2022 BOINC.Italy raised €7,239.41 and spent €7,034.16 for maintaining the portal.

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126 <https://www.boincitaly.org/donazioni.html> site visited on 17/10/2022

127 <https://www.boincitaly.org/forum/boincitaly/115081-campagna-donazioni-2020.html> site visited on 17 /10/2022

128 [https://docs.google.com/spreadsheets/d/1bEpxvhJgGJSzEJ\\_qC5ePdDiS9131uU454nIrEf-Mng/edit#gid=0](https://docs.google.com/spreadsheets/d/1bEpxvhJgGJSzEJ_qC5ePdDiS9131uU454nIrEf-Mng/edit#gid=0) site visited on 10/17/2022

### Chapter 3 Survey with non-probability sample of the virtual community of BOINC.Italy: demographics, motivations and activities

What are the actual activities and to what extent are they carried out by the volunteers of BOINC.Italy?

To answer this question, I administered a questionnaire to the community virtual BOINC.Italy to analyze the activities carried out by the group.

The sampling performed is non-probability and the sample is self-selected.

It is almost impossible to define a population for two main reasons: there is no one single team (there is a "BOINC.Italy" team for each project) and the virtual community is very fluid so it is impossible to determine who is actually part of the community and who is not (for example in the month of September there were 40 accesses from of 40 different users).

The population of BOINC.Italy, taking into account only the BOINC.Italy portal and not the individual teams, is equal to 3896 users<sup>129</sup> (Figure 15).



3896	Offline		stefano17	0
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Pagina: 1 ... 121 122 123 124 125 126 127 128 129 130

Forum > Profilo > Lista Utenti

Tempo creazione pagina: 0.20'

Figura 15: Numero totale degli utenti, Antonio Cerrato, 2022, fonte: lista utenti del portale di BOINC.Italy

<sup>129</sup> <https://www.boincitaly.org/forum/profilo/list.html?start=3870>

Some users may have created more than one account. Also some users have created an account on the BOINC.Italy portal to be active only for a few days.

Other volunteers may only follow the Twitter or Facebook account of BOINC.Italy by participating only in discussions on social networks.

The questionnaire was published on the BOINC.Italy130 forum. The administrators they independently published the questionnaire both on their telegram channel and on their Facebook page131 .

The number of respondents was 21.

The questionnaire and data processing can be consulted through the link in the following note132 or in the "Data and processing" section at the end of the processing.

The first question of the questionnaire concerns the age of the volunteers

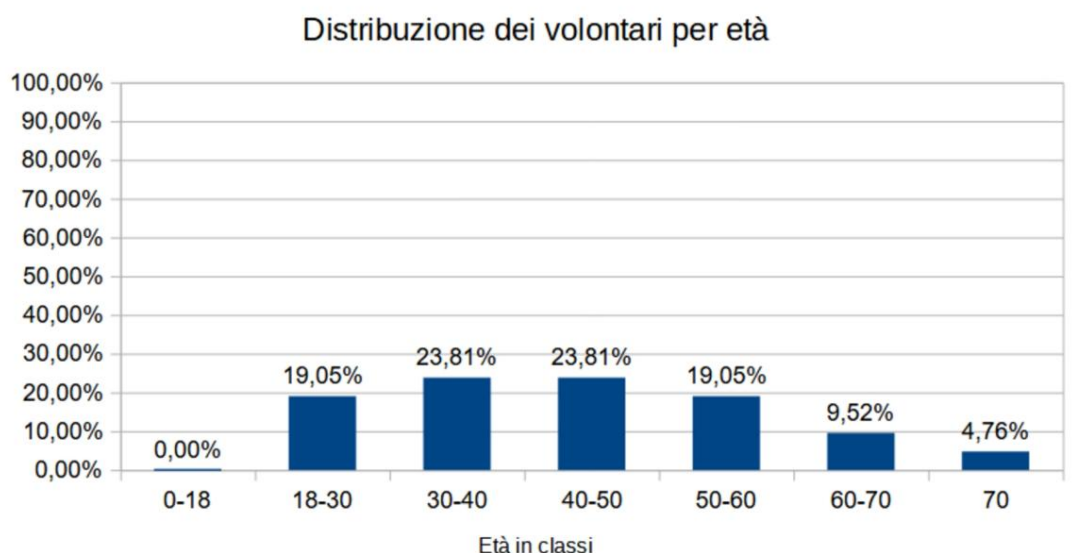


Grafico 1: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

130 <https://www.boincitaly.org/forum/boincitaly/115265-questionario-per-il-team-di-boinc-italy-tesi-magistrale,-corso-app,-unimi.html#137937> website site visited on 10/15/2022

131 <https://www.facebook.com/boincitaly/posts/pfbid02wQSRf41L5vZTSXe3NLkNtc95GCUMyCNsJX9NKBBoED6bCuUyHjgWftQ6qpYuWdABPI> site site visited on 15/10/2022

132 <https://docs.google.com/spreadsheets/d/1xschMGjrJog714kFZeGvwro4vgfKAxc-L5ykhFM5fAo/edit?usp=sharing>



As you can see (Graph 1) BOINC.Italy is not frequented by minors but it is frequented above all by people between the ages of 30 and 50 (47.62%).

As regards the gender of the respondents (Graph 2), we can note a low participation of women, while participation by men is a lot high. It is currently not possible to determine the cause of low participation of women to distributed computing, probably the causes are to be found not in the platform itself (there are no entry barriers for the genre) but the causes may be exogenous.

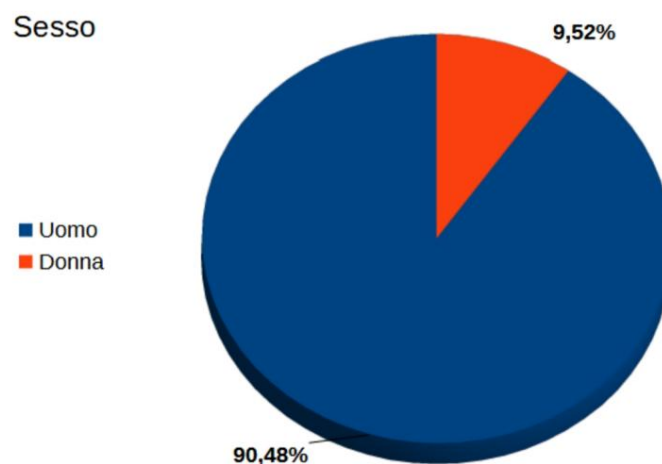


Grafico 2: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

Respondents were asked for the qualification obtained (Graph 3)

We can see how compared to the ISTAT 2011133 census, the volunteers of BOINC.Italy have a higher education qualification than the Italian average. None of respondents have an elementary school diploma as their highest educational qualification; most of respondents have a secondary school diploma and form the 57.14% of respondents, while graduates (three-year degree and master's degree or a single cycle) are 33.4% of respondents. As with the average license, there are none PhD volunteers.

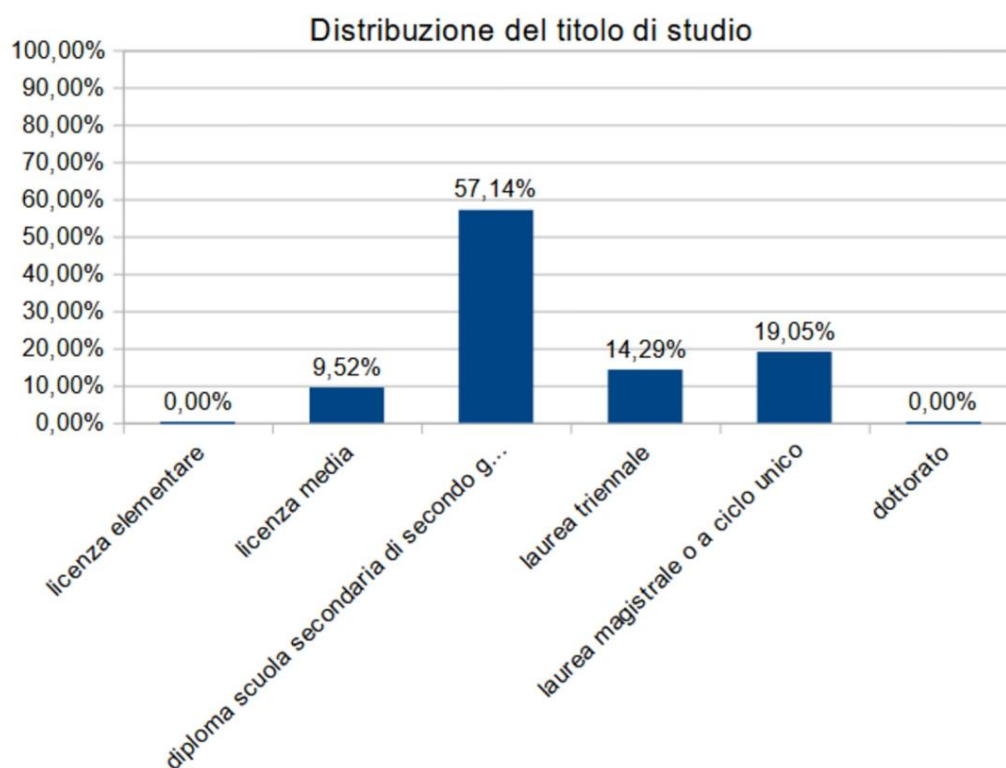


Grafico 3: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

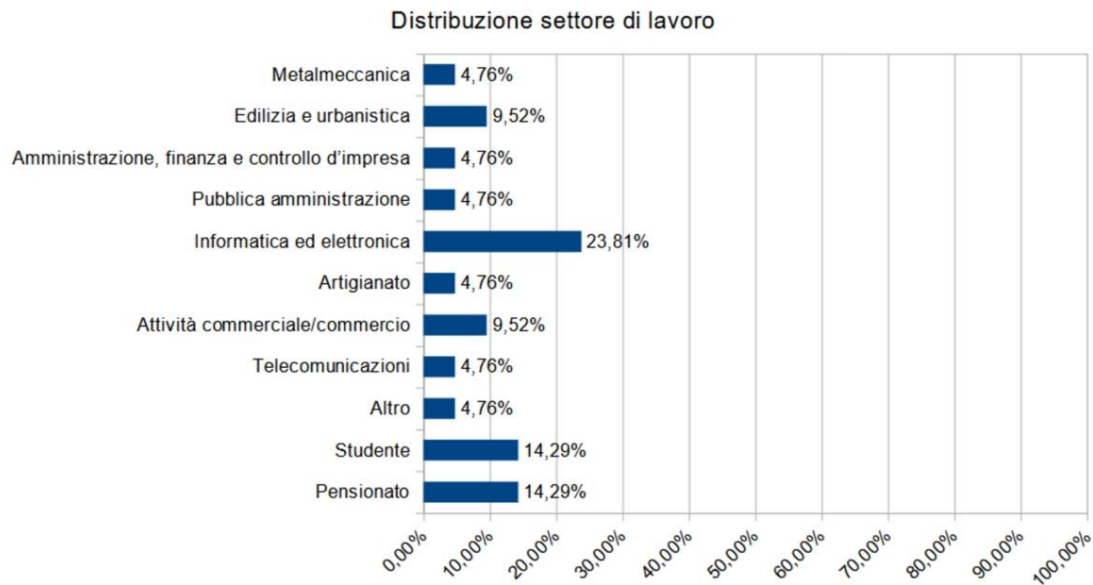


Grafico 4: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

As regards the profession (Chart 4) we can see that 23.81% of respondents work in the field of information technology and electronics, 14.29% of respondents consisted of pensioners and 14.29% were students. The passion for information technology could be one of the variables influencing the decision in the participate in distributed computing, not surprisingly distributed computing, first on SETI and then on BOINC, it starts to catch on right in the early years of usage expansion of the internet.

Respondents were asked what are the main motivations for supporting the distributed computing. Respondents could choose up to a maximum of 3 answers, no user has decided to enter a further answer to those presented.

As we can see (Graph 5) all respondents selected "I want help in the progress of scientific research", 3 users selected the option of socialization. Even the challenges don't seem to have an impact on motivation towards distributed computing.

Only one user selected the "earnings through cryptocurrencies" option. TO BOINC can be hooked an Account Manager which allows you to get a cryptocurrency (Gridcoin) through the credit system (this cryptocurrency will come briefly described in chapter 4 to understand the views of the volunteers and the researchers).

The main motivation is undoubtedly to help researchers in the elaboration of data.

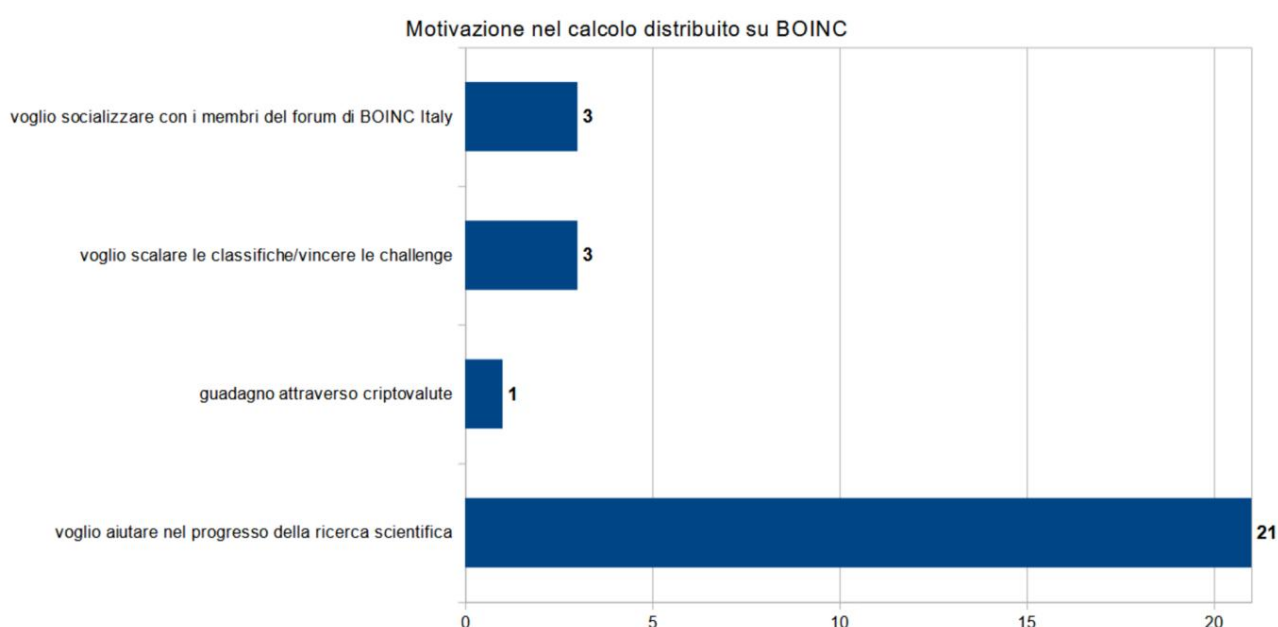


Grafico 5: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

It was also asked, with an open-ended question (question n. 6), what they are were the reasons that led to support distributed computing and research scientific. Several answers have been given. Summarizing the opinions it emerged that the scientific progress helps the whole community and increases the common welfare. 2 users have signaled that they have joined distributed computing in order not to keep les idle Unused CPUs or to make the most of old PCs. 1 user points out that the resources for scientific research are scarce by the state why it is

merged with BOINC. Another user explains that he has decided to donate computing power because he would have liked to undertake scientific studies if he could.

The main motivation is therefore scientific research but with different nuances ranging from philanthropy to optimizing CPU usage.

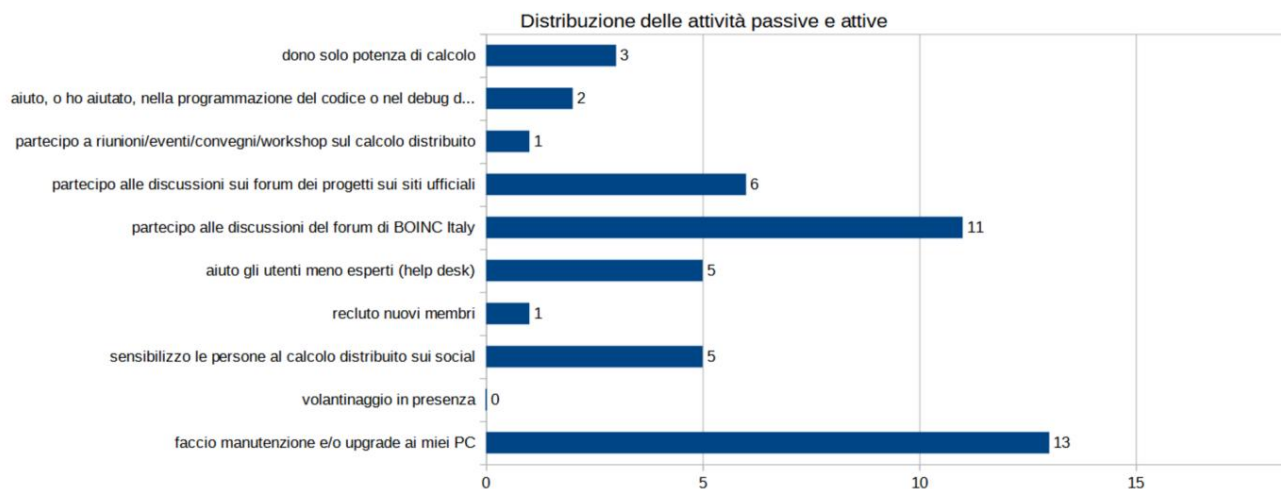


Grafico 6: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

The champion was asked what activities are done in addition to donating power of project calculation.

13 users maintain and upgrade hardware to improve or optimize the power of your PC or to donate more computing power.

11 users participate in the discussions on the BOINC.Italy forum while only 6 users participate in discussions on project sites (probably because of the barrier linguistics). A small minority of the sample carries out help desk activities helping other users with problems with the software. 2 users help debugging and coding computational projects.

Clearly for these latter activities you need to have computer knowledge advanced.

Active recruitment of new members is very low as is participation in ads events in attendance while the leafleting has not been selected by users (probably also due to the recent pandemic). The activities are done mainly through electronic devices and at a distance.

3 users, on the other hand, declared that they did not carry out any of the activities listed, but to donate only computing power. These 3 users only perform passive activities with very little interaction with the Italian community.

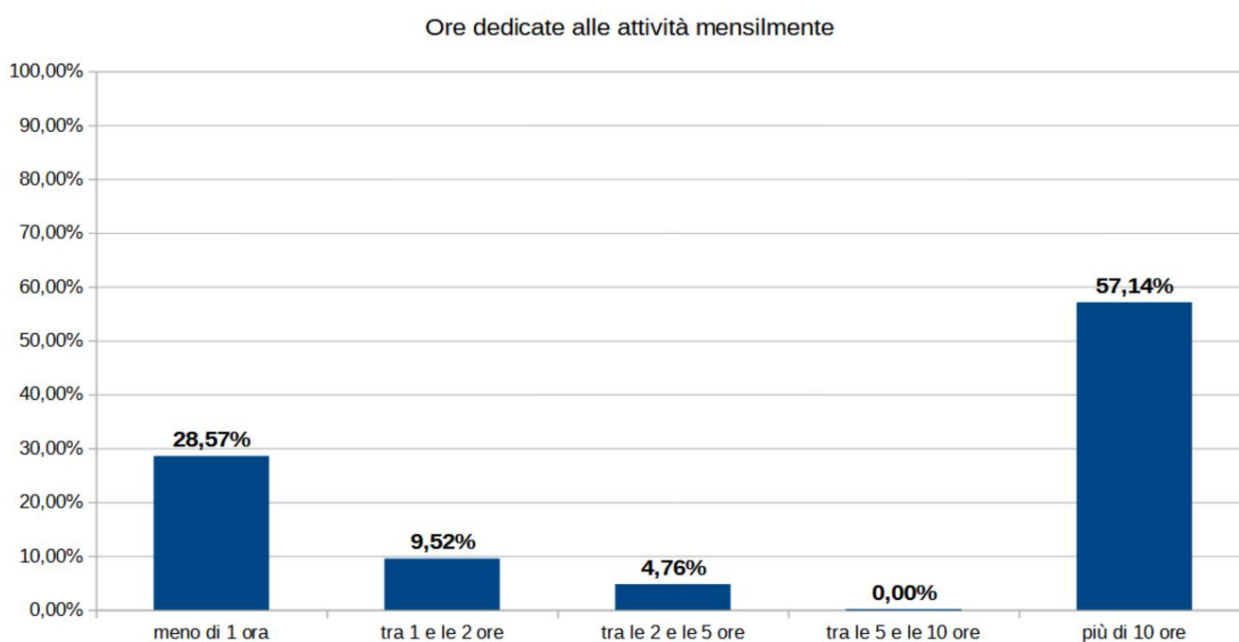


Grafico 7: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

For the hours dedicated to BOINC activities each month (the passive donation of computing power) (Chart 7) we can note two main ones groups of volunteers: an average group dedicates a few hours a month to the activities (maximum 2 hours) and is equal to 38.09% of the sample; while another group, 57.14% of the sample, spend more than 10 hours a month volunteering on distributed computing. A small percentage, 4.76%, dedicates between 2 and 5 hours per month to activities related to

distributed computing. Essentially we can divide the virtual community of BOINC.Italy into two groups, one is formed by very active users and the other by users inactive.

N.b.:

\* Questions 10 and 11 of the questionnaire will be analyzed in chapter 4 while the answers of question 12 will be useful for some food for thought in chapter 5

## **Chapter 4 The role of researchers and their relationship with volunteers. The function of companies in the BOINC network**

Also the researchers-administrators have a very important role in the network of BOINC. They are the ones who ask for computing power and who set ed times project goals. They take care of the communication of the forums and announce the results scientists to volunteers also collaborate with public and private bodies.

The contribution of enterprises to distributed computing on BOINC will also be analysed, in particular IBM's World Community Grid project will be described.

Volunteers and the administrator of the Italian Tn-Grid project were asked for theirs point of view on various issues related to distributed computing through interviews discursive or email interviews.

N.b.:

\*Full interviews are available via the section "Text files, video files ed audio, data and processing" at the end of the report or through the link in the following note<sup>134</sup>

### **4.1 BOINC projects in the Italian academic world, the types of projects and the causes of underutilization of BOINC in Italy**

BOINC is still an underused tool in academia, and in particularly in Italy it is a little-known platform. There is currently only one active Italian project/container, Tn-Grid, which in turn hosts the gene@home project.

There are two other Italian projects that have achieved their goals or have had trouble creating it. For example the project of the University of Catania had a very short life, while the SIMONE@home project, a project by a PhD student at the University of Milan, he has had good success since shorten the research times that the PhD student had set.

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<sup>134</sup> <https://drive.google.com/drive/folders/1QQuGK7dle8aEI9Dg9uBIPz3aWqGcsvru?usp=sharing>



#### 4.1.1 SIMONE@home

According to the BOINC.Italy portal, SIMONE@home's goal was to carry out “a research in the medical field that allows us to deepen the determination computational analysis of the free energy change for a transformation, in particular of an unfolding process of a small polypeptide”<sup>135</sup> .

The cost of the project was less than 500 euros. He allowed the PhD to save a lot of time as admitted by the administrator of BOINC.Italy:

*“That's the classic project that I call "doctoral" [...] there are doctoral students that, to carry out the doctoral thesis, need computing power. Viva god then, either your university or your research center has the power of calculation, and he doesn't always give it to you, or do as Simone did who did a spot project. He got a computer at his house, not even a very powerful computer. This is another thing you can do. He did the project. His was done server at home and from his home he distributed work which then returned to him. [...] He did the doctoral thesis with a homemade BOINC project, in the true sense of word: inside his house. [...] Here this is another very strange thing, that is who is who he thought "can I do a research, a scientific project at home?". [...] At the start there were 5 or 6 of us, then he opened it to a hundred people and its adsl line of home was a bit under stress but within 4 months he brought home the result. “*

Interviewer: “So with less than 1000 euros, he will have created ... (ed.) a project BOINC)”

*“Much less, much less than 1000 euros. It was an 8 core, with 16GB of ram or maybe even less, 8 GB of ram.*

*He was very pleased, he said “if I had to wait to get in line for applying to the university, the time machine” ... the days went by. Of course then*

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<sup>135</sup> <https://www.boincitaly.org/staff/137-uncategorised/1857-simonehome.html> site visited on 22/10/2022

*he got his PhD and closed the project. But also many abroad. . . i them  
I call doctoral project. They last 3, 4, 5 (ed months) that is, they are temporary, but it is not  
a problem. We're still helping someone in need, meanwhile. We are  
doing science and there is no problem. [...] We do not discriminate between you  
you're Berkeley or you're the last faculty [...] even better. [...] If you are small and need  
help even better.”*

- Conversational interview of 04/10/2022 with Stefano Bologna, director of  
BOINC.Italy

#### **4.1.2 Tn-Grid**

Tn-Grid (Trento Grid) is a container of BOINC projects. It currently hosts the  
gene@home project whose goal is to find causal relationships between genes. The algorithm  
of gene@home amplifies gene regulatory networks (or GRNs) that usually  
understand correlations between two genes. Gene@home aims to estimate possible relationships  
between a list of new genes and the already known gene regulatory network<sup>136</sup> .

The initial goal of Tn-Grid was to create a container for projects based on  
BOINC, for Trentino-Alto Adige therefore not only for the University of Trento  
but also for other entities. It is currently involved, among the universities, only  
the University of Trento.

The institutions involved in the platform (and in gene@home) are the following: University of  
Trento, Department of Information Engineering and Computer Science (DISI),  
Department of Cellular, Computational and Integrative Biology (CIBIO), Fondazione  
Bruno Kessler (research institution of the Autonomous Province of Trento, which deals  
mainly of computer science and physics), the Edmund Mach Foundation (a body that yes  
deals with research in the field of biology) and the Trento Research Area of  
National Research Council of Italy.

To simplify, the CNR and the University of Trento take care of the infrastructure  
computer science and BOINC's science applications writing. The foundation

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<sup>136</sup> <https://gene.disi.unitn.it/test/genehome/en/description/basic-description.php> site visited on 23/10/2022

Edmund Mach is responsible for providing the biology gene datasets and CIBIO provides the human gene datasets; both analyze data processed by volunteers.

Currently there is no researcher or PhD student who deals only with Tn-Grid, since there are no resources to dedicate solely to the BOINC project, therefore the working hours on Tn-Grid are part of the hours devoted to scientific research job description of technical collaborators and researchers. The people directly involved in Tn-Grid there are about ten, not counting students and PhDs that they have been involved over time.

We can therefore define the research group as a task force.

#### **4.1.3 The costs of Tn-Grid**

I estimated the costs of creating a small project for the BOINC platform taking Tn-Grid costs as an example.

For the hardware part, Tn-Grid uses a virtualized machine with 4 cores and 4 GB of RAM. A similar machine has a very low cost (about 300 – 400 euros) and it is only a one-off initial cost.

Electricity, broadband and storage costs are covered by the university.

Being very low costs we can define them negligible. Wishing anyway calculating these costs, for a natural person and not for a public body, would be the following:

- data archiving: 100 euros per year for 2 tera of archiving, taking into consider the services of Google<sup>137</sup> -

the cost of a fiber optic internet line costs around 25 euros per month <sup>138</sup>, therefore 300 euros per year

- the electricity cost for a quadcore server is around 100 euros per year

Electricity, internet line and storage would cost around 500 euros a year.

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<sup>137</sup> <https://one.google.com/about/plans?hl=it> site visited on 24/10/2022

<sup>138</sup> <https://offer-internet.it/fibra-ottica> site visited on 24/10/2022

So for the first year, the BOINC project would cost 900 euros. Years subsequent only 500 euros per year (the cost of maintenance is negligible).

The major cost could be related to human capital if Tn-Grid had a team or a researcher as personnel dedicated to the distributed computing project only, but the scientific production of Tn-Grid falls within the working hours dedicated to research.

For example, in the event of the introduction of a new application, they can be dedicated even 10 days of work, while in the case of ordinary management the working hours are yes substantially reduce having to monitor the progress of the project.

A researcher in Italy, on average, receives a salary of around 39,000 euros<sup>139</sup> therefore the main cost of a small-medium BOINC project is linked above all to any staff dedicated solely to the BOINC project.

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<sup>139</sup> [https://www.payscale.com/research/IT/Job=Research\\_Scientist/Salary](https://www.payscale.com/research/IT/Job=Research_Scientist/Salary) site visited on 24/10/2022

## Stato di elaborazione

Lavoro		#	Utenti		#
Tasks ready to send		6590	With credit		3235
Attività in corso		55008	With recent credit		868
Workunits waiting for validation		1	Registered in past 24 hours		2
Workunits waiting for assimilation		11	Computer		#
Workunits waiting for file deletion		0	With credit		62811
Tasks waiting for file deletion		0	With recent credit		<u>5802</u>
Transitioner backlog (hours)		0.00	Registered in past 24 hours		31
			Current GigaFLOPS		<u>29924.66</u>

Attività per applicazione				
Applicazione	Non inviato	In corso	Tempo di esecuzione delle ultime 100 attività in ore: medio, minimo, massimo	Utenti nelle ultime 24 ore
gene@home PC-IM	6590	55008	4.12 (0.07 - 98.67)	478

Figura 16: Potenza di calcolo registrata il 24 Ottobre alle ore 17:45, 2022, Antonio Cerrato, fonte: stato del server Tn-Grid [http://gene.disi.unitn.it/test/server\\_status.php](http://gene.disi.unitn.it/test/server_status.php)

Computing power, in general, comes at a cost. If the volunteer computers on Tn Grids have a computing power of approximately 30,000 GigaFLOPS (Figure 16) we can convert and approximate this power to about 6,000 CPUs ( 1 CPU Intel(R) Core(TM) i7 = 5 GigaFLOPS<sup>140</sup>).

The cost to activate 4 CPUs (on Milan), based on the prices offered by Amazon EC2, is equal to about 0.15 dollars per hour<sup>141</sup>, therefore about 1,300 euros per year.

The same computing power as Tn-Grid would cost around 1,950,000 euros a year, but thanks to the volunteers it is a cost of 0 euro.

<sup>140</sup> [https://setiathome.berkeley.edu/cpu\\_list.php](https://setiathome.berkeley.edu/cpu_list.php) site visited on 10/24/2022

<sup>141</sup> <https://aws.amazon.com/it/ec2/pricing/on-demand/> site visited on 10/23/2022

#### 4.1.4 The algorithm: generic or specific?

We can distinguish two types of projects based on their duration. The first type, very useful for doctoral research, lasts a few months and does not need to particular computing power. The second type of project has a duration of medium-long term and needs a lot of computing power.

The temporal distinction also depends a lot on the type of algorithm adopted; in case of generic algorithm the algorithm can be applied to many datasets and therefore the project can have a long duration, in case of specific algorithm they can use a few datasets and probably only those created by the research group therefore the computing power to be used is minimal because the calculation is short-lived:

*“To have serious use of BOINC or you have a very generic algorithm, like folding of a protein, which has a very generic algorithm that you can run on n-thousand protein forever, okay? [...] Or very basic algorithms. In that case there it is useful, research groups often don't have this kind of need here. [...] Our algorithm (gene@home's ed) works because it's a very algorithm generic, that is, it is an algorithm that practically searches, in a slightly stronger way than what is the concept of correlation, of finding causal relationships between variables. We we apply this to genetic datasets, however everywhere you have a set of variables with gods experimental values you can apply those algorithms there, so you can apply it also to humanistic, financial data.”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

#### 4.1.5 Why is BOINC little used in Italian universities?

As regards the use of BOINC in Italian universities, there would be three causes for its low usage: Research groups with BOINC get too much computing power, there is a fear of changing the method and/or approach to research and in overall there is rudder in change and ultimately there are few career options in case of multidisciplinary scientific publications.

For the first cause in the case of short-term scientific research calculations, it is convenient use university or research center resources. The cost, in terms of cost opportunity, for the creation and implementation of the BOINC server and the project (simplifying: server creation, algorithm writing, site creation, involvement of the first volunteers etc.) is initially high and then in case of calculations short it is better to use computing power within the institution to which they belong or buy it on the market.

*“The problem with using BOINC is that, BOINC dramatically increases the computing power you have available. So BOINC is of no use in solving the research group problem that has a bill to do and takes 2 months. Why that bill to do, which takes 2 months, with BOINC you do it in 1 day. Less into reality, but then between realization and everything. What if you have nothing more to do? What are you doing? That is, there is overhead to put up a BOINC system and to adjust the algorithm, check if the algorithm at least has checkpoints, if there is a pattern of validation that doesn't exist, which maybe isn't necessary if you do it on machines let's say that you trust. And so too fast a count in the end is meaningless, wait for these two months and over. It's much more efficient. Starting at par probably perhaps arrives account first without BOINC.”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

So researchers should evaluate whether a lot of power is actually needed computational or not. The result of the decision is based on the economic concept of “make or buy”<sup>142</sup> .

Researchers should consider buying computing power or using machines of the institution (buy) if:

- the algorithm is very specific, so it cannot be used in other contexts research (so you need little computing power)
- contracts to buy computing power do not contain many clauses against the research groups and therefore there is no actual situation of opportunism on the part of the supplier (holdup problem<sup>143</sup>), for example: increase in the price of CPU over time based on any maintenance costs
- the search requires little power but must be continuous, constant and based on the need of the researcher
- the calculation times are very short and short-term (less than 4 - 6 months)

Research groups should consider creating a BOINC project (make) this :

- the algorithm is generic and reusable
- provide for short and medium term calculations (4 - 6 months minimum)
- a lot of computing power is needed for the research question
- low budget to allocate to hardware
- they can devote part of their time to communicating with volunteers

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<sup>142</sup> Besanko D., Dranove, D, Shanley M., Schaefer S., (2017), *Economia dell'industria e strategie d'impresa*, pp 119 - 155

<sup>143</sup> Besanko D., Dranove, D, Shanley M., Schaefer S., (2017), *Economia dell'industria e strategie d'impresa*, p. 147



A second cause is in the search paradigms. Research groups tend to they innovate little in their research models<sup>144</sup> because they already produce a good number of scientific publications:

*“Plus there's a fairly strong inertia in the research that we essentially say i established groups tend to put together, we call it “the paper mill”, one scheme in which many publications are made because your career and your ability to raising funds is proportional to the number of publications you have. [...] People tends to be conservative in its search patterns.”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

The third cause is multidisciplinary which means, for a researcher, having to publish scientific articles not in a single journal but in multiple journals. This entails not having numerous scientific publications in a single field but many publications divided into several sectors (and therefore in several journals). It could be a strong one entry barrier for those wishing to use BOINC. So the researchers, for reasons career, they cannot divide their publications in several journals.

*“Multidisciplinary today is not even very profitable today because, to me the scientific career is of no interest, but if you choose the scientific career you must choose a sector, from those of the Miur, and you have to publish in magazines that belong to that sector over there. That is, my publications are in completely different sectors from each other and therefore do not count. They count for very little. [...] If you are a physicist which also does computer science aspects, or you publish only in physics journals or only in journals information technology. If you do it on both, when you submit your resume for a*

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<sup>144</sup> Corbetta P., (2020), Social research: methodology and techniques. The paradigms of reference, p. 13

*competition, you have to choose one of the two. This mechanism makes it difficult move around, right?"*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

#### **4.2 Communication between researchers and volunteers**

Users can be informed of individual project developments in various ways.

Surely one of the easiest ways to communicate with users is through the section "Notices" from the BOINC Manager. Here are essentially the messages of notice of the home of the individual projects.

The same notice is published in the "News" section of the project forum.

Notices, or minor communications, can also be published on social networks network as in the case of Rosetta@Home.

In fact, the Rosetta@Home Twitter page retweeted, for example, a post of the Institute for Protein Design announcing entry into phase 3 of experimentation of the vaccine to counter the Covid-19145 .

The vaccine was obtained, in part, thanks to the computing power of volunteers BOINC (in July 2022 South Korea purchased a batch of 10 million doses<sup>146</sup>).

As we saw in Chapter 2, virtual communities are also engaged in communicate notices and news on the progress of projects through the various virtual community forum discussions; think for example of the referents of projects for the BOINC.Italy community.

In some cases there has not always been a particular attention in the communication from part of the administrators-researchers of the projects. For example, the Rosetta@Home twitter account was inactive from April 5, 2017<sup>147</sup> to March 18, 2020<sup>148</sup> (about 3

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<sup>145</sup> <https://twitter.com/UWproteindesign/status/1520106011830366208> site visited 10/18/2022

<sup>146</sup> [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=15029#106480](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=15029#106480) site visited 10/18 /2022

<sup>147</sup> <https://twitter.com/RosettaAtHome/status/849721992202924032> site visited 10/18/2022

<sup>148</sup> <https://twitter.com/RosettaAtHome/status/1240174183595659264> site visited 10/18/2022

years of inactivity). Fortunately, warnings on the forum are much more frequent, in the the same period there were 24 notices/scientific news on the project<sup>149</sup> .

#### 4.2.1 Communication management

Often the lack of communication from researchers creates a sense of frustration and abandonment by volunteers who devote cycles of computing and the own free time to BOINC projects.

It may happen that there are server malfunctions but, in some cases, these malfunctions are not communicated on the site and often volunteers point it out this lack of communication.

For example, at the end of October 2021 there were problems with the project Rosetta@Home.

The user "Sid Celery" reports, on 27 October 2021 (20:13:19 UTC), that the project was stopped for a quick change in the filesystem, also the feeder (a of the server) of Rosetta would seem not to work<sup>150</sup>. Other users start reporting further problems, for example the number of processes that must be validated by the server begin to be much higher than the number of processings which have already been validated.

On October 31st the TSD user loses his patience and begins like this "As usual there is no information about what is happening. I don't know what I am doing here<sup>151</sup>" that is "As usual, no information on what's going on. I don't know what's there I do here" (meaning it could donate computing time to projects they have actually processing to be distributed to volunteers instead of waiting for any elaborations on Rosetta).

After which the user announces his/her departure from the BOINC platform to join to the platform, also of distributed computing, Folding@Home.

Another user, Bryn Mawr, tries to minimize the problems<sup>152</sup> .

<sup>149</sup> [https://boinc.bakerlab.org/rosetta/forum\\_forum.php?id=202](https://boinc.bakerlab.org/rosetta/forum_forum.php?id=202) site visited on 10/18/2022

<sup>150</sup> [#103032](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103032) site visited 10/18/2022

<sup>151</sup> [#103067](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103067) site visited 10/18/2022

<sup>152</sup> [#103069](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103069) site visited on 10/18/2022

Again the TSD user points out to the user Bryn Mawr that he is not interested in the credits and that he doesn't want weekly updates but updates every 5 weeks would be enough for him<sup>153</sup>.

Another user, [VENETO] boboviz, with a certain amount of sarcasm, replies to two other users that for him an update every 5 months instead of every 5 weeks would be enough<sup>154</sup>, emphasizing how updates on problems or on the novelties of the project are few and after a long time.

The wu validation problem would seem to have been resolved on November 2nd, as announced by user Grant (SSSF)<sup>155</sup>. Meanwhile, no administrator-wanted replied to the technical problems thread, in fact there was no reassurance towards users (who meanwhile continued to make hardware available, with the related costs in energy terms, totally free) or the notice of a technical problem with the server.

10 days later, on November 12, there are new server problems and it comes always announced by a user and not by an administrator<sup>156</sup>. Le wu that volunteers processing via virtualbox would seem to have numerous problems, and none researcher informed users of any problems.

Also the user boboviz, on November 14, declares "I hope that ALL of these problems with virtual wu will, however, contribute to strengthening the research science of the project. But it's clear that they have a LOT of trouble interfacing with i volunteers"<sup>157</sup>. Meanwhile, more experienced users have recommended ways to solve the problem. On November 15, two more users leave the Rosetta project for unirsi a World Community Grid e a Tn-Grid.

On November 16, user Jim1348 scolds researchers and project administrators because the only result is wasted users' time<sup>158</sup>

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153 [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=6893&postid=103070#103070](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103070#103070) site visited on 10/18/2022

154 [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=6893&postid=103072#103072](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103072#103072) site visited on 10/18/2022

155 [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=6893&postid=103087#103087](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103087#103087) site visited on 10/18/2022

156 [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=6893&postid=103178#103178](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103178#103178) site visited 10/18/2022

157 [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=6893&postid=103279#103279](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103279#103279) site visited on 10/18/2022

158 [https://boinc.bakerlab.org/rosetta/forum\\_thread.php?id=6893&postid=103349#103349](https://boinc.bakerlab.org/rosetta/forum_thread.php?id=6893&postid=103349#103349) site visited on 10/18/2022

Meanwhile, no researcher or administrator has revealed himself in this period of time, only the most experienced users have tried to ease the tension.

One of the administrators of Tn-Grid, currently the only Italian project on BOINC, explains how communication is a fundamental factor for the maintenance of a project, for the aggregation of users on the forum and above all on the calculation:

*“Communication is key. [...] You know how it is, don't you? Problems can always happen, it's obvious isn't it? Then a system administrator or a researcher system or one inside the system who simply says “look what we have problems, we don't know when we'll fix them” this works a hundred times better in terms of maintaining rapport versus saying nothing.*

*[...] Tell the truth. To say that simply that there are problems, in fact that*

*What I don't understand are forums where people ask questions and nobody answers. [...]*

*It seems that they go by inertia (ed referring to other projects), it's a thing of volunteer, right? When one participates in volunteer stuff, and put that you already*

*Do you want to participate in BOINC, why do you choose this project? Well, for a thousand reasons that in the end, they are the same reasons why you decide if you want to give six pennies to an NGO that deals with social and you decide one, that is, money is limited right? What are the criteria? Among the criteria there are also, so to speak, criteria given by the communication. Meaning what*

*what do I know, I give money to Emergency and Emergency sends me a papyrus every year which he explains to me, by line and by sign, where he spent the money. [...] It seems to me a factor important. [...] Communication is fundamental.”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

Users can also help administrators with problem management communication. The discussions are many and clearly the time of the researchers is

limited, so the researcher-administrators have to decide which threads answer and which ones not, moreover it is not certain that they are able to identify the problems before of users (the users participating in the project forums are dozens if not hundreds, while researchers are clearly fewer).

Again the administrator of Tn-Grid explains the role of users in the management and communication on the Trentino project forum:

*“Often (users' note) they notice that something is wrong, they warn me like “look that the server is down”. Yes, they are useful. For example, they often solve problems for me of communication that is in the sense. As I am convinced that the part of communication is important to keep, in short, the volunteers a little tied to project sometimes the volunteers ask questions which, however, are answered by others volunteers. This saves me time to give the answer. [...]*

*There's been a whole talk between users lately about whether it's more useful from the point from an energy point of view, use FMA applications rather than those without SSE2. That speech there that was interesting but they carried it forward in the user group, I didn't have to intervene.*

*Often, let's say, answers are given, I'll give a trivial example. There is a user who he protests [...] he says “but what, you act as user of the day someone who hasn't been for 7 years doing nothing for the project” this is something BOINC really does. I have gave a first reply, 8 august, then at some point this AnandBhat has explained everything and so on. Practically it was more exhaustive, that is I could have done it too, but he explained well how the system works.”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Institutions at CNR-IMEM, branch office in Trento

Again we can see an example of citizen science in the citizen science: having to continuously respond to users would be costly in terms of

time, especially in projects with few administrators, therefore more expert users they help researchers by answering other users' questions without waiting for one official answer or expanding on the researchers' answer. This results in savings time for researchers who can invest the same: in answering the questions more complex, in alerts or research activities. It must be borne in mind that i researchers, in effect, manage virtual communities similar to team admins.

#### **4.3 Gridcoin: is it ethically right to earn from volunteering? The point of view of researchers and volunteers**

Gridcoin is a cryptocurrency from the world of BOINC. It is not an official cryptocurrency, that is, it was not conceived by the University of California, Berkeley or by Anderson but it was created by a third party. Gridcoin was officially launched on October 16, 2013 by Rob Halförd<sup>159</sup> (nickname of Gridcoin creator whose identity is currently unknown).

Essentially volunteers are rewarded with this cryptocurrency based on their contributed via calculation within the BOINC platform.

1 Gridcoin (GRC) is worth around \$0.01160 and the value of the cryptocurrency is stable around that dollar value.

Users can mine currency alone or in a group (called a "pool").

Gridcoin has had a significant impact on virtual communities. BOINC was born as a tool of volunteering but today it is also a way to earn. Gridcoin had no effect negatives on research, indeed large cryptocurrency teams/pools have made it stable the supply of computing power.

*"If you look at the statistics (Tn-grid's ed) among the top participants apart from Helmut [...] and Technologov [...]. In terms of history, the 3 gridcoin pools and the 2 charity engines they are the ones with the highest total credit because they are constant, maybe they don't have peaks*

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<sup>159</sup> <https://gridcoin.us/wiki/> site visited on 10/23/2022

<sup>160</sup> <https://crypto.com/price/gridcoin> site visited on 10/23/2022

*as the volunteer with the participating farm for 1 month. But if you put the tops in order total credits, they are the only ones with the purple diamond badge.”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

In virtual communities the debate is still open: there are those who are in favor of the entry of systems that generate cryptocurrencies and who don't. Taking for example the BOINC.Italy community, as can be seen from the related discussion on their forum<sup>161</sup>, most part of the virtual community continues to process without Gridcoin and therefore remaining on the mission of volunteering and tolerating the existence of cryptocurrency e the presence of users in the team.

As previously illustrated, the Italian virtual community accepts donations even via cryptocurrency, so admins and the community at large don't they are against using cryptocurrencies regardless. Some users, especially those with dozens of CPUs, they see Gridcoin as a way to recoup expenses, mostly for bills, or to reinvest what they earn in hardware best to further increase the number of processed wu.

*“So we as a community on Gridcoin have always been neutral. We are neither pro nor against. Do you want to participate in Gridcoin? Free to do so, the hardware is yours. Do not I can force you to nothing. However you're helping science, that's for sure. We we prefer to do it another way. That is, we prefer to do it for free because it's voluntary work, if you earn something afterwards and as many do that earning there you reinvest it in hardware, because many play this game here: “the one I'll take later with gridcoin I'll get more hardware to score more points” and go scale with the computing power that you donate to projects is welcome. Absolutely, it is anyway computing power that is given to scientific research. We stay out of it, that is*

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<sup>161</sup> <https://www.boincitaly.org/forum/segnalazioni-richieste-e-suggerimenti/114367-gridcoin.html> site visited on 23/10/2022



*we know it exists: we do not condemn it, we do not participate in it. Please donate. We let's do it another way. That's why I said volunteering 2.0, because you we give free."*

- Conversational interview of 04/10/2022 with Stefano Bologna, director of BOINC.Italy

Gridcoin does not negatively affect scientific research, indeed in some cases stabilizes the supply of computing power by making BOINC more attractive to groups research. The choice made by the Italian virtual community is based on ethical and coherence i.e. if BOINC was born as a volunteer tool then it must remain in the sphere of free activities carried out for the community.

#### **4.4 Businesses as an actor in the BOINC network**

Some enterprises participate in distributed computing by making BOINC available computing power, for example through office PCs. It is not uncommon to find among the users of a small, medium and large business project. Firms often add to the user description a brief description of the company's activities and a link to reach the company website.

Multinationals have played a key role in the creation and management of some projects.

##### **4.4.1 IBM e World Community Grid**

Surely a successful case is that of IBM. The multinational launched World Community Grid, or rather a project container, on November 16, 2004. World Community Grid (WCG) is certainly the largest container of sub-projects of distributed computing on BOINC. Between completed and active projects, WCG arrived at support 31 distributed computing sub-projects.

WCG is part of the “Social services” section of the broader “Citizenship initiatives” of IBM162. IBM promotes initiatives of this kind to give boost to its image and to increase the stakeholders who gravitate towards it around your network. WCG therefore falls within the concept of corporate social responsibility163 .

IBM has included WCG in the 100 Icons of Progress, i.e. it is one of the 100 most impactful innovations by IBM on humanity164. On September 13, 2021 IBM has announced that WCG will be managed by the Krembil Research Institute and no longer by the IT multinational165. Data migration started on February 28th 2022, while the management and recovery of project wu processing is still in the recovery phase.

The news was partly greeted with some discontent by the volunteers166 .

IBM ensured a good progress of the project also thanks to the possibility, from part of companies, foundations, associations and universities, to become a partner of IBM as well as providing a lot of computing power itself.

IBM managed the partnerships through national foundations. For example in Italy operated the IBM Italia Foundation. To become a partner you had to guarantee “a total of 50 RTDs and the average contribution of 2 RTD's per day” where RTDs stands for Run Time Days. Currently the Italian partners for WCG are 10: Associazione degli Industrialists of Vicenza, ASPHI Foundation, Information Systems, Sodalitas, MolecularLab, Immaginario Scientifico of Trieste, Department of Computer Science e Telecommunications of the University of Trento, Department of Computer Science and Systems of the University of Pavia, ENI, Province of Agrigento167 .

The Krembil Research Institute would like to maintain IBM's guidelines for accepting projects proposed by research groups168 .

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162 <https://www.ibm.com/ibm/responsibility/citizenship.shtml> site visited on 10/24/2022

163 Hatch, Cunliffe, (2013), Theory of organization, p. 321 164

<https://www.ibm.com/ibm/history/ibm100/us/en/icons/> site visited 10/24/2022 165

[https://www.worldcommunitygrid.org/about\\_us/article.s?articleId=732](https://www.worldcommunitygrid.org/about_us/article.s?articleId=732) site visited 10/24/2022 166

[https://www.worldcommunitygrid.org/forums/wcg/viewthread\\_thread,43699\\_offset,0](https://www.worldcommunitygrid.org/forums/wcg/viewthread_thread,43699_offset,0) site visited 10/24/2022 167

<https://www.ibm.com/easytools/runtime/hspx/prod/public/X0027/PortalX/page/pageTemplate?c=fd63fa97b39b4663afc96a18d1973435&s=3ee9674b01694bd4a6650354e3983eff> site visited on 24/10/2022

168 <https://www.worldcommunitygrid.org/research/proposal.s> site visited on 24/10/2022

A project, to be accepted:

- must have benefits for humanity
- it must be conducted by public bodies or non-profit organizations, therefore it must not generate dividends
- any data produced must be made public, accessible and free of charge scientific community
- the problem to be solved must be decomposable in wu and the elaborations must be such as to be able to satisfy the offer of computing power of the volunteers

Hard to predict how WCG will evolve in the future, currently transitioning from IBM to the Krembil Research Institute seems very difficult.

*“What I've noticed is that even World Community Grid doesn't have that many projects lately, and this is perhaps not a good sign”*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters Trent secondary school

#### 4.4.2 The scientific and social commitment of companies

Anderson has tried several times to involve private subjects in the platform BOINC.

A very interesting example could be that of Suzuki, the famous company Japanese car manufacturer.

Suzuki originally wanted to run BOINC on their cars, when they were parked. The automaker had built a client on ARM and had introduced a custom graphical interface. Unfortunately the project was abandoned and today only a few photos of the prototype remain (Figure 17).

This is just one of many partnerships Anderson has tried to nurture over time<sup>169</sup>



Figure 17: Suzuki Car Demo - BOINC, 2019, David P. Anderson, source: [https://continuum-hypothesis.com/boinc\\_history.php#companies](https://continuum-hypothesis.com/boinc_history.php#companies)

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<sup>169</sup> [https://continuum-hypothesis.com/boinc\\_history.php#companies](https://continuum-hypothesis.com/boinc_history.php#companies) site visited on 26/10/2022

BOINC would appear unattractive to businesses. There is no real public relations team, and this did not contribute to the knowledge of platform or build strong partnerships with businesses.

To make BOINC attractive to companies not strictly connected to the sector, yes they should take targeted action.

Taking Treedom<sup>170</sup> or 3Bee<sup>171</sup> as an example, which are companies that sell products but at the same time strongly sensitize people towards the issues environmental, BOINC should make enterprises understand the importance of the impact of scientific research on the community. Firms like Treedom and 3Bee have caught on the attention also of big giants like Samsung, OVS, Ferrero etc. Businesses who invest in activities with an impact on the community obtain, in return, prestige and the improvement of its image towards customers. Another great one example is certainly the SpaceX company, which has managed to capture the interest of masses and to increase interest in scientific research in space. Knowledge distributed computing platforms should also make use of testimonials e ambassador.

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<sup>170</sup> <https://business.treedom.net/it> site visited on 26/10/2022

<sup>171</sup> <https://www.3bee.com/business> site visited on 26/10/2022

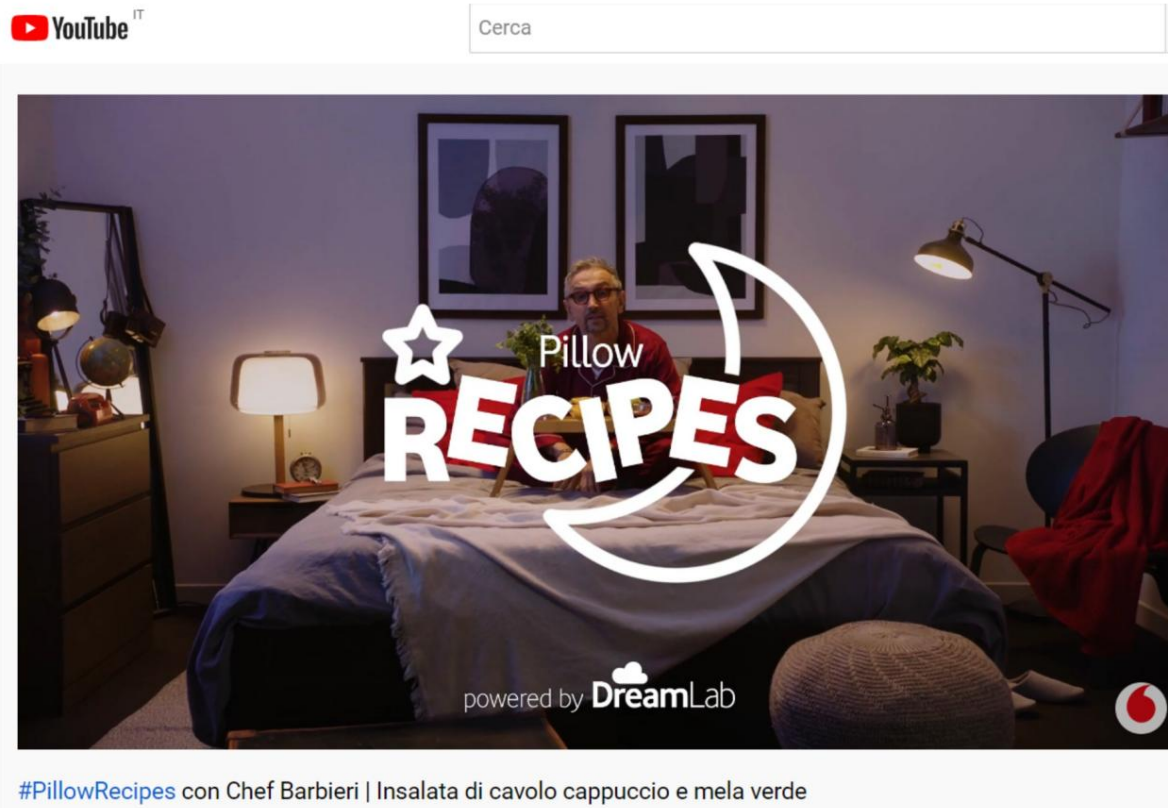


Figura 18: Il testimonial chef Bruno Barbieri spiega l'utilizzo di DreamLab, 2022, Antonio Cerrato, fonte: video YouTube "#PillowRecipes con Chef Barbieri | Insalata di cavolo cappuccio e mela verde"

The Vodafone Italia Foundation has shot a series of videos, called #PillowRecipes, with well-known starred chef Bruno Barbieri (Figure 18) for their calculation project distributed DreamLab172 indeed researchers at Imperial College were studying the antiviral properties of some ingredients (mainly fruit and vegetables). The chef Barbieri, in the videos, briefly explains the use of DreamLab: while the user sleeps, the smartphone processes calculations and hence the name "Pillow Recipes". The videos totaled approximately 6,000 views. On 10/27/2020 they were 67,421 registered users who actively support the Italian AIRC project "The Explorer from the cells cancerous (Phase 2)".

172 <https://www.youtube.com/watch?v=5XAzBk0a85c&t=2s> site visited on 26/10/2022

BOINC could do similarly involving the likes of Neil Tyson, famous science communicator, or Mark Hamill, a well-known American actor who has played Luke Skywalker in the Star Wars saga (many projects are themed astronomy).

The closure of the SETI@home project (analysis of data processed by volunteers is still active) and the Arecibo radio telescope have had a strong impact on the minor number of news circulating about BOINC, the SETI program itself had a strong cultural impact over the last 20 years and in fact has been cited or included in numerous science fiction works. The recent Covid-19 pandemic has certainly awakened interest in the platform often putting the projects themselves in difficulty, especially of the medical field, which could not meet the power supply of calculation.

#### **4.5 The opinion of the volunteers on the problems of BOINC**

BOINC. Italy volunteers were asked what are the main problems of BOINC with a multiple choice question (Graph 8).

57% of the sample answered that there is little publicity from institutions public and private. Indeed BOINC should be a tool widely used due to its simplicity and vision but they do exist very little information and news online.

9.52% of the sample thinks that there is little involvement on the part of researchers on forums, social networks, etc. Also in this case it was analyzed that in some cases i researchers think that communication is superfluous as well as the management of forum e social.

9.52% of the sample think that the BOINC infrastructure is underdeveloped compared to competitors (other voluntary distributed computing projects), while another 9.52% of the sample thinks that there are no problems related to BOINC.

3 users (respectively 4.76% of the sample) reported it as a problem related to BOINC: the credit system, the use of BOINC to mine cryptocurrency and the indifference of the people.

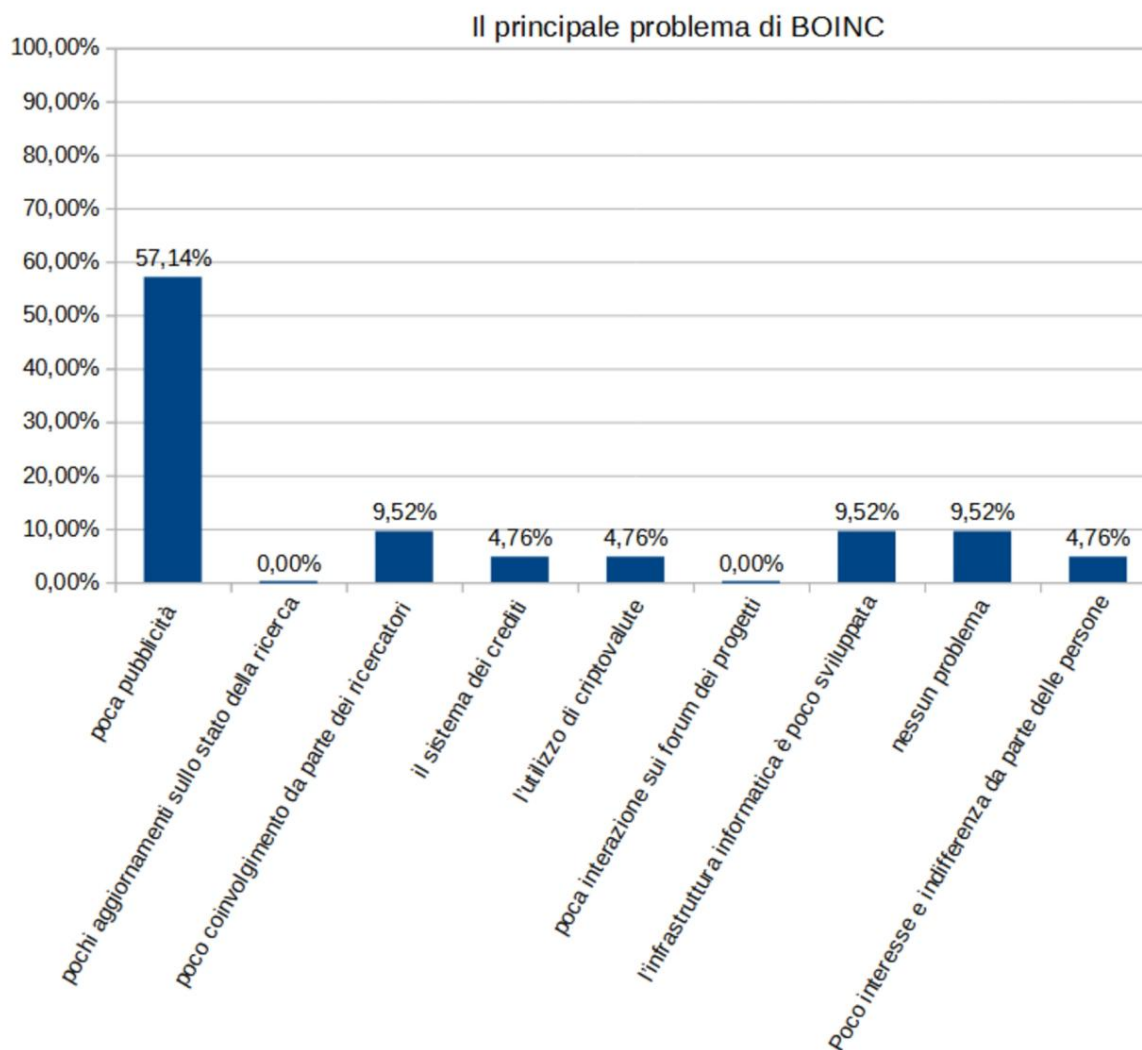


Grafico 8: Elaborazione di Antonio Cerrato, 2022, fonte: dati raccolti con somministrazione di un questionario presso la comunità virtuale di BOINC.Italy

It was also asked, with an open-ended question, what characteristics should be added to BOINC.

38% of the sample believes that BOINC has all the desired characteristics. The remaining 62% of respondents sent a series of improvement proposals between their very various:



creating a direct chat with project administrators, multiple projects on mobile devices and for GPUs, greater control over the processing in progress, more efficiency in wu distribution, greater customization of settings for wu processing, more attractive graphics for screensavers (some projects show screensavers based on processing when the PC is not on use), reward system (such as Gridcoin).

For the majority of volunteers there would therefore be room for improvement BOINC, many of these improvements would also help make it more palatable distributed computing.

## Chapter 5 The future prospects of distributed computing

Anderson has been very critical of the future of BOINC in recent years.

First of all, he expected greater involvement on the part of the volunteers public relations issue, but without a centralized structure hardly it can have an impact on multinationals or towards public bodies. The goal was make the BOINC Wiki the central element in transmitting guides and information on the distributed computing platform, which has not happened<sup>173</sup> .

According to Anderson, BOINC is unappealing to research groups because the power of calculation is not immediately available, in fact you have to involve a good number of volunteers and they can always decide to eliminate their own machines from the project therefore the computing power is not fixed but varies over time. To overcome this problem was created Science United, in which the volunteer does not chooses the single project but can choose research areas (astronomy, medicine etc.). This way there will always be computing power available for i researchers<sup>174</sup> .

As testified by the administrator of the Tn-Grid project, Valter Cavecchia, e by the administrator of BOINC.Italy, Stefano Bologna, the danger that the projects will not have computing power is non-existent. Indeed, often some volunteers migrate to other platforms for lack of processing. Plus Gridcoin pools or projects such as Charity Engine<sup>175</sup> provide the necessary security for researchers to have a minimum amount of computing power always available over time.

### 5.1 Centralized supercomputing and BOINC: we still need the projects of distributed computing? The EuroHPC case

I advantages of the supercalcolo centralized I am remarkable.

An ordinary computer performs each task in series, then to start a task

<sup>173</sup> [https://continuum-hypothesis.com/boinc\\_history.php#volunteer](https://continuum-hypothesis.com/boinc_history.php#volunteer) site visited on 10/27/2022

<sup>174</sup> [https://scienceunited.org/su\\_about.php](https://scienceunited.org/su_about.php) site visited on 27/10/2022

<sup>175</sup> <https://www.charityengine.com/marketplace/grants> site visited on 27/10/2022

must finish the previous one first, while hpc (high performance computing) allows you to solve complex problems using parallel processing<sup>176</sup> .

The HPC allows to reduce the activity in the laboratory<sup>177</sup>, in fact the majority of the tests they are not carried out physically but through simulations. The results more promising, especially in the medium range, are finally tested in the laboratory.

If a state has data processing centers for scientific research, it shouldn't depend on multinationals and/or other states. Obviously the data processing centers they are in limited quantities so there are selection criteria for the proposals.

Let's take EuroHPC for example. It is a public-private partnership of the Union which aims to "strengthen European excellence and industrial strength, a support the digital transformation of its economy while ensuring its technological sovereignty". The goal is to create an infrastructure made up of more supercomputer to make the European Union independent in the field of power computing and to increase the experience and skills of companies and researchers. THE public participants are the European Union (represented by the Commission) and related Member States to which are added 3 other non-EU states, i.e. Iceland, Norway and Turkey<sup>178</sup> .

EuroHPC consists of 8 supercomputers: Lumi in Finland (375 PetaFLOPS), Leonardo in Italy (249.47 PetaFLOPS), Marenostrum 5 in Spain (205 PetaFLOPS), Vega in Slovenia (6,92 PetaFLOPS), Meluxina in Lussemburgo (12,81 PetaFLOPS), Karolina in the Czech Republic 9.59 (PetaFLOPS), Discoverer in Bulgaria (4.51 PetaFLOPS) and Deucalion in Portugal (7.22 PetaFLOPS)<sup>179</sup>. The overall power is 870.52 PetaFLOPS. If we considered it, a single supercomputer would occupy the second position in the top 500 supercomputers of June 2022<sup>180</sup>

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<sup>176</sup> <https://www.ibm.com/it-it/topics/hpc> site visited on 10/29/2022

<sup>177</sup> <https://www.oracle.com/it/cloud/hpc/what-is-hpc/> site visited 29/10/2022

<sup>178</sup> [https://eurohpc-ju.europa.eu/about/discover-eurohpc-ju\\_en#benefits-of-supercomputing](https://eurohpc-ju.europa.eu/about/discover-eurohpc-ju_en#benefits-of-supercomputing) website visited 29/10/2022

<sup>179</sup> [https://eurohpc-ju.europa.eu/about/our-supercomputers\\_en](https://eurohpc-ju.europa.eu/about/our-supercomputers_en) site visited on 29/10/2022

<sup>180</sup> <https://www.top500.org/lists/top500/list/2022/06/> site visited on 29/10/2022

Since the computing power is limited, the time allocation is based on a selection of proposals. There are 9 steps to evaluate the proposals.

A first check is the administrative one, the Peer-Review office examines the online registration and the Project Scope and Plan document<sup>181</sup> which describes the research, the subjects involved, the scientific importance of the proposal, the quality of the verification and validation of simulations and predictions, the software used, the related libraries etc.. In the second phase the technical feasibility of the proposals that can be technically accepted, accepted with reserve or rejected (in the event of a rejected proposal, the evaluation will still proceed). In the third stage the proposals are sorted, based on the research topic, to the Domain Panels; the Domain Panel Chair assigns a proposal to two panellists, who evaluate the proposal proposal based on 3 criteria: Excellence, Innovation and Impact, Quality and Efficiency of the implementation. In the fourth stage each Domain Panel assigns separately a score after which a first classification is formed and they come Identify resource recommendations for each proposal. In the fifth stage the proposals are not discussed on the basis of membership in a Domain Panel but come treated all together; in the super panel meeting a ranking is created and the resource recommendations for each proposal. In the sixth stage the potency of calculation is allocated according to the ranking and according to the recommendations, in case of running out of resources some proposals are rejected. In the seventh stage the list of accepted proposals is sent to the EuroHPC Board of Directors which approves them computing power allocations. In the eighth phase the Peer-Review office communicates, by email, the results which are also viewable in the related peer platform reviews. In the ninth and final phase, the proposing body accepts the assigned resources and the host bodies provide access to the resources<sup>182</sup> .

The allocation lasts 1 year and is renewable for a further year<sup>183</sup>. Between the registration of the proposal and communication of the allocation of resources

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<sup>181</sup> Copy of the Project Scope and Plan

document: [https://docs.google.com/document/d/1x5xhsy4ecF6UdBJUJE0qfpKA49e785NebJgnf\\_V8Mng/edit?](https://docs.google.com/document/d/1x5xhsy4ecF6UdBJUJE0qfpKA49e785NebJgnf_V8Mng/edit?usp=share_link)

<sup>182</sup> <https://prace-ri.eu/hpc-access/eurohpc-access/eurohpc-ju-regular-access-mode/regular-access-applicant-information/> site visited

on 29/10/2022 <sup>183</sup> <https://prace-ri.eu/call/eurohpc-ju-call-for-proposals-for-regular-access-mode-2022-11-04-cutoff/> site visited on 10/30/2022

about 3 months pass and a certain amount of produce has to be produced documentation. Based on the final classification, it is not said that there is enough computing power for all proposals. The demand for computing power can be done only if the project requires at least 10 million CPU hours or 1 million GPU hours<sup>184</sup>. This excludes PhD projects or otherwise short-term projects. EuroHPC, therefore, does not exclude the possibility on the part of the research institutions to use distributed computing voluntarily, indeed we can say that EuroHPC satisfies the demand for medium-term computing power (minimum 1 year, maximum 2 years) while distributed computing platforms, in particular BOINC, meet a little all the needs in particular the demand for power short and very short term as well as long term calculation. I asked to the Tn-Grid administrator his point of view on these supercomputer networks, in detail of EuroHPC and the future of BOINC:

Interviewer: *These supercomputer networks [...] can overshadow the voluntary distributed computing?*

*So in my opinion not, at the moment when these things are paid for. For access these resources here however you have to pay, you pay informally in the sense that you have to win projects, but in the end you pay money, however they are of resources. The good I see in this kind of approach is to go out, try to get out of the point of view of scientific research from the usual ... from the monopoly that they have cloud services from Amazon, Google etc and Microsoft. [...] But having a hat European who do not have a monopoly of these large companies second it's good to me. On the issue of distributed computing, in my opinion it must serve as it is born at the beginning [...] I what I say, you start with an innovative idea [...] that for obvious reasons no one finances it [...] you start with a BOINC system, after a while you have enough tools if it's a scientific thing, I'm not talking about a thing interesting but pseudo scientific, in a good way like looking for prime numbers bigger and bigger or try to prove the Collatz conjecture, are things that*

...

<sup>184</sup> <https://prace-ri.eu/call/eurohpc-ju-call-for-proposals-for-regular-access-mode-2022-11-04-cutoff/> site visited on 01/11/2022

*After n years, after a few years, you have the publication mechanism, you have a feedback if your work makes sense or no longer makes sense. At that point BOINC there shouldn't be anymore [... ] If (ed the project) works it should be*

*funded* come on *channels* *officers* *Of* *financing.*

- Conversational interview of 06/10/2022 with Valter Cavecchia, director of Tn-Grid and Technical Collaborator of Research Bodies at CNR-IMEM, headquarters secondary Of Trent

BOINC therefore could be an excellent "incubator of ideas" not dissimilar, at least on a conceptual level, from university spin-offs. The project was born on BOINC and after 1 or 2 years is evaluated based on what it has produced in terms of data and scientific publications. If the project has some impact then it should be financed by the domestic state.

## **5.2 Ibercivis and World Community Grid as models for a project**

### **European or Italian multidisciplinary**

Ibercivis is a Spanish container project (also called multidisciplinary project). It was born from the Zivis pilot project of the University of Zaragoza. Ibercivis was born officially on 20 June 2008 again as a project of the University of Zaragoza but other scientific bodies are also involved: the Institute of Biocomputation and Physics of Complex Systems (BIFI) also from the same Spanish university, the Centro of Energy, Environmental and Technological Research (CIEMAT), il Extremadura Center for Advanced Technologies (CETA-Ciemat), the Superior Council of Investigaciones Científicas (CSIC, similar to the CNR) and the RedIRIS (public body, is a network of research centers and universities)<sup>185</sup>. 13 sub-projects have produced scientific publications<sup>186</sup> in the fields of physics, chemistry, medicine and

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<sup>185</sup> <https://web.archive.org/web/20210727221833/https://ibercivis.es/about-the-ibercivis-foundation/?lang=en> site visited on 01/11/2022

<sup>186</sup> BOINC publications list [https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxcp-5c2sq8S6kx3TftZGII91oSxqk/edit?](https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxcp-5c2sq8S6kx3TftZGII91oSxqk/edit?usp=share_link)

[usp=share\\_link](https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxcp-5c2sq8S6kx3TftZGII91oSxqk/edit?usp=share_link)

of social sciences involving not only Spanish but also Portuguese universities and of Latin America. Ibercivis is managed by 13 experts including five figures who deal with project management, one person deals with the drafting of European proposals, a computer scientist, an expert in communication and a sociologist<sup>187</sup>.

The Ibercivis foundation actively promotes non-citizen science only through BOINC projects but also with other projects and initiatives. There Ibercivis platform currently does not host active sub-projects but that is enough normal being a very discontinuous platform in wu production.

We can compare, at least on a conceptual level, the waves of Ibercivis projects to the runs of CERN<sup>188</sup> or to moments of pause between projects to improve and/or renew the team, introduce new projects, improve the code, etc. Ibercivis is very active on social networks: the YouTube channel has 52,332 total views and 360 registered<sup>189</sup>, the Instagram page has 673 followers<sup>190</sup>, the Facebook page has 1893 "Likes"<sup>191</sup> and the Twitter page is followed by 4210 followers<sup>192</sup>.

Surely Ibercivis can be a good example of a European project volunteering on BOINC also having a large communication team. The projects they are proposed by Iberian or Latin American bodies and universities, but they do not exist information on the site regarding the project selection criteria. We can but assume that any college project is actually good from a scientific research point of view then controls for selection they should be minimal; selection criteria exist for contexts such as those of EuroHPC where resources (computing power) are limited. A project-container European could therefore replicate the structure of Ibercivis with some selection criteria minimums similar to those of WCG (criteria listed in paragraph 4.4.1 IBM and World Community Grid). A possible European project, as previously described, it would not conflict with EuroHPC but would rather act as an incubator and network

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<sup>187</sup> <https://ibercivis.es/el-equipo-de-ibercivis/> site visited on 02/11/2022

<sup>188</sup> <https://lhc-commissioning.web.cern.ch/schedule/LHC-long-term.htm> site visited on 02/11/2022

<sup>189</sup> <https://www.youtube.com/c/IbercivisCiencia/about> website visited on

02/11/2022 <sup>190</sup> <https://www.instagram.com/ibercivis/> website visited

on 02/11/2022 <sup>191</sup> <https://www.facebook.com/Ibercivis/> site visited

on 02/11/2022 <sup>192</sup> <https://twitter.com/ibercivis> site visited on 02/11/2022

of supercomputers of the European Union by accelerator, the computing project European distributed could also be independent and parallel with respect to Euro HPC. This way researchers could always have computing power available, which would not be dispersed in micro-projects, while volunteers could always meet the demand for computing power and could choose the below projects like in WCG (Figure 19) where volunteers can choose to select only some projects or can choose to receive wu of non projects as well selected if there is no wu for previously selected projects<sup>193</sup>. A possible European (or national) project would increase cooperation between departments by one same university (Tn-Grid with the University of Trento is an excellent example).

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<sup>193</sup> <https://www.worldcommunitygrid.org/ms/viewMyProjects.do> site visited on 02/11/2022



**Available Projects**

[All](#) | [None](#)

[OpenPandemics - COVID-19](#)

[Africa Rainfall Project](#)

• Please review the [system requirements](#) before opting to participate in this project

[Help Stop TB](#)

[Mapping Cancer Markers](#)

[Smash Childhood Cancer](#)

**Please note:** Some projects may occasionally have periods where no work is available. If you choose to receive work for only one project, the project may, at times, not have work units available for download. For this reason, we recommend that you select more than one project.

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If there is no work available for the project(s) I have selected above, please send me work from another project.

Please opt me in to new projects as they become available.

Figura 19: Impostazioni WCG per la scelta del progetto, 2022, Antonio Cerrato, fonte: WCG <https://www.worldcommunitygrid.org/ms/viewMyProjects.do>

### 5.3 The role of public institutions in distributed computing according to BOINC.Italy volunteers

The BOINC.Italy volunteers were asked, with an open-ended question, how public institutions (also from the European Union) could be involved in the distributed computing. The volunteers responded with a series of reflections. A voluntary offers tax breaks for those who buy hardware for reasons of volunteer work or for electricity bills. 4 volunteers would like schools and universities were involved first:

*"Stimulating, especially in high school/university, the concept of "citizen science" and that everyone can contribute, in their own small way, to scientific research."*

-Volunteer

n.

4

*"I believe that everything should start from the schools. Maybe not from the primary, but from secondary teachers could talk about the distributed computing system and,*

*addressing certain topics of the study program, they could lead attention to projects with some affinity. Ways to get kids involved are many (create groups of class, take part in challenges, etc.)”*

- Volunteer n. 3

A volunteer offers ad hoc scholarships for those undertaking studies related to distributed computing. Another volunteer proposes, however, the creation of one European platform:

*“By creating a multidisciplinary Boinc project and "incubator" in which to bring together projects minors Of university it is institutes European“*

- Volunteer n. 9

There are those who want to integrate distributed computing with the green economy by lengthening the cycle vital of tablets and smartphones:

*“A collection body for old smartphones, compatible with the Boinc platform, which would be reused to increase the size of the grill Of calculation“*

- Volunteer n. 13

Another 4 volunteers suggest an enhancement of communication to let let citizens know about distributed computing platforms:

*“Ordinary people should be sensitized more than anything else. Everything else will come by itself. There BOINC platform and other types of science sharing platform is a environment Of niche bit known at lot .”*

- Volunteer n. 7

Two volunteers propose installing BOINC on public PCs Administration.

3 volunteers, on the other hand, are skeptical about the involvement of institutions national or European:

*“Public institutions must support research with funding. No research center can think of using only and exclusively the calculation distributed Of BOINC.”*

- Volunteer n. 20

85.71% of the sample is in favor of involving the entities (at various levels). public while 14.29% of the sample is against the involvement of institutions in distributed computing. Volunteers expect more funding of citizen science projects and greater publicity of citizen science initiatives this type.

#### **5.4 Unused computing power: the example of the secondary school degree in Italy**

BOINC can be installed on various electronic devices and on various operating systems (Windows, MacOS, Linux)<sup>194</sup>. In general, PCs almost never use all 100% their computing power, in most cases PCs are needed mainly for surfing the internet and that involves 10% usage up to a maximum of 30% CPU. So essentially today we buy pc of which not we use 75% of the computing power. Schools could be a place perfect for awareness of distributed computing and citizen science. THE BOINC projects are often the subject of the subjects studied in school especially in the secondary school programs. Wanting to take an example

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<sup>194</sup> [https://boinc.berkeley.edu/wiki/System\\_requirements](https://boinc.berkeley.edu/wiki/System_requirements) site visited on 03/11/2022

precisely the latter, how much computing power institutions are not using public? Most of the educational establishments have adopted the electronic register so each class has at least 1 computer. Taking into consideration of the pcs of low-end (less than 500 euros) we can hypothesize the use, as CPU, of Core i3 (Intel) or Ryzen 3 (AMD)<sup>195</sup>. Assume the use of Core i3 processor with 4 cores, we have a base frequency (considering the CPU with the lowest frequency) of 2.30 GHz<sup>196</sup>. In Italy there are 124,552 classes for the academic year 2022/2023<sup>197</sup> therefore we can hypothesize the presence of 124,552 electronic registers and therefore of as many computers physically present in the classrooms (I exclude the classrooms from this calculation computers and PCs used for administrative purposes). We have, theoretically, a layout  $124,552 \times 4 = 498,208$  processors. Let's assume a use of BOINC at 50% (249,104 processors) we can calculate the FLOPS:

$Nop \times f_{clock} \times N_{core} = 2.3GHz \times 16 \times 249,104 = 9,167,027.2$  GigaFLOPS or 91.67 PetaFLOPS

You would basically have a small supercomputer that you could run into less than 30 minutes. If we think of all the public bodies and related offices (municipalities, Provinces, Regions, Universities, Ministries, schools of all levels, etc.) we can easily guess that we have a gigantic supercomputer, not used, but located throughout the Italian peninsula.

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<sup>195</sup> Example of an agreement for the supply of PCs (lot 1) [https://www.acquistinretepa.it/opencms/opencms/scheda\\_iniziativa.html?idIniziativa=f6ac8fc1b4c73b46](https://www.acquistinretepa.it/opencms/opencms/scheda_iniziativa.html?idIniziativa=f6ac8fc1b4c73b46) site visited on 03/11/2022

<sup>196</sup> <https://ark.intel.com/content/www/it/it/ark/products/series/195733/10th-generation-intel-core-i3-processors.html> site visited on 03/11/2022

<sup>197</sup> Miur , (2022), Focus "Main school data - Start of the 2022/2023 school year", p. 8

## Conclusions

The concept of citizen science has been proposed through the Computing Platform distributed BOINC, briefly retracing the birth and structure of the platform and analyzing the scientific production in 20 years of activity. In time complex virtual communities have arisen around BOINC, these groups have increased the general engagement of the platform also through the use of the gamification. Among the various communities one of the most active is certainly the community Italian BOINC.Italy, which was administered a questionnaire to identify the motivations of volunteering 2.0 and the users' relationship with the ei platform researchers. Even the Italian academic world has participated, with some projects, in BOINC; there are factors that have influenced the use of BOINC in Italy. There communication between volunteers and researchers is essential to establish a relationship mutual trust. Businesses have also played an important role in the network BOINC by donating computing power or creating projects for the platform. The future perspectives of distributed computing are varied and there are different paths applicable both at national and European level. On that basis I think it was demonstrated how the BOINC platform can be a great tool for alternative scientific production (at least 994 scientific publications in 20 years). to paid data processing services. Around the platform were born some very complex virtual communities which, through their activities, increased the efficiency and effectiveness of scientific research. Although the platform has only one tool for the aggregation of users, teams, the latter have formed groups complex and more or less informal groups that had not been imagined in the design of the platform. Volunteers are not mere users of research science as a public good but they are an active part in providing this good to community. Furthermore, I believe it is demonstrated as a national project-container or European is easily implemented compared to the in-house construction of one supercomputers. Citizens become, with citizen science projects, an extension

of research institutions. If we think of the participation of BOINC.Italy members in the researchers night 2019, let's see how the end user, the citizen, is the same as provides information about research activities to other citizens. Over the years it is an osmotic exchange of ideas was established between citizens and researchers. BOINC has knocked down the classic communication barriers between researchers and citizens by making i daily relationships, and not occasional, and minimizing the distance between citizens and institutions of research.



## Bibliography

- Besanko D., Dranove, D, Shanley M., Schaefer S., (2017), *Economia dell'industria and business strategies*, isedi, Milan
- Corbetta P., (2020), *Social research: methodology and techniques. The paradigms of reference*, Il Mulino, Bologna
- David P. Anderson, (2019), *BOINC: A Platform for Volunteer Computin*, Journal of Grid Computing,
- de Vita P., Mercurio R., Testa F., (2007), *Business organization: structure and relationship mechanisms*, G. Giappichelli Editore, Turin
- Hatch Jo M., Cunliffe L. Ann, (2013), *Organization theory*, Il Mulino, Bologna
- Massimo Florio, (2019), *Investing in Science*, The MIT Press, London, England
- Miur, (2022), *Focus "Main school data - Start of the school year 2022/2023"*  
<https://miur.gov.it/documents/20182/6891182/Principali+dati+della+scuola+-+Focus+start+school+year+2022-2023.pdf/cb3b168f-fb9e-a359-85ff2f7b8964098d?version=1.0&t=1663851622661>
- Pierangelo Crucitti, (2016), *Citizen Science. Participatory science. Principles, examples and perspectives of a constantly growing phenomenon*, Science and research  
[https://www.researchgate.net/publication/321850316\\_Citizen\\_Science\\_Fare\\_scienza\\_in\\_a\\_participatory\\_way\\_Principles\\_examples\\_and\\_prospects\\_of\\_a\\_growing\\_phenomenon\\_constant](https://www.researchgate.net/publication/321850316_Citizen_Science_Fare_scienza_in_a_participatory_way_Principles_examples_and_prospects_of_a_growing_phenomenon_constant)
- University of California, (2022), *License Agreement*, University of California, Berkeley  
<https://docs.google.com/document/d/1tEF1IAclJH7AUdITCDc24dEezJt7ASBjceMW2p1C6iU/edit?usp=sharing>



## Sitography

- <https://obsproject.com>
- <https://meet.google.com>
- <https://it.libreoffice.org>
- <https://www.google.com>
- <https://earthwatch.org/expeditions/unearthing-ancient-history-in-tuscany>
- [https://it.wikipedia.org/wiki/Calcolo\\_distribuito#:~:text=Il%20calcolo%20distributed%20is%20a,system%20distributed%20is%20said%20program](https://it.wikipedia.org/wiki/Calcolo_distribuito#:~:text=Il%20calcolo%20distributed%20is%20a,system%20distributed%20is%20said%20program)
- <https://www.anandtech.com/show/>
- <https://www.hwupgrade.it/news>
- <https://www.top500.org/lists/top500/2022/06/>
- <https://it.wikipedia.org>
- <http://www.programmiamo.altervista.org/hwsw/hwsw11.html> -
- <https://boinc.berkeley.edu/download.php>
- [https://boinc.berkeley.edu/wiki/How\\_BOINC\\_works](https://boinc.berkeley.edu/wiki/How_BOINC_works) -
- [https://boinc.berkeley.edu/wiki/Account\\_managers](https://boinc.berkeley.edu/wiki/Account_managers) -
- [https://boinc.berkeley.edu/wiki/Computation\\_credit](https://boinc.berkeley.edu/wiki/Computation_credit)
- [https://boinc.berkeley.edu/boinc\\_papers/credit/text.php](https://boinc.berkeley.edu/boinc_papers/credit/text.php)
- <https://github.com/BOINC/boinc/>
- <https://einsteinathome.org/it-it/application-source-code-and-license>
- <https://wiki.ligo.org/Computing/LALSuite> -
- <https://einsteinathome.org/it-it/application-source-code-and-license>
- <https://boinc.berkeley.edu/info.php>
- <https://einsteinathome.org/it-it/privacy>
- [https://continuum-hypothesis.com/boinc\\_history.php](https://continuum-hypothesis.com/boinc_history.php)
- <https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxceP5c2sq8S6kx3TftZGll91oSxqk/edit?usp=sharing>
- <https://www.nsf.gov/about/>
- <https://boinc.bakerlab.org/rosetta>
- [https://www.rechenkraft.net/wiki/Willkommen\\_beim\\_Verein\\_Rechenkraft.net\\_e.V.](https://www.rechenkraft.net/wiki/Willkommen_beim_Verein_Rechenkraft.net_e.V.)
- <https://www.rechenkraft.net>
- <https://www.rechenkraft.net/forum/> -
- <https://www.setiusa.us/forum.php>
- <https://www.boincgames.com>

- <https://www.boinc-af.org>
- <https://www.boincitaly.org/forum.html> -
- <https://www.worldcommunitygrid.org> -
- [https://www.seti-germany.de/boinc\\_pentathlon/start.php](https://www.seti-germany.de/boinc_pentathlon/start.php) -
- <https://www.boinc-af.org> -
- [https://wcg.fandom.com/wiki/World\\_Community\\_Grid\\_Wiki](https://wcg.fandom.com/wiki/World_Community_Grid_Wiki) -
- <https://explore.transifex.com> -
- <https://www.youtube.com> -
- <https://www.facebook.com> -
- <https://web.archive.org>
- <https://setiathome.berkeley.edu>
- <https://gene.disi.unitn.it>
- <https://one.google.com>
- <https://offerta-internet.it/>
- <https://www.payscale.com>
- <https://aws.amazon.com>
- <https://gridcoin.us>
- <https://crypto.com>
- <https://www.ibm.com>
- <https://business.treedom.net/>
- it - <https://www.3bee.com>
- <https://scienceunited.org>
- <https://www.oracle.com>
- <https://eurohpc-ju.europa.eu>
- <https://prace-ri.eu>
- <https://ibercivis.es>
- <https://www.instagram.com>
- <https://lhc-commissioning.web.cern.ch>
- <https://twitter.com>
- <https://www.acquistinretepa.it/>
- <https://ark.intel.com>

## **Text files, video and audio files, data and processing**

- License Agreement, Berkeley Open Infrastructure for Network Computing (BOINC):

<https://docs.google.com/document/d/1tEF1IAcIJH7AUdITCDc24dEezJt7ASBjceMW2p1C6iU/edit?usp=sharing>

- BOINC scientific production list (scientific articles) <https://docs.google.com/spreadsheets/d/124JZfQMU1CEbJxceP5c2sq8S6kx3TftZGll91oSxqk/edit?usp=sharing>

- Questionnaire for the BOINC.Italy team and data processing <https://docs.google.com/spreadsheets/d/1xschMGjrJog7I4kFZeGvwro4vgfKAxcL5ykhFM5fAo/edit?usp=sharing>

- Talk and email interviews <https://drive.google.com/drive/folders/1QQuGK7dle8aEI9Dg9uBIPz3aWqGcsvru?usp=sharing>

- Project Scope and Plan document (EuroHPC) [https://docs.google.com/document/d/1x5xhsy4ecF6UdBJUJE0qfpKA49e785NebJgnf\\_V8Mng/edit?usp=share\\_link](https://docs.google.com/document/d/1x5xhsy4ecF6UdBJUJE0qfpKA49e785NebJgnf_V8Mng/edit?usp=share_link)