FUTURE SPACE

Presentation attachments

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Cosmic civilizations

Topic: Searching for life in the Universe.

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⌛ Main presentation

➲ Slide 2

Why we haven't made contact with alien civilizations?

Enrico Fermi noticed that if the Galaxy contains such an amount of technologically developed civilizations, how come we can't observe any traces of their existence, e.g. signals they send, probes, spaceships, or representants of those civilizations. This is the so-called *Fermi paradox*. If we haven't observed any tracks of the aliens yet, this means that either:

- The assumptions concerning extraterrestrial civilizations are wrong and life is far more scarce.
- Alien civilizations send different signals to space, however our civilization is not developed enough to detect them.

➲ Slide 3

Why we haven't made contact with alien civilizations? There are many reasons why we have not noticed any traces of alien space civilizations, for example:

- Annihilation of civilizations.
- The Earth holds the only life in the universe.
- The distance between stars near which alien civilizations live. The distances between two stars around which life exists can reach hundreds, thousands, or even more light years. The two civilizations might fall before they can contact one another.
- The ZOO hypothesis, which states that other cosmic civilisations intentionally avoids communication with Earth to allow humans to evolve without interference.
- The planetarium hypothesis, which states that humanity is in a simulation, and the aliens are the ones running it.
- Others. Can you give an example of any other reason?

➲ Slide 4

Falls of cosmic civilizations

The disaster that may destroy cosmic civilizations, can be divided into three parts:

- Natural-inflicted catastrophes. These catastrophes are large-scale events, for example geological or climatological that have the potential to cause destroy whole or large part of a civilization.
- Self-inflicted catastrophes. These catastrophes are caused by the activities of a given civilization.
- External catastrophes. These catastrophes are independent of the activities of a given civilization and the natural processes of the planet on which the civilization exists.

➲ **Slide 5**

Why we haven't made contact with alien civilizations?

One possibility (point one on slide 3) is that technical civilizations destroyed themselves, were destroyed by external disaster and so on, before our civilization becomes technical civilization and we learned to receive electromagnetic waves, build advanced telescoped etc.

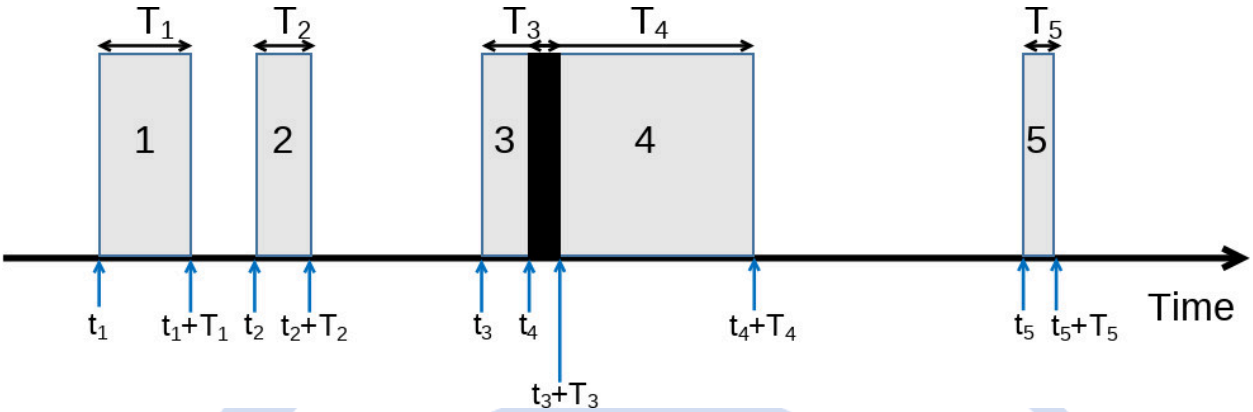


Figure: Rise and death of cosmic civilizations as a function of time. Let us assume, that up now, there were 5 cosmic advanced civilizations in our universe. Civilization "1" lived T_1 years and fell before civilization "2" was born (at the time $t_2>t_1+T_1$). From this figure we can see that during the existence of civilization "1", "2" and "5" it is not possible to meet (discover) another cosmic civilization. The situation is different in time when the civilizations "3" and "4" exist. Because the civilization "3" fell after the civilization "4" was born ($t_3+T_3>t_4$) it is possible for them to make contact in time interval when these civilizations coexist (i.e. for time $t\in [t_4,t_3+T_3]$). Even if these civilizations live at the same time, it may not be possible to contact each other. For example, let us assume that two civilizations live in the same time interval lasting 100000 years, but the distance between them is 300000 lys. Do you know why? Hint: the speed of light is finite.

❖ Footnote: *A light-year is a unit of length defined as distance that light travels in vacuum in one Julian year (365.25 days). 1 light year equals about 9.46 trillion kilometers.*

➲ **Slide 6**

Probability of causal contacts between communicating civilizations

Let us assume, that cosmic civilizations live finite and constant time and are born in a random times. We can make two observations:

- For a given number of civilizations, the probability of contact is the larger, the larger is life time of these civilizations.

Figure caption: In this figure we show schematically two hypothetical scenarios. In both cases, we assume that there have bee 9 civilizations in the universe. In the first case (top figure) we assume that civilisations live T_1 years, in the second one - T_2 years (bottom figure). We assume that $T_1>T_2$. This means that in the first case, there is less "empty space" in the timeline and therefore a greater chance of simultaneous coexistence of at least two civilizations.

❖ Footnote: *These are the time intervals when no civilization exists.*

➲ Slide 7

Probability of causal contacts between communicating civilizations

For a given constant life time of the civilizations, the probability of contact is the larger, the larger is the number of these civilizations that have occurred in the universe.

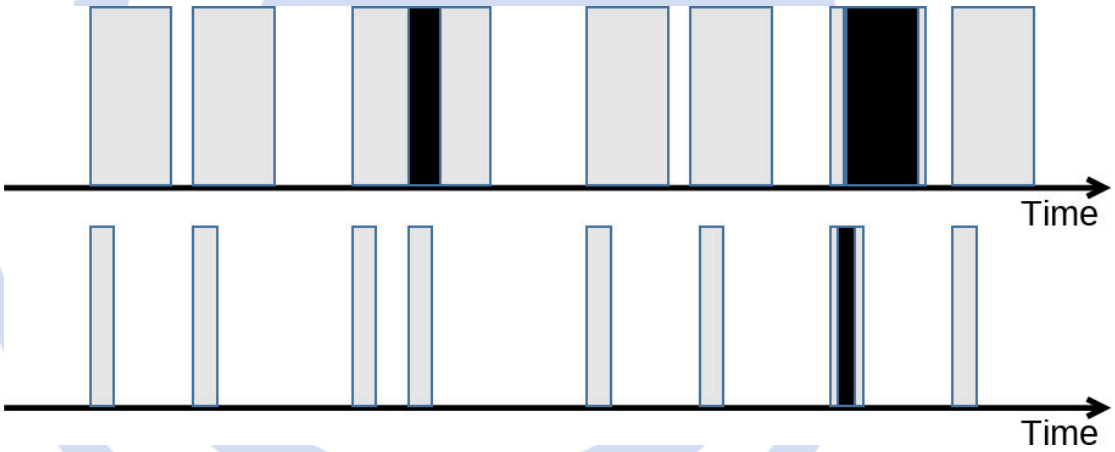
Figure caption: In this figure we show schematically two hypothetical scenarios. In both cases, we assume that the civilizations live finite and the identical time. In the first case (top figure) we assume that there have been 8 civilizations in the universe, in the second one (bottom figure) - 5. This means that in the first case, there is less "empty space" in the timeline and therefore a greater chance of simultaneous coexistence of at least two civilizations.

➲ Slide 8

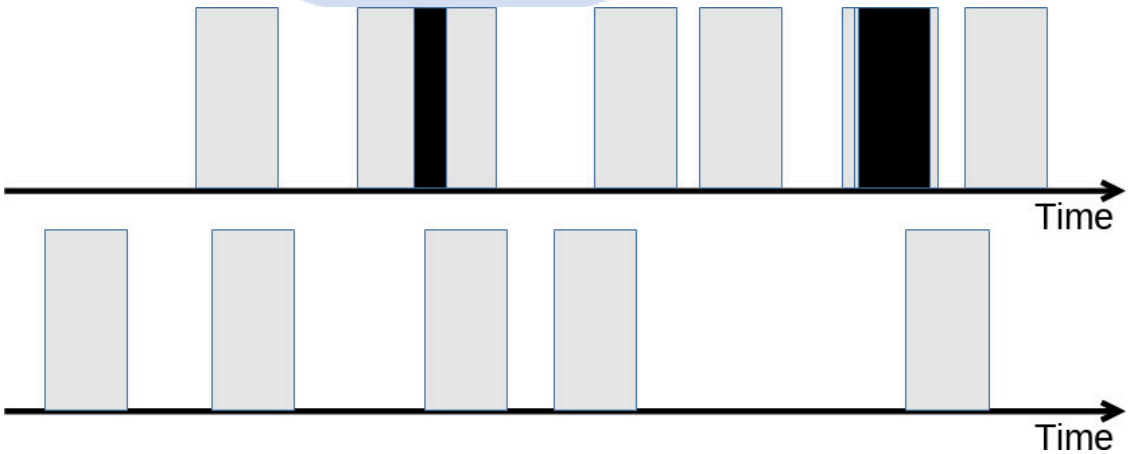
Probability of causal contacts between communicating civilizations

Let us assume, that cosmic civilizations live finite and constant time, T, and are born in a random times. We can make two observations:

- For a given number of civilizations, the probability of contact is the larger, the larger is life time of these civilizations.



- For a given constant life time of the civilizations, the probability of contact is the larger, the larger is the number of these civilizations that have occurred in the universe.



⌛ Additional material

➲ Slide 2

Web application to calculate probability of contact between technical civilizations

Link to the application: https://futurespaceproject.eu/civilizations/

After clicking on the preceding link the following view appears. By using this website you will be able to estimate the chances of meeting two technical civilizations assuming different scenarios regarding the lifetime of these civilizations, their total number, etc.

There are two language versions of this application: Polish and English.

➲ Slide 3

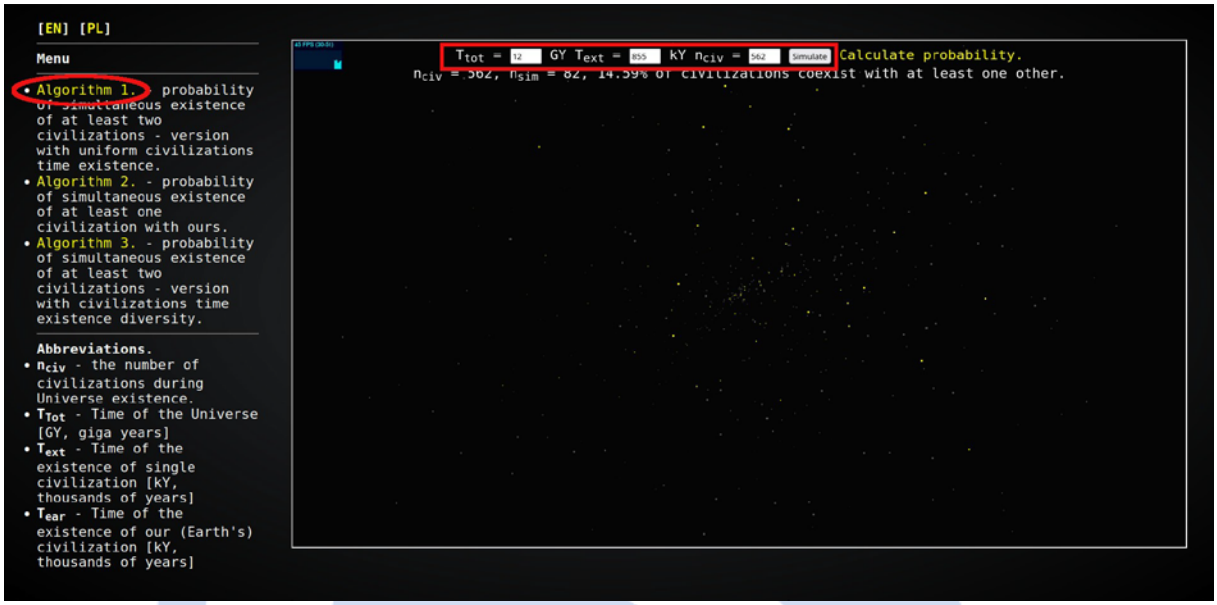
Web application to calculate probability of contact between technical civilizations

On the left side of the website we have a selection of three different scenarios on the rise and fall of civilization. By clicking on the hyperlink, we choose the appropriate one. The fields to be completed contain randomly generated numbers.

➲ Slide 4

First scenario - probability of simultaneous existence of at least two civilizations - version with uniform civilizations time existence.

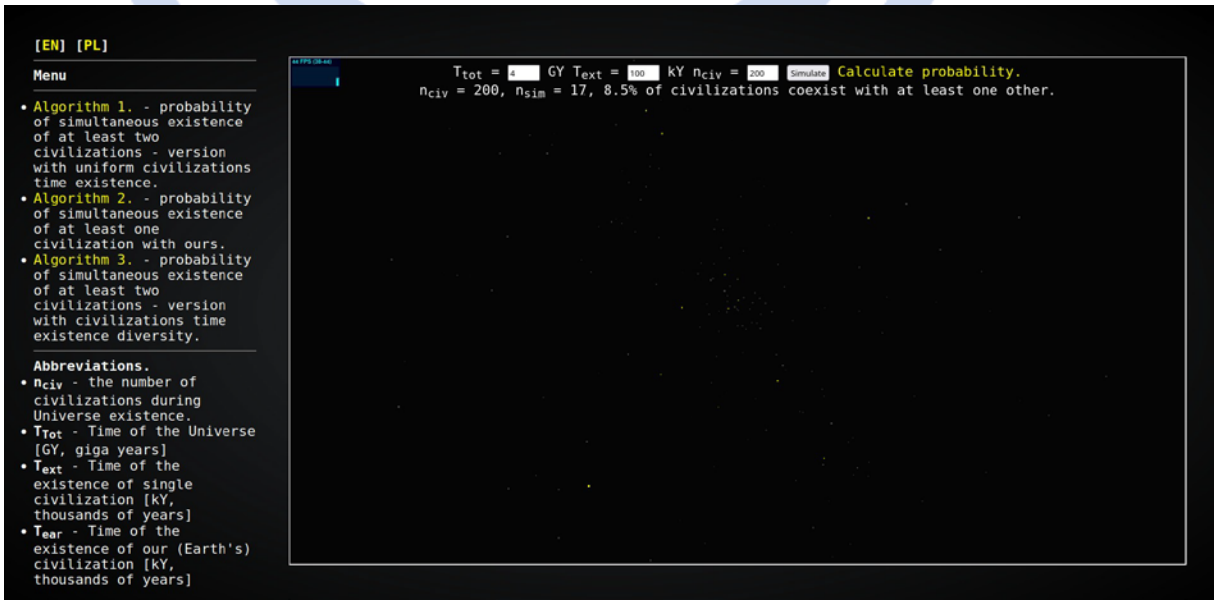
In this scenario we assume, that technical civilizations started to born T_{tot} years ago. Each of these civilizations lives T_{ext}. During the time T_{tot} exactly nciv civilizations can be born. We assume, that the civilization can be born in random (uniformly distributed) moments of time.



➲ Slide 5

First scenario - probability of simultaneous existence of at least two civilizations - version with uniform civilizations time existence.

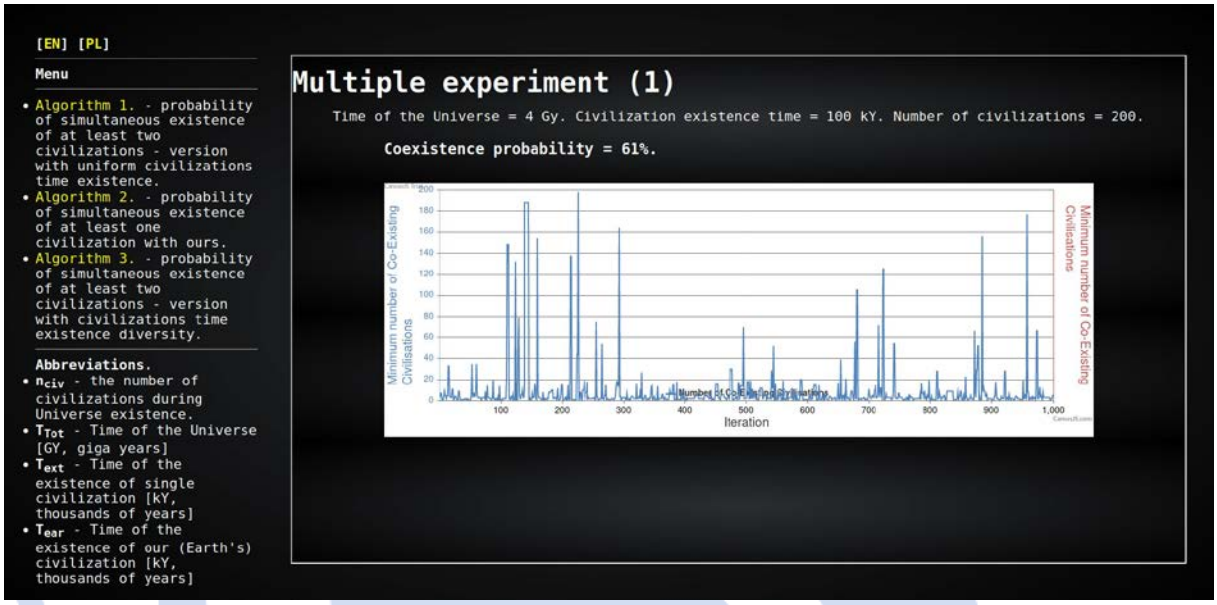
After entering the data and clicking the" Simulate" button, the result of a single simulation of the universe is displayed. Gray are all civilizations that existed during the existence of the universe, yellow are those that coexisted with at least one other civilization. Below we see the simulation results for T_{tot} = 4 Gyrs, T_{ext} = 100 kyrs and n_{civ} =200.



➲ Slide 6

First scenario - probability of simultaneous existence of at least two civilizations-version with uniform civilizations time existence.

After clicking the ”Calculate probability” link, a script that generates about 1000 such simulations for the entered data is launched. The graph shows the number of coexisting civilizations for each simulation. Based on this result, the probability that there will be at least two coexisting civilizations in the universe is given.



➲ Slide 7

First scenario - probability of simultaneous existence of at least two civilizations-version with uniform civilizations time existence.

Algorithms used in the exercises are probabilistic. Thus, when students run the same algorithm second time, with the same input parameters, obtained probability may differ. Similarly, when we toss a fair coin 100 times, we should expect to get roughly 50 “Heads” and 50 “Tails”. In practice, in one experiment we can obtain for example, 45 “Heads” and 55 “Tails”, in the second one - 52 “Heads” and 48 “Tails”. The algorithm is implemented as follows:

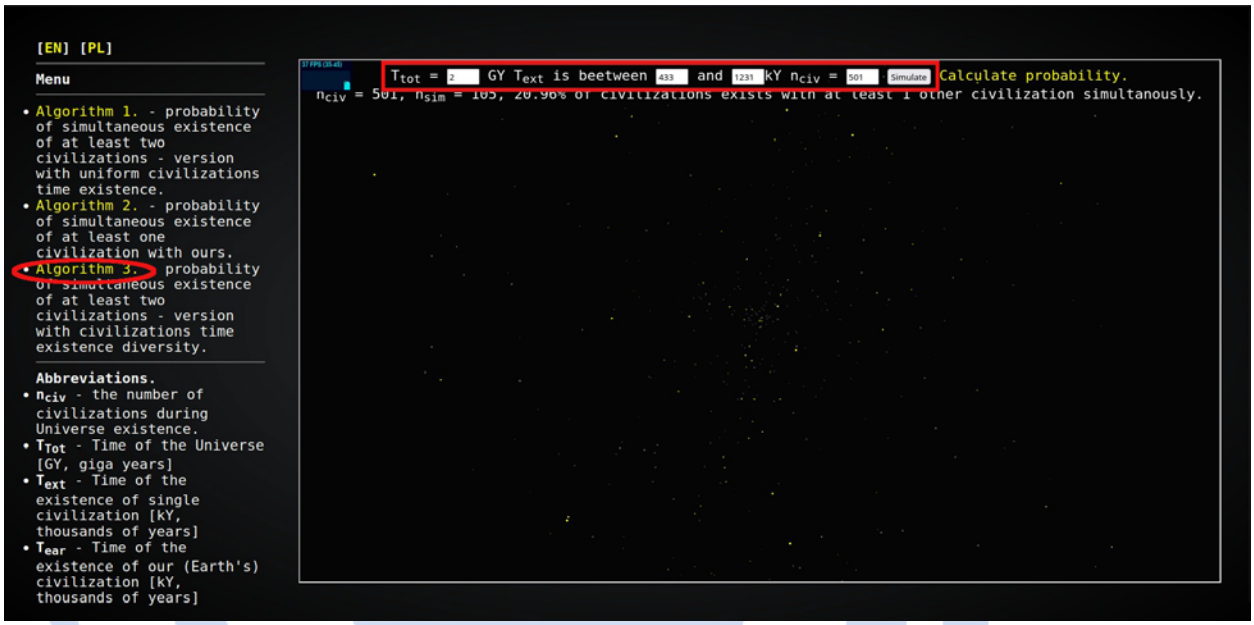
1. Input parameters: T_{tot} , T_{ext} , n_{civ} .
2. Initialize “event counter” L = 0.
3. Generate randomly n_{civ} positive numbers, t_i , smaller than T_{tot} , where t_i is a time when i civilization started to live. It means that i civilization lives in a time interval [t_i , t_i + T_{ext}]
4. For i civilization check if another civilization, j , started to live in the time interval [t_i , t_i + T_{ext}]. If yes, increase even counter, L, by 1.
5. Repeat points 3 and 4 N times.
6. Output: probability = L/N.

Algorithms 2 and 3 are implemented similarly.

➲ Slide 8

Second scenario - probability of simultaneous existence of at least one civilization with ours

Probability of simultaneous existence of at least one civilization with ours (or any that has been existed) for T_{ear} years. We assume, that technical civilizations started to born T_{tot} years ago. Each of these civilizations lives T_{ext}. During the time T_{tot} exactly n_{civ} civilizations can be born. We assume, that the civilization can be born in random (uniformly distributed) moments of time. The meaning of the results when the buttons ”Simulate” and ”Calculate probability” are clicked are analogous to the first algorithm.



➲ Slide 9

Third scenario - probability of simultaneous existence of at least two civilizations - version with civilizations time existence diversity.

In this scenario we assume, that technical civilizations started to born T_{tot} years ago. Each of these civilizations exists for a certain non-constant number (uniformly randomly distributed) of years. During the time T_{tot} exactly n_{civ} civilizations can be born. We assume, that the civilization can be born in random (uniformly distributed) moments of time. The meaning of the results when the buttons ”Simulate” and ”Calculate probability” are clicked are analogous to the first algorithm.

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https://futurespaceproject.eu/