E.T. Counter 1.0

E.T. Counter roughly calculates the number of inhabited planets and advanced civilizations that currently exist in our galaxy, based on your own specifications and assumptions. It relies on estimated percentages, probabilities and average values. The algorithm is inspired by Isaac Asimov's book "Extraterrestrial Civilizations" and the Green Bank formula (mainly created by F. D. Drake).

You are invited to provide your settings for future versions of the program. Send your ETC file via e-mail (cf. About E.T. Counter). Please make sure you specify your name and possibly some comments on your assumptions in Step 5. I would like to add a lot of different settings by different people to the program. However, I cannot *guarantee* to include your settings.

E.T. Counter 1.0

Freeware. Freely distributable. Does not expire. No installation required.

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Please make sure you have the latest version available. Visit the Homepage at http://www.sf-soft.de.

This is a minor revision of the first release, May 1999.

The following operating systems are supported:

- Windows 95/98
- Windows NT 4.0

Step 1: Stars in our Galaxy #1

At first, specify the **number of stars in our galaxy**. As far as I know, 200,000,000,000 is a good guess. Asimov speaks of 300,000,000,000.

The **percentage of stars that have planets** is still uncertain. Planets around stars other than our sun cannot be observed directly.

E.T. Counter assumes that the star population II and the first generation of population I cannot have a planetary system with chemical elements that are of vital importance for the evolution of life. Thus the percentage of **2nd generation population I stars** is to be specified. According to Asimov, this is 10%.

Stars that are **part of a multiple star system** are less suitable for the evolution of life because the partner stars could diminish their ecospheres considerably (cf. step 2). It is commonly accepted that at least 50% of all stars belong to a multiple star system. Asimov speaks of 50-70%.

The mere fact that a star belongs to the second generation of population I does not guarantee the presence of heavy elements. Therefore the **percentage** of such **stars that were created in regions with access to heavy elements** is to be specified.

Step 2 >

Step 2: Stars in our Galaxy #2

Stars with a mass of more than 1.44 relative sun masses are assumed to have a life expectancy too short for the evolution of life forms on planets around them. Stars with a mass of less than 0.33 sun masses are also excluded. One reason is that ecospheres are very close to such dwarf stars, not allowing a planet within it to rotate freely. The planet would always face the star with the same side. Therefore only stars with a sun-like mass are considered.

Specify the share of each **star type**. Giant stars are comparatively rare, dwarf stars are most common.

The **probability that a** single **star has a life-enabling ecosphere** is equal to 1 by default. However, the ecosphere of a star that belongs to a binary or, more general, a multiple system, may be greatly affected by the presence of a nearby partner star. It may be diminished by radiation or gravitational fluctuations originating from the other star. Specify the probability of existence of an effective ecosphere around a sun-like star for each partner star type.

< Step 1 Step 3 >

Step 3: Habitable Planets

As a provisional result, the number of sun-like stars in our galaxy that have at least one planet and enable the evolution of life within their ecospheres is displayed.

Specify the **probability that a planet actually exists in the ecosphere**. (In order to reflect the conceivable assumption that on average even several planets could exist in the ecosphere, it is allowed for once to specify a "probability" greater than 1.) According to simulations carried out by NASA scientist Michael Hart in 1978, the ecosphere of a star is that narrow, that the presence of a planet within its boundaries is highly unlikely. However, computer simulations by the American astronomer Stephen Doyle suggest just the opposite.

Specify the **probability that the planet has a suitable mass** (and thus a suitable gravitation for life forms) and provides certain **chemical elements** that form necessary materials and substances. A gas giant for instance fulfills neither of these preconditions.

Specify the probability that the planet additionally meets the additional requirements mentioned in the program and thus is to be considered "**habitable**".

Specify the **probability that** (at least primitive) **life forms actually evolve on a habitable planet**. This is really hard to guess. The default value is based on the Laplace principle, a fifty-fifty chance. For those who think that this is a too optimistic estimation: Asimov, professor of biochemistry, assumes a probability of 1!

< Step 2 Step 4>

Step 4: Advanced Civilizations

A provisional result is displayed, the number of planets in our galaxy that are currently inhabited.

Specify after how many years, from the beginning of existence of a planet, you expect the **first primitive life forms** to evolve (earth: round about 1,000,000,000 years), provided that life really evolves on this planet.

*Specify after how many years, from the beginning of existence of a planet, you expect the genesis of the **first advanced civilization** (earth: appr. 4,500,000,000 years). The planet itself is suspected to exist 10,000,000,000 years on average (until its sun becomes unstable and dies).

Specify the **total time the planet is inhabited by advanced civilizations**. This is the most crucial part of the whole calculation, and the most difficult one. You have to estimate how long an average civilization exists until it becomes extinct. This may happen naturally, or the civilization annihilates itself by means of devastating weapons. It is conceivable that another civilization succeeds on the same planet some time after the disappearance of the previous one.
The total time the planet is inhabited by advanced civilizations is equal to the number of succeeding advanced civilizations multiplied by their average life expectancy. It is 25×1,000,000 = 25,000,000 years by default (at a guess). The number must not exceed 10,000,000,000 - (the previous number*).
The total time the planet is inhabited highly affects the probability that it is inhabited *right now*.

Specify the **average distance between neighboring 2nd generation population I stars** in our galaxy. These stars are located in the spiral arms of the milky way, so they are relatively far from one another -- 7.6 light-years on average, according to Asimov. Other sources report 5 light-years.

In order to project the number of civilizations in our galaxy to the whole universe, two numbers are significant. On the one hand, the **average size of galaxies**, measured by the size of the milky-way, is to be specified, on the other hand the total **number of galaxies** in the universe. The average galaxy is considerably smaller than ours. 0.033 is the multiplier Asimov mentions.

E.T. Counter does not consider the possibility that there are several other universes besides ours...

< Step 3 Step 5 >

Step 5: Textual Settings Description

Please enter your name and optionally further information about you (your native country, address, ...). If your profession or education is related to the topic, please let us know!

The "comments" field is designated for any explanations of your assumptions as well as for arguments and sources of information. These hints are greatly appreciated when you submit your settings to the author (cf. About E.T. Counter). Thank you for participating!

E.T. Counter's Algorithm

All variables that are to be specified by the user are named according to the corresponding program step and their relative position in this step. For example, "45" is the fifth variable specified in step 4 (=the average size of galaxies relative to ours).

Furthermore the following acronyms are used in the equations:

RSSE: Number of "relevant" single stars with a suitable ecosphere
RSM: Number of "relevant" stars that belong to a multiple star system
RSME: Number of "relevant" stars with a suitable ecosphere that belong to a multiple star system
RS: Total number of "relevant" stars (sun-like stars that have a suitable ecosphere and at least one planet, as explained at the beginning of step 3)
IP: Number of currently inhabited planets in our galaxy
DIP: Average distances between neighboring inhabited planets
NG: Number of currently existing advanced civilizations in our galaxy
DNG: Average distances between the N neighboring advanced civilizations in our galaxy
NU: Number of advanced civilizations in the universe

RSSE = 11 × 12 × 13 × 15 × 22 × (**1** - 14) × 24

RSM = 11 × 12 × 13 × 15 × 22 × 14

RSME = RSM × (21 × 25 + 22 × 26 + 23 × 27)

RS = RSSE + RSME

IP = RS × 31 × 32 × 33 × 34 × (**10,000,000,000** - 41) / **10,000,000,000**

DIP = 34 × (11 × 13 / IP) ^ (1/3)

NG = Max [**1**, IP × 43 / **10,000,000,000**]

DNG = 34 × (11 × 13 / N) ^ (**1**/**3**)

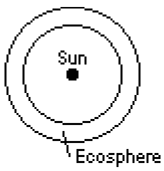
NU = N × 45 × 46

Notes:

- Variable 42 is only used to limit variable 43 to (**10,000,000,000** - 42) at maximum.
- The results shown in E.T. Counter's main window are rounded when displayed in order to facilitate reading.
- Constant star birth and death rates are assumed.
- It is assumed that simple life forms on a habitable planet, once evolved, do not become extinct.

Ecosphere

The ecosphere of a star is the only place where life can evolve. It is sufficiently far from the sun and yet sufficiently close to it to ensure a moderate level of radiation and temperature.



Star Populations

The oldest stars in our galaxy belong to the so-called star population II. They are concentrated in the galactic core and the halo. Stars of population II and their possibly existing planetary systems do not contain elements other than hydrogen and helium. The mere existence of these two elements is not sufficient for the evolution of life.

Stars that belong to the population I formed later in the outer areas of the galaxy, where matter was not as dense as in the core. Initially they also contained only hydrogen and helium, but stars of a second generation possibly contained heavier elements originating from explosions of early dying giant stars, that created these vital materials.

Therefore E.T. Counter assumes that only stars of the 2nd generation of population I that were created in regions with access to heavy elements possibly have life-enabling planetary systems.

Introduction

What can we learn from the results that E.T. Counter presents to us?

Nearly everybody has heard about the enormous dimensions of the universe and its countless stars. The idea was born that it is highly likely that *we are not alone*, that earth is not the only inhabited planet and that humanity is not the only advanced (?) civilization. Large projects such as SETI have been undertaken in order to make contact to extraterrestrial beings, without success until now. Some of us are assuming that aliens already have visited earth or still visit it, but the final proof is missing.

E.T. Counter can help us to evaluate the aforementioned assumptions.

Life could be a unique precious gift to the solar system, but it is also conceivable that the galaxy is teeming with life. -- Lacking a possibility to travel faster than light, how likely is it that we are visited by aliens in view of astronomical distances? -- How likely is it that we will receive signals from extraterrestrial intelligences, let alone establish a bidirectional contact? -- How likely is it that we will find an earth-like planet around a nearby star and we will be able to colonize it in the future?

E.T. Counter gives us an idea and offers to experiment with diverging assumptions.