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

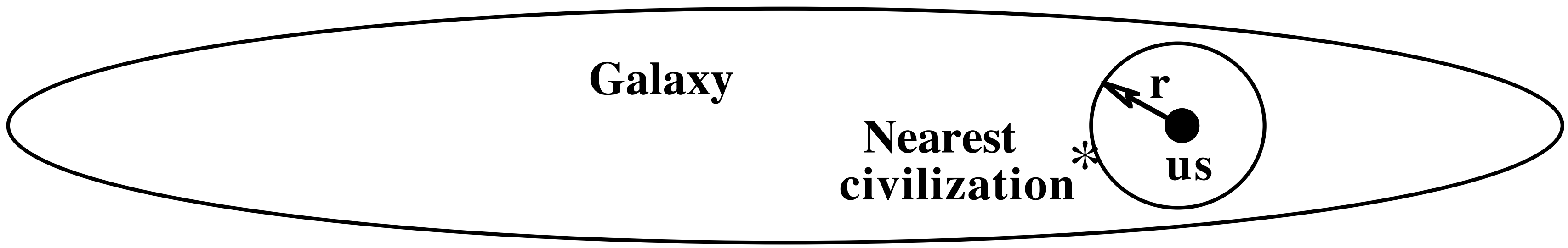
Drake Equation:

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

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, which are suitable for life
f_ℓ	=	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 of lifetime of communicable civilizations
r	=	Average distance to nearest civilization

Distance to Nearest Neighbor

1. Assume civilizations spread uniformly but randomly through galaxy

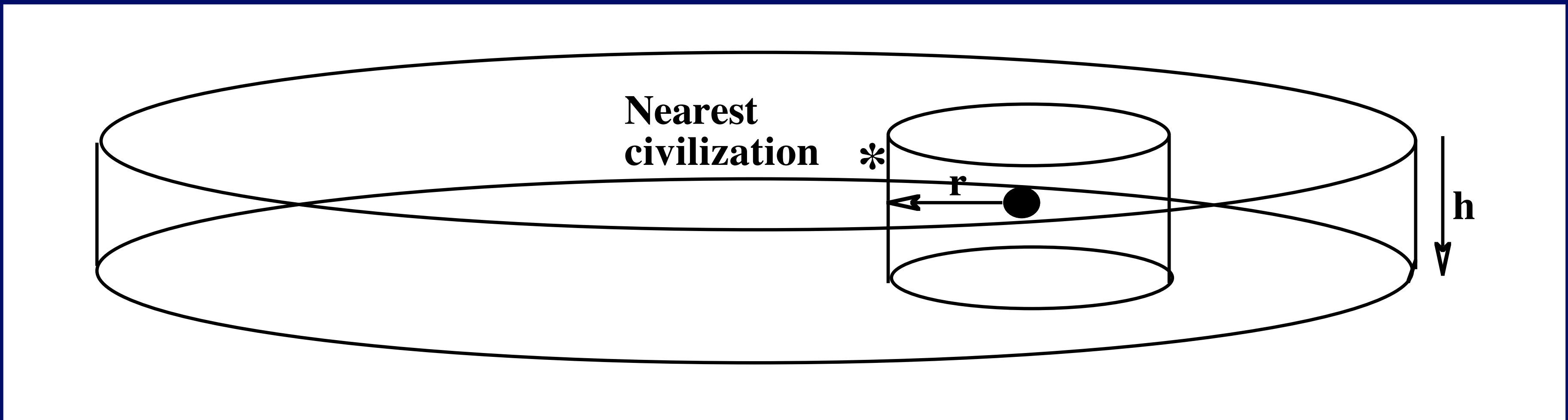


r = radius of imaginary sphere centered on us
that touches nearest civilizaztion

search vol $\propto$ r^3

$$\Rightarrow \quad r = \frac{10^4 \, \ell y}{N^{1/3}}$$

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 $\propto r^2 h$

so $r = \dfrac{5 \times 10^4 \; \ell y}{N^{1/2}}$

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 $N > 8000$, $$r = \frac{10^4 \text{ light years}}{N^{1/3}}$$

If $N < 8000$, $$r = \frac{5 \times 10^4 \text{ light years}}{N^{1/2}}$$

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 $N > 8000$, $\quad r = \dfrac{10^4 \text{ light years}}{N^{1/3}}$

If $N < 8000$, $\quad r = \dfrac{5 \times 10^4 \text{ light years}}{N^{1/2}}$

Evaluating YOUR Drake Equation

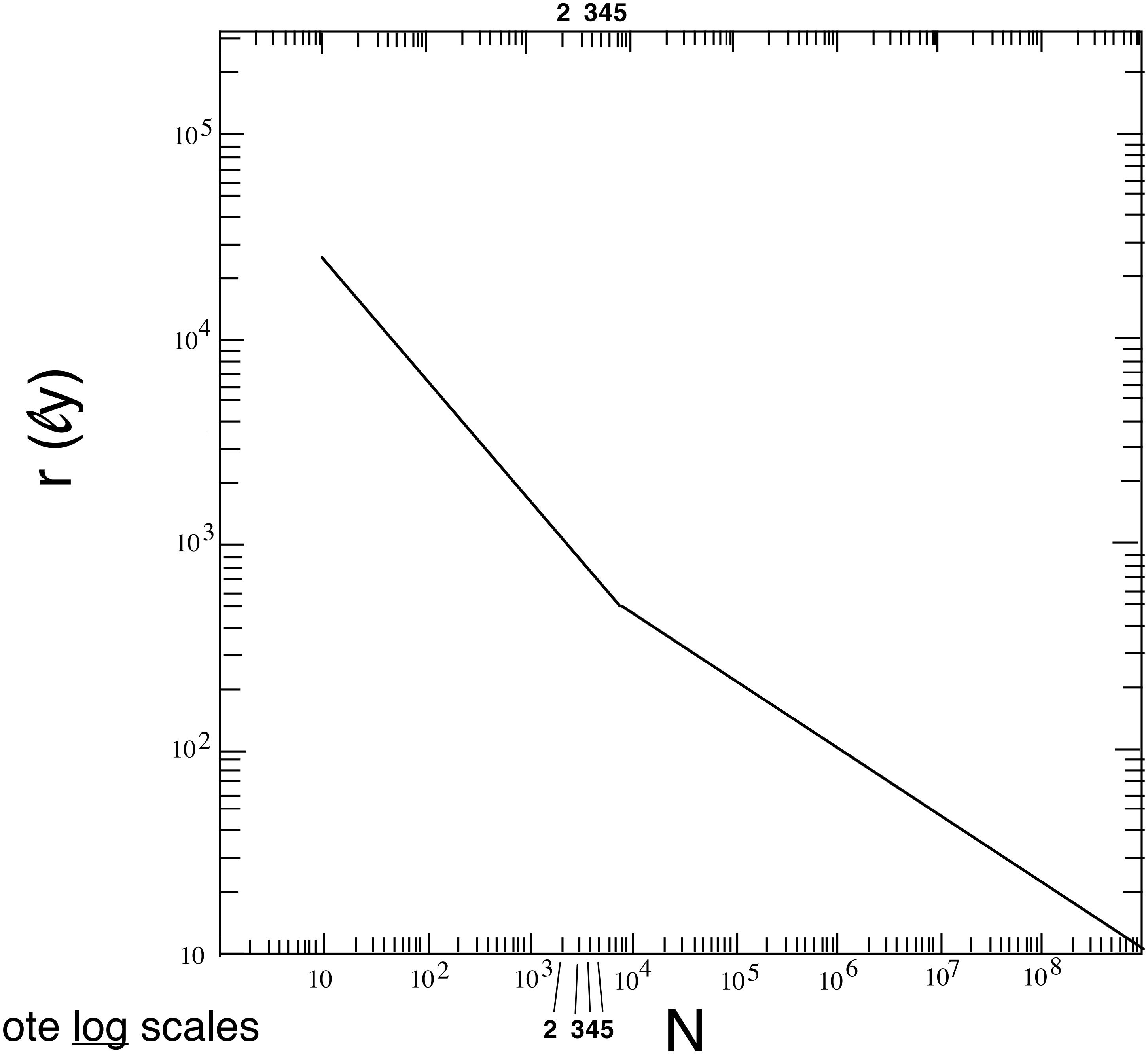
- Almost no answers are wrong
  - It must be possible for us to exist
  - N must be no greater than the number of stars in the Galaxy
    - May imply limit on L
- Ways to evaluate:
  - Plug into equations
  - Use calculator on web
    - http://www.as.utexas.edu/astronomy/education/drake/drake.html
  - 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 $N < 8000$, $$r = \frac{5 \times 10^4 \text{ light years}}{N^{1/2}}$$



Note <u>log</u> scales

Points to bear in mind

- r is based on assuming spread uniformly
  - Could be less in 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