

Evaluating your Drake Equation

Basic Ideas

- Number of Civilizations in our Galaxy
 - Product of rate of emergence and L
 - Running product gives rate for each step
 - Until L , we have rates
 - Through f_c , we get “communicable” civilizations
 - Multiplying by L gives the number (N)
 - Assumes “steady state” between birth and death of civilizations

Drake Equation:

$$N = R_* f_p n_e f_\ell f_i f_c L$$

N = number of communicable civilizations in our galaxy

R_* = Rate at which stars form

f_p = Fraction of stars which have planetary systems

n_e = Number of planets, per planetary system,

f_ℓ = Fraction of suitable planets where life arises

f_i = Fraction of life bearing planets where intelligence develops

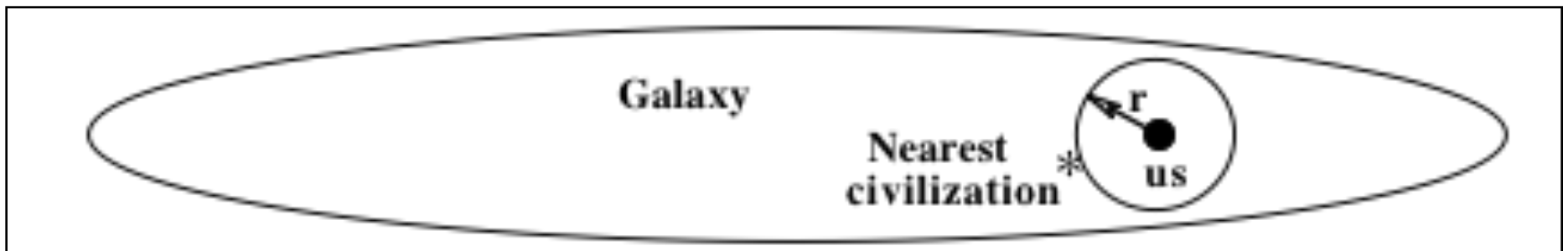
f_c = Fraction of planets with intelligent life which develop a technological phase during which there is a capacity for and interest in interstellar communication

L = Average lifetime of communicable civilizations

r = Average distance to nearest civilization

Distance to Nearest Neighbor

1. Assume civilizations spread uniformly but randomly through galaxy

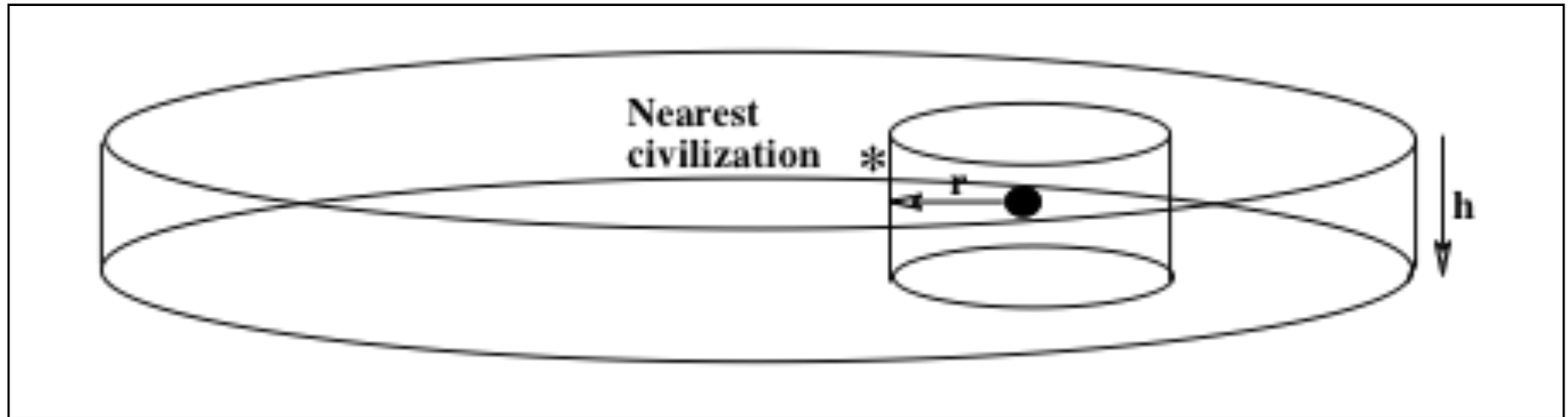


r = radius of imaginary sphere centered on us that touches nearest civilization

search vol $\propto r^3$

$$\Rightarrow r = \frac{10^4 \text{ ly}}{N^{1/3}}$$

Distance to Nearest Neighbor



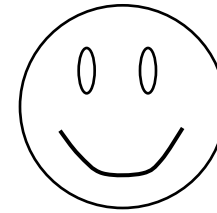
If $N < 8000$, r from previous formula is 500 ly

About equal to thickness of Galaxy

Use cylinder for search vol $\propto r^2 h$

$$\text{so } r = \frac{5 \times 10^4 \text{ ly}}{N^{1/2}}$$

Happy Feller



	R	f_p	n_e	f_ℓ	f_i	f_c	L	N	r
Estimate	50	1	1	1	1	1	5×10^9	2.5×10^{11}	1.6 ly
Birthrate	50	50	50	50	50	50	 2.5 out of 4 stars		

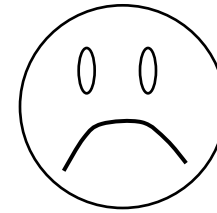
If $N > 8000$,

$$r = \frac{10^4 \text{ light years}}{N^{1/3}}$$

If $N < 8000$,

$$r = \frac{5 \times 10^4 \text{ light years}}{N^{1/2}}$$

Angela Angst



	R	f_p	n_e	f_ℓ	f_i	f_c	L	N	r
Estimate	5	0.1	0.1	0.01	0.01	0.01	100	5×10^{-6}	---
Birthrate	5	0.5	0.05	5×10^{-4}	5×10^{-6}	5×10^{-8}			

Never two civilizations at
same time

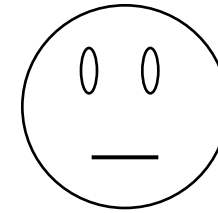
If $N > 8000$,

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If $N < 8000$,

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Mr. Average Guy



	R	f_p	n_e	f_ℓ	f_i	f_c	L	N	r
Estimate	10	0.5	0.89	0.5	0.7	0.6	1×10^6	9.4×10^5	100
Birthrate	10	5	4.45	2.23	1.56	0.94			

1 out of
 4×10^5 stars

$10 \times 10^5 = 10^6$

If $N > 8000$,

$$r = \frac{10^4 \text{ light years}}{N^{1/3}}$$

If $N < 8000$,

$$r = \frac{5 \times 10^4 \text{ light years}}{N^{1/2}}$$

Evaluating YOUR Drake Equation

- Almost no answers are wrong
 - It must be possible for us to exist
 - N must be no greater than the number of stars in the Galaxy
 - May imply limit on L
- Ways to evaluate:
 - Plug into equations
 - Use calculator on web
 - <http://www.as.utexas.edu/astronomy/education/drake/drake.html>
 - Ask us for help

Your Drake Equation

	R	f_p	n_e	f_ℓ	f_i	f_c	L	N	r
Estimate									
Birthrate									

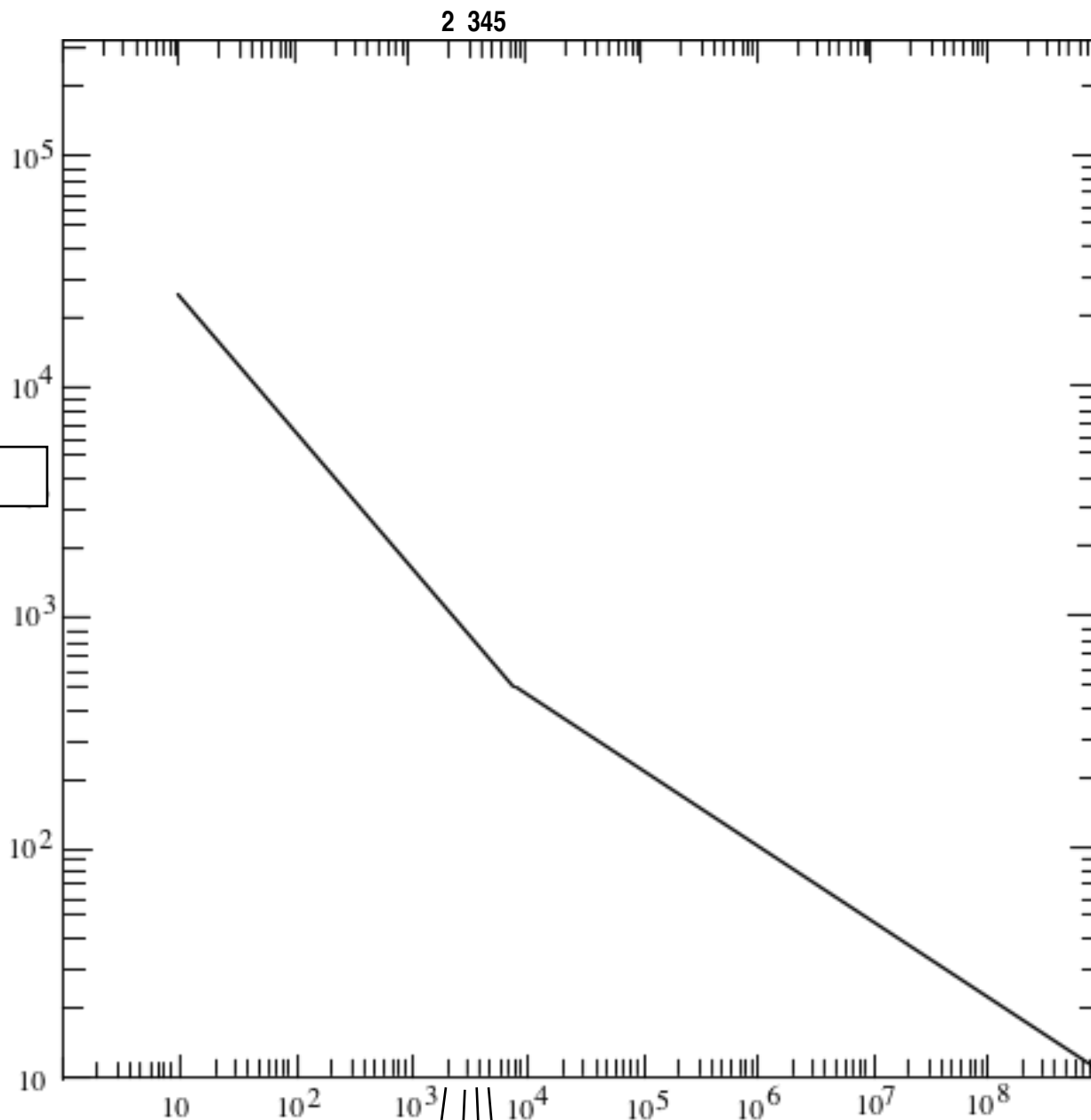
If $N > 8000$,

$$r = \frac{10^4 \text{ light years}}{N^{1/3}}$$

If $N < 8000$,

$$r = \frac{5 \times 10^4 \text{ light years}}{N^{1/2}}$$

$r(\ell y)$



Note log scales

Points to bear in mind

- r is based on assuming spread uniformly
 - Could be less if closer to center of MW
- r is based on averages
 - Could be closer but unlikely
- r is less uncertain than N
- Since signals travel at c , time = distance in ly
- If $L < 2r$, no two way messages