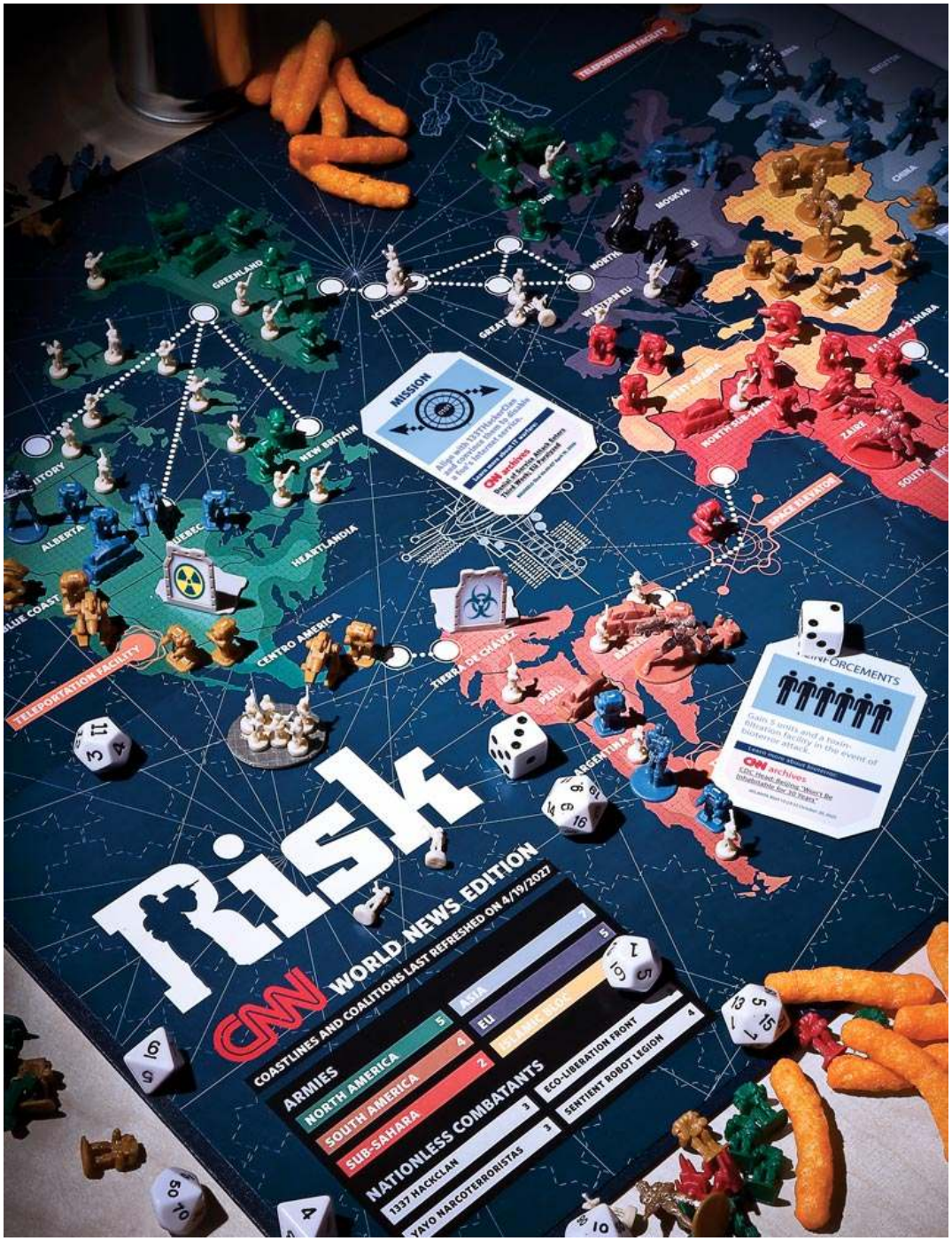
Swine flu, black swans, and Geneva-eating dragons

Anders Sandberg
Future of Humanity Institute
James Martin 21st Century School
Oxford University

SAVANNAH LINE

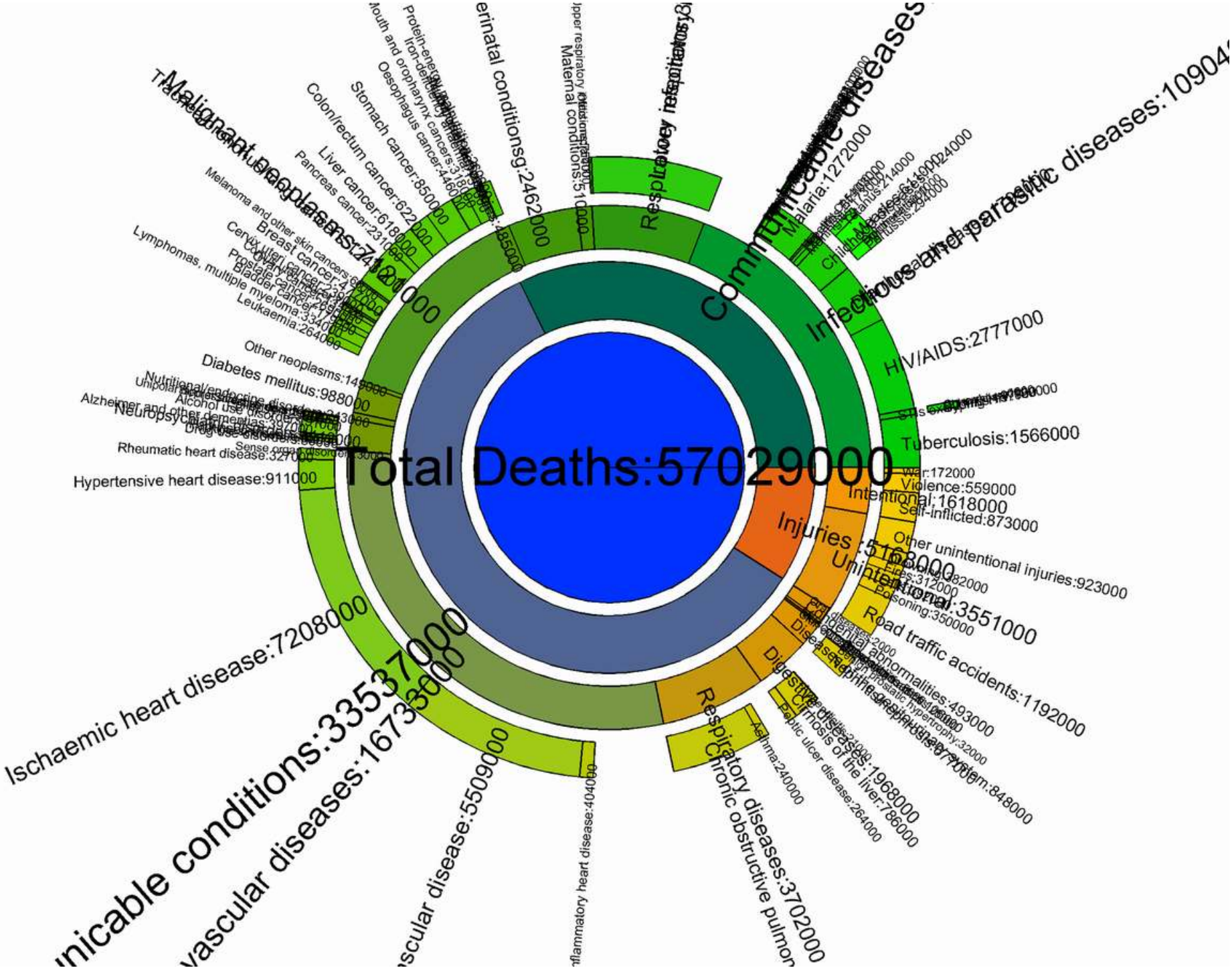

Risk
CNN WORLD NEWS EDITION
COASTLINES AND COALITIONS LAST REFRESHED ON 4/19/2027
ARMIES
NORTH AMERICA 5
SOUTH AMERICA 4
SUB-SAHARA 2
ASIA 7
EU 5
ISLAMIC BLOC 5
NATIONLESS COMBATANTS
1337 HACKCLAN 3
YAYO NARCOTERRORISTAS 3
ECO-LIBERATION FRONT 4
SENTIENT ROBOT LEGION 4
MISSION
CNN archives
TELEPORTATION FACILITY
GREENLAND
ICELAND
NEW BRITAIN
HEARTLANDIA
CENTRO AMERICA
ALBERTA
BLUE COAST
TIERRA DE CHAVEZ
PERU
ARGENTINA
MOSKVA
NORTH
WESTERN EU
CHINA
EAST SUB-SAHARA
ZAIRE
SPACE ELEVATOR
CNN archives

Cognitive
biases

Risks we have experience with: everyday mortality

"You won't skid if you stay in a rut."

-Kin Hubbard

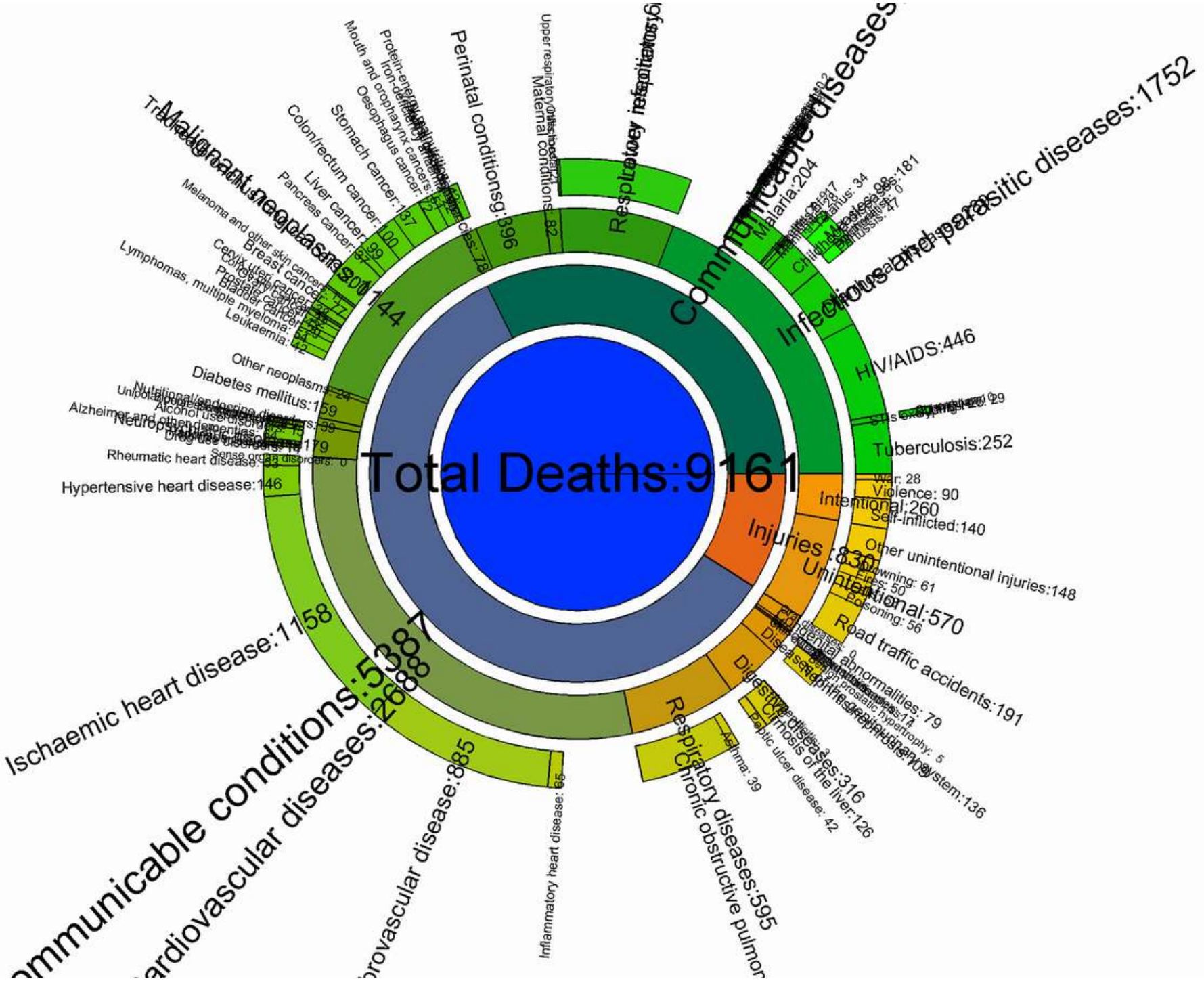


Total Deaths:57029000
Communicable diseases
Infectious and parasitic diseases:10904
Malignant neoplasms:7101000
Ischaemic heart disease:7208000
Hypertensive heart disease:911000
Rheumatic heart disease:327000
Diabetes mellitus:988000
Other neoplasms:149000
Leukaemia:264000
Lymphomas, multiple myeloma:334000
Melanoma and other skin cancers:6
Breast cancer:4
Liver cancer:618000
Pancreas cancer:231000
Colon/rectum cancer:622000
Stomach cancer:850000
Oesophagus cancer:446000
Mouth and oropharynx cancers:318000
Iron-deficiency anaemia:
Protein-energy
Maternal conditions:510000
Upper respiratory
Respiratory
Malaria:1272000
HIV/AIDS:2777000
Tuberculosis:1566000
Injuries :5168000
Intentional:1618000
War:172000
Violence:559000
Self-inflicted:873000
Other unintentional injuries:923000
Unintentional:3551000
Fires:312000
Poisoning:350000
Road traffic accidents:1192000
Congenital abnormalities:493000
Diseases:1968000
Cirrhosis of the liver:786000
Peptic ulcer disease:264000
Asthma:240000
Respiratory diseases:3702000
Chronic obstructive pulmon
Inflammatory heart disease:404000
Vascular disease:5509000
Vascular diseases:16733000
Unicable conditions:33537000

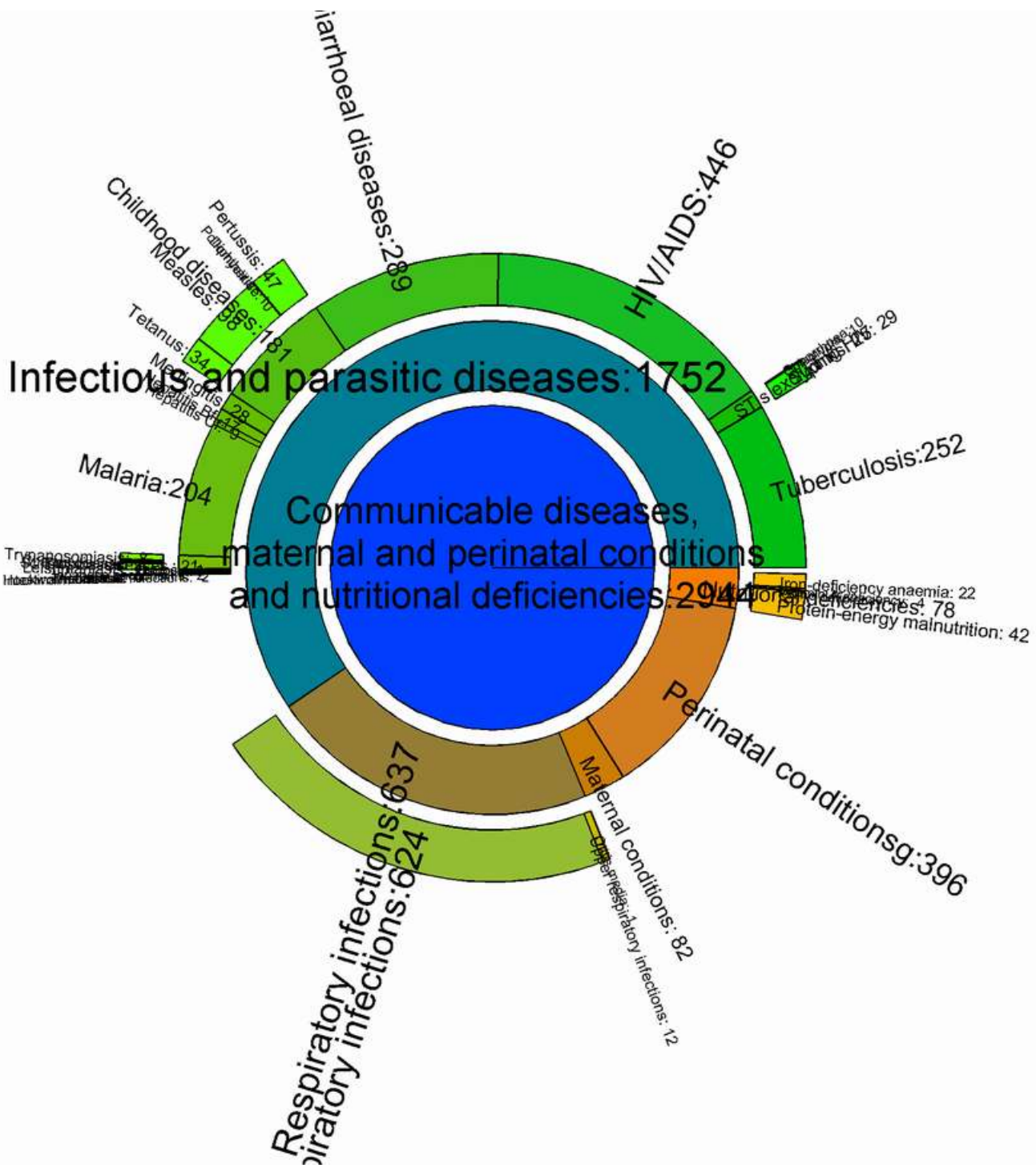
Micromorts

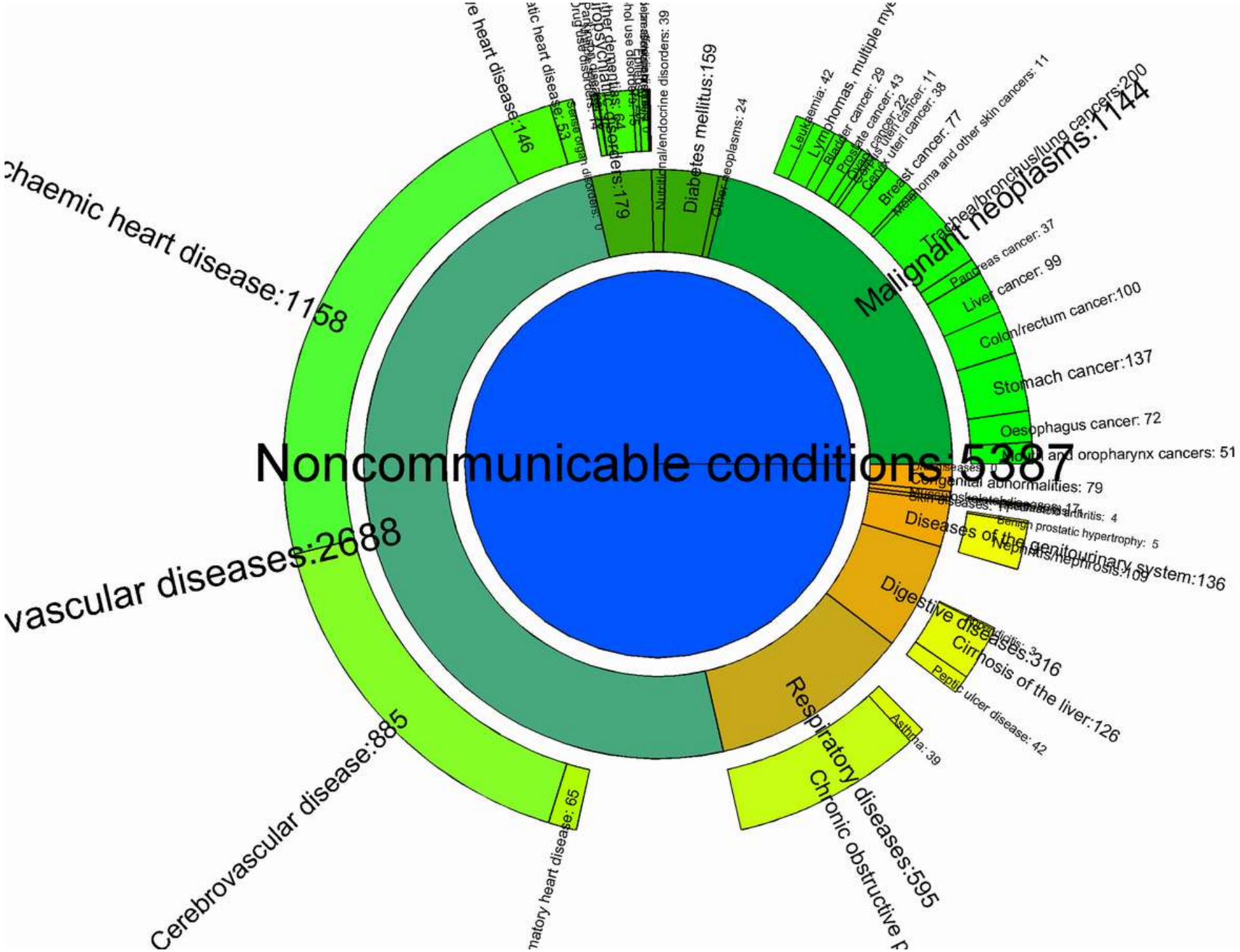
1 micromort = one-in-a-million probability of death

- ***Suggested by Ronald A. Howard***
- ***Good for rough comparisons***
- ***People usually pay between $4 and $20 to reduce risk one micromort***
- ***Accident risk: ~1 mmt/day***
- ***Mortality: grows approximately by 10% per year from 100 mmt/y at age 10***
  - ***Mortality rate for a 37 year old male is ~3.4 micromorts per day.***

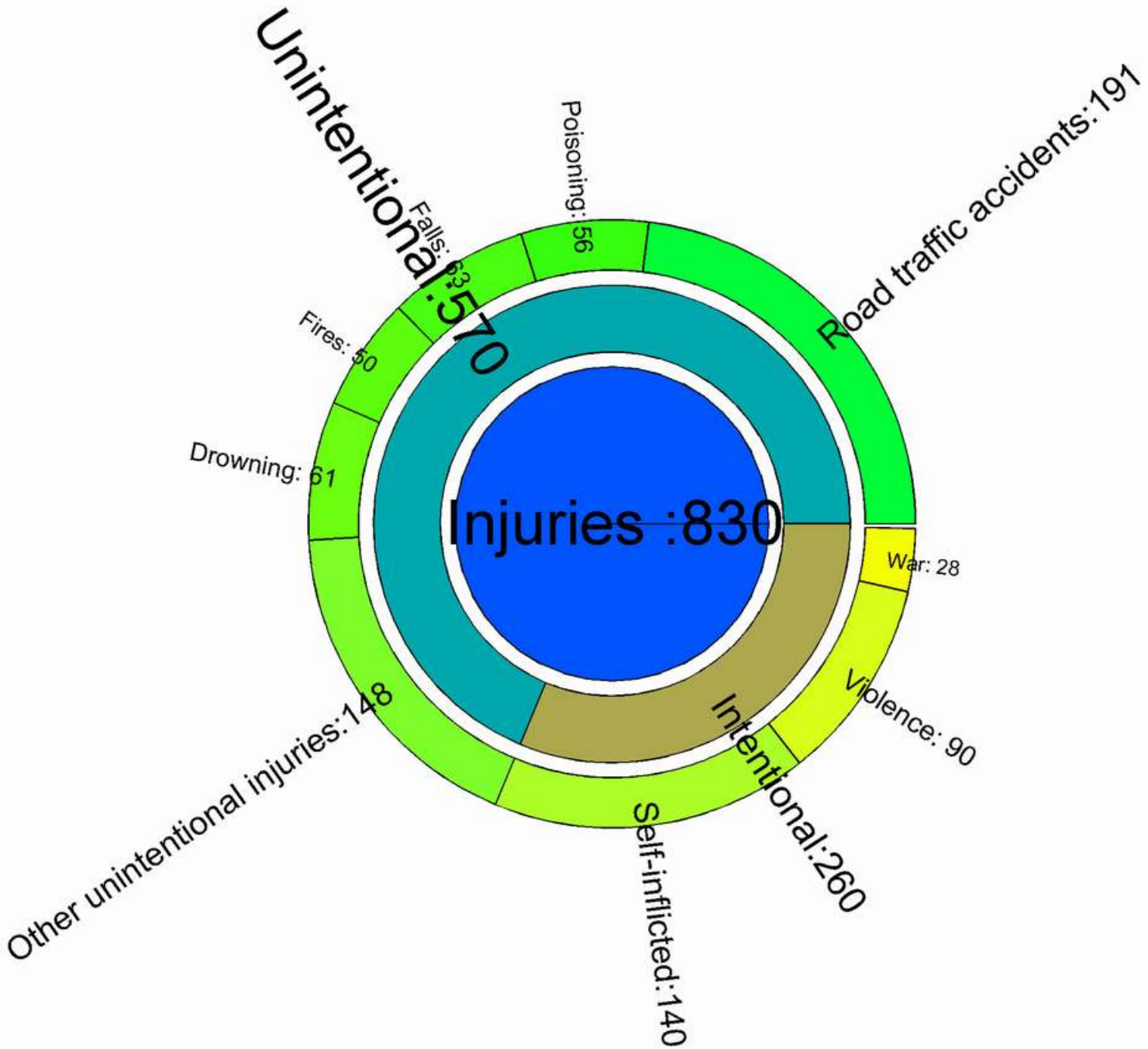


Total Deaths:9161
Communicable diseases
Infectious and parasitic diseases:1752
Malignant neoplasms:1144
Perinatal conditionsg:396
Maternal conditions: 82
Malaria:204
HIV/AIDS:446
Tuberculosis:252
Injuries :830
Intentional:260
Unintentional:570
Road traffic accidents:191
Other unintentional injuries:148
Ischaemic heart disease:1158
Communicable conditions:5387
Respiratory diseases:595
Chronic obstructive pulmon
Inflammatory heart disease: 65
Hypertensive heart disease:146
Diabetes mellitus:159
Other neoplasms: 24
Rheumatic heart disease:
Lymphomas, multiple myeloma:
Leukaemia: 42
Breast cancer:
Liver cancer:
Pancreas cancer:
Colon/rectum cancer:
Stomach cancer:
Oesophagus cancer:
Mouth and oropharynx cancers:
Alzheimer and other dementias:
Alcohol use disorders:
Sense organ disorders: 0
Asthma: 39
Peptic ulcer disease: 42
Cirrhosis of the liver:126
Digestive diseases:316
Congenital abnormalities: 79
Poisoning: 56
Fires: 50
Drowning: 61
Violence: 90
War: 28
Self-inflicted:140
Malignant neoplasms:


Infectious and parasitic diseases:1752
Communicable diseases, maternal and perinatal conditions and nutritional deficiencies:2944
Childhood diseases:181
Pertussis: 47
Measles: 98
Tetanus: 34
Malaria:204
Diarrhoeal diseases:289
HIV/AIDS:446
Tuberculosis:252
Nutritional deficiencies: 78
Iron-deficiency anaemia: 22
Protein-energy malnutrition: 42
Perinatal conditionsg:396
Maternal conditions: 82
Respiratory infections:624
Respiratory infections: 12



Noncommunicable conditions:5387
Malignant neoplasms:1144
Trachea/bronchus/lung cancers:200
Breast cancer: 77
Melanoma and other skin cancers: 11
Cervix uteri cancer: 38
Cervix uteri cancer: 11
Prostate cancer: 43
Bladder cancer: 29
Lymphomas, multiple mye
Leukaemia: 42
Diabetes mellitus:159
Other neoplasms: 24
Nutritional/endocrine disorders: 39
Mouth and oropharynx cancers: 51
Oesophagus cancer: 72
Stomach cancer:137
Colon/rectum cancer:100
Liver cancer: 99
Pancreas cancer: 37
Congenital abnormalities: 79
Diseases of the genitourinary system:136
Benign prostatic hypertrophy: 5
Nephritis/nephrosis:109
Digestive diseases:316
Cirrhosis of the liver:126
Peptic ulcer disease: 42
Respiratory diseases:595
Asthma: 39
Chronic obstructive p
Cerebrovascular disease:885
matory heart disease: 65
vascular diseases:2688
chaemic heart disease:1158
e heart disease:146
atic heart disease: 53
Sense organ disorders: 0
Nutritional/endocrine disorders: 39

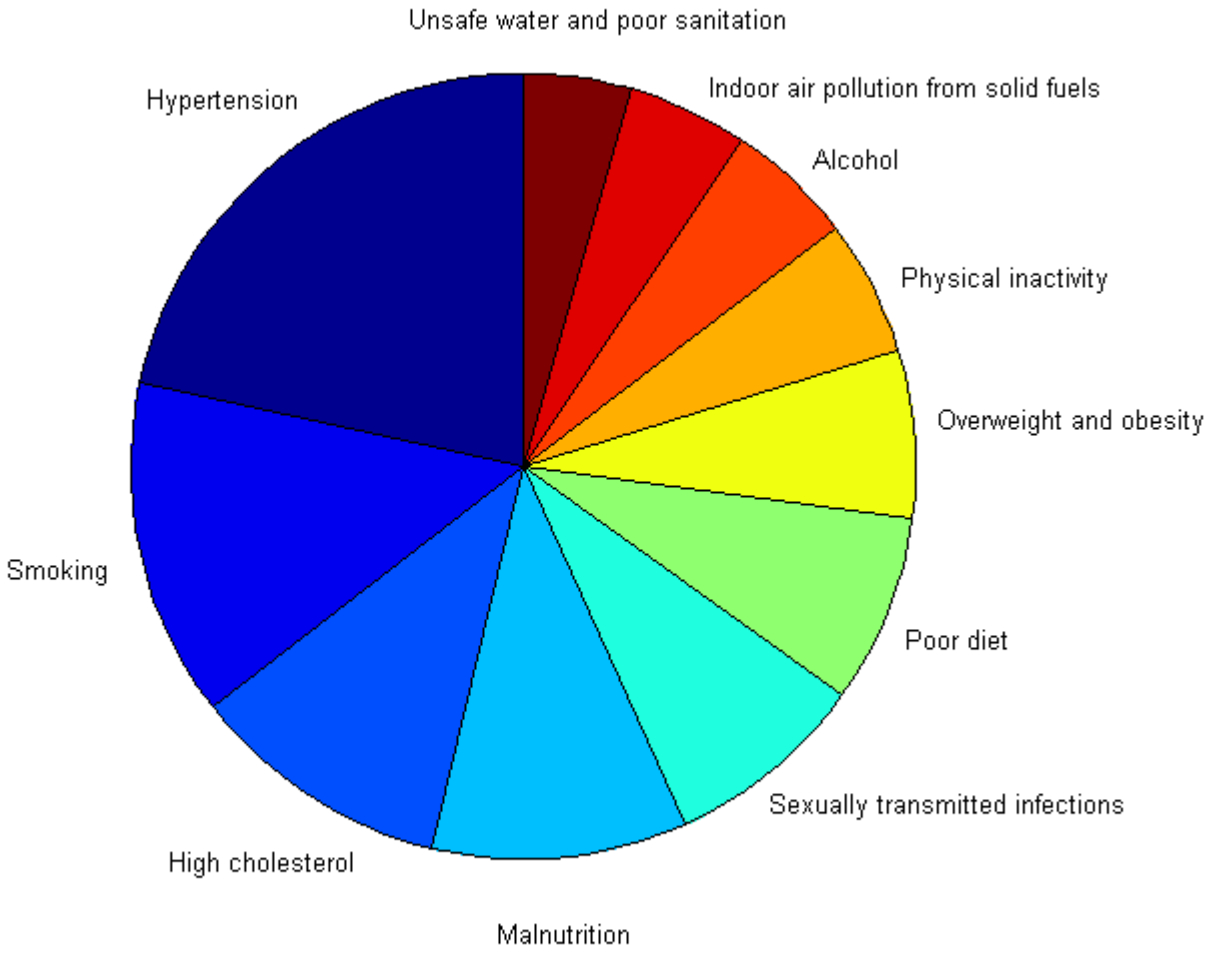

Injuries :830
Unintentional:570
Falls: 63
Poisoning: 56
Road traffic accidents:191
Fires: 50
Drowning: 61
War: 28
Violence: 90
Other unintentional injuries:148
Intentional:260
Self-inflicted:140

1 micromort risks

- *Smoking 1.4 cigarettes*
  - *(cancer, heart disease)*
- *Drinking 0.5 liter of wine*
  - *(cirrhosis)*
- *Spending 3 hours in a coal mine*
  - *(lung disease)*
- *Spending 3 hours in a coal mine*
  - *(accident)*
- *Living 2 days in New York or Boston*
  - *(air pollution)*
- *Living 2 months with a smoker*
  - *(cancer, heart disease)*
- *Drinking Miami water for 1 year*
  - *(cancer from chloroform)*
- *Travelling 6 minutes by canoe*
  - *(accident)*
- *Travelling 10 miles by bicycle*
  - *(accident)*
- *Travelling 230 miles by car*
  - *(accident)*
- *Flying 1000 miles by jet*
  - *(accident)*
- *Flying 6000 miles by jet*
  - *(cancer from cosmic radiation)*
- *Travelling 6000 miles by train*
  - *(accident)*
- *Living 2 months in Denver*
  - *(cancer from cosmic radiation)*
- *One chest X-ray*
  - *(cancer)*
- *Living 150 years within 20 miles of nuclear power plant*
  - *(cancer from radiation)*
- *Eating 100 charcoal-broiled steaks*
  - *(cancer from benzopyrene)*
- *Eating 40 tablespoons of peanut butter*
  - *(liver cancer from aflatoxin B)*
- *Taking one ecstasy tablet*
- *Making 2 riding trips*
- *1/8 hang-gliding trip*
- *1/5 scuba trip*

Micromorts per year (US)

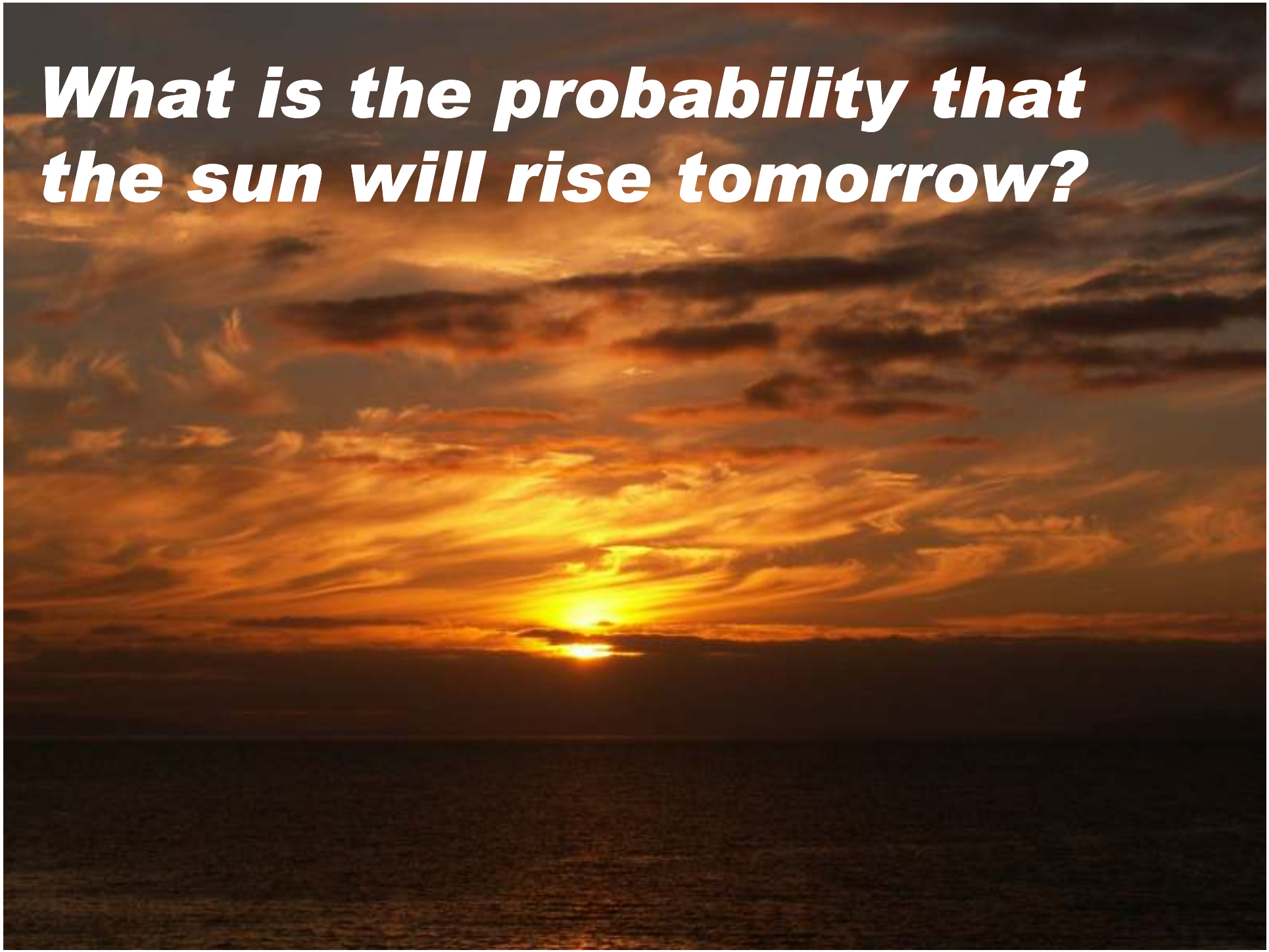
- *All causes, age 80: 80000*
- *Heart disease: 2519*
- *Stroke: 589*
- *Unintentional injury: 340*
- *Cancer: 195*
- *Car accident: 148*
- *Leukaemia: 76*
- *Homicide: 64.8*
- *Accidental poisoning: 35*
- *Food poisoning: 17.7*
- *Drowning: 15.6*
- *Fire: 12.1*
- *Killed by co-worker: 9*
- *Tuberculosis: 5*
- *Train accident: 2*
- *Electrocution: 1.5*
- *Airplane accident: 0.9*
- *Asteroid impact: 0.76*
- *Floods: 0.4*
- *Terrorism: 0.3*
- *Lightening: 0.2*
- *Insect sting: 0.2*
- *Earthquake: 0.1*
- *Train crash: 0.09*
- *Struck by fallen airplane: 0.06*
- *Hurricane: 0.04*
- *Bioterrorism: 0.018*
- *Fireworks accident 0.01*

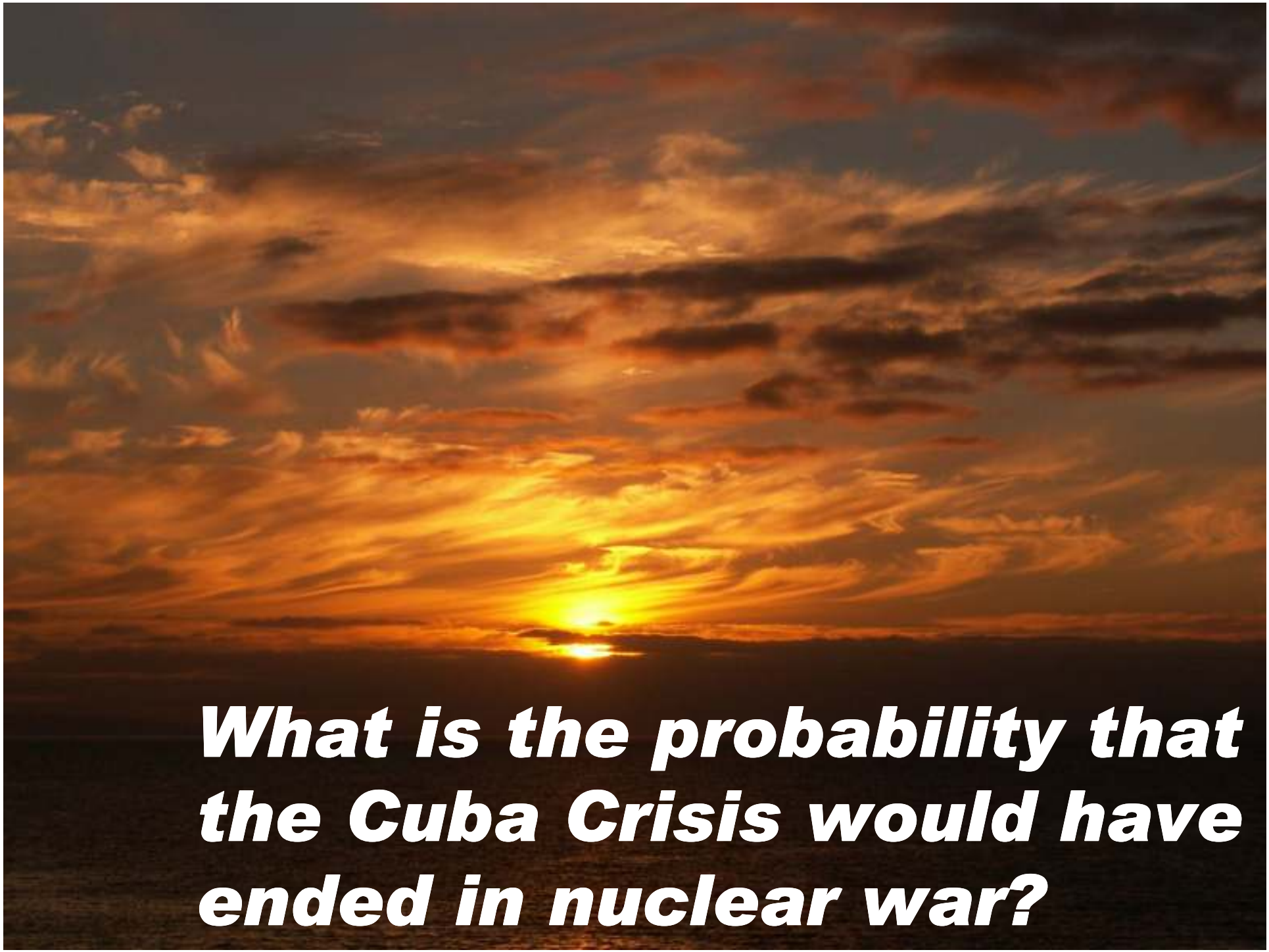

Unsafe water and poor sanitation
Indoor air pollution from solid fuels
Alcohol
Physical inactivity
Overweight and obesity
Poor diet
Sexually transmitted infections
Malnutrition
High cholesterol
Smoking
Hypertension

Risks we almost have experience with: swine flu

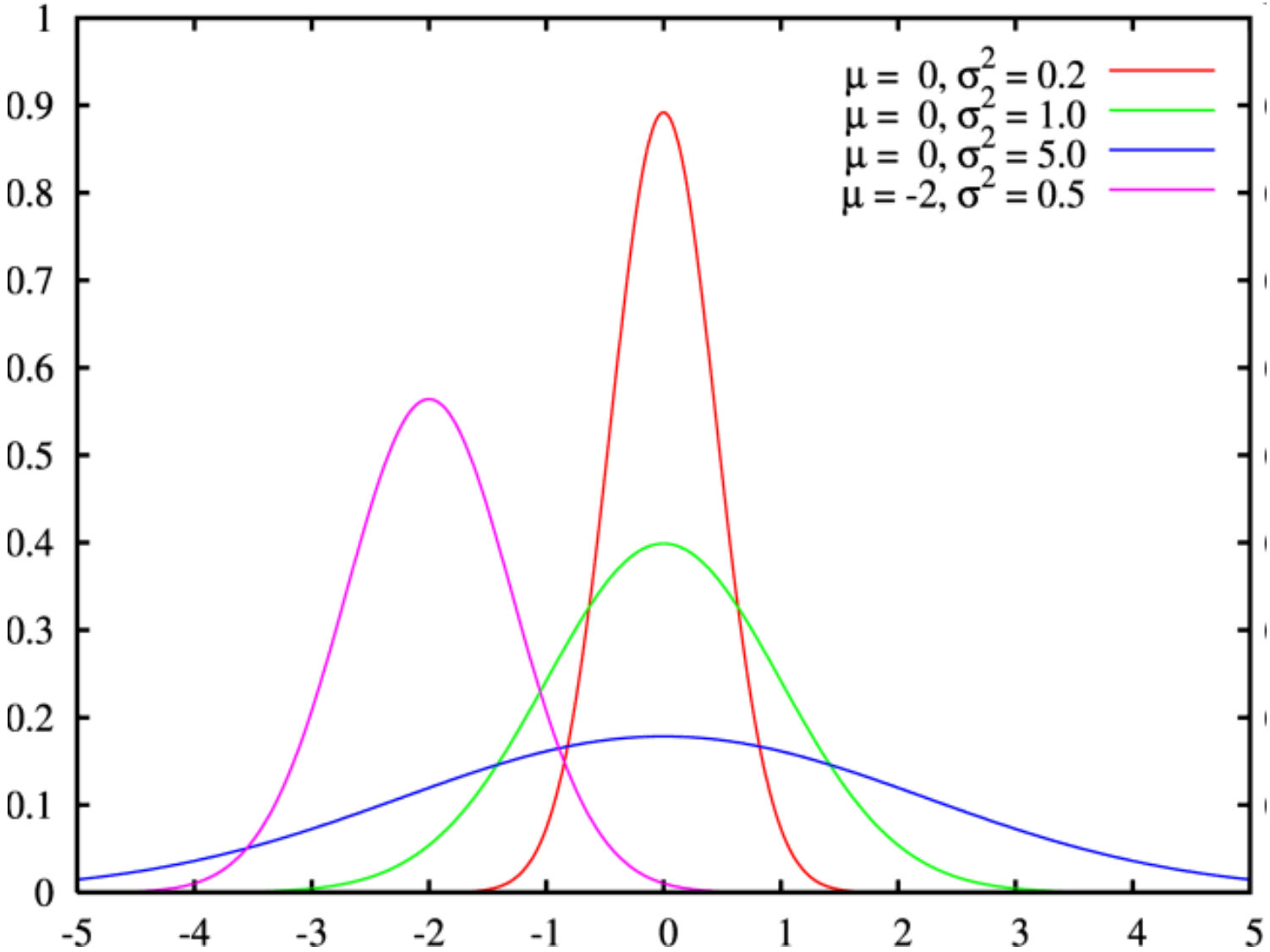
How bad could it be?

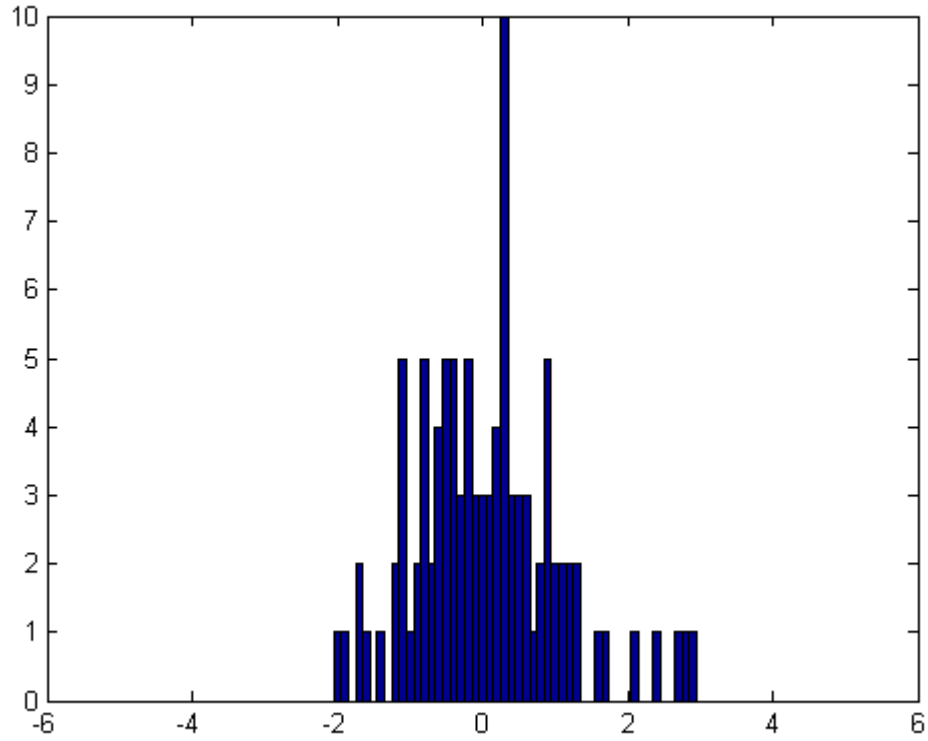
The Doctor: "Think how bad things could possibly be, then add another suitcase of bad."

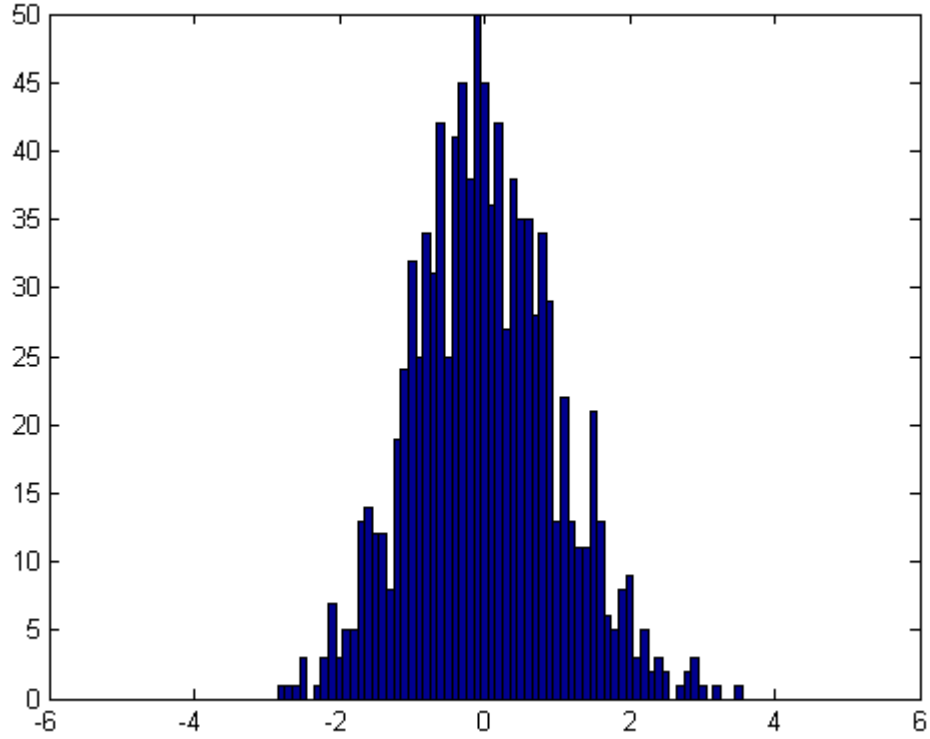

What is the probability that the sun will rise tomorrow?

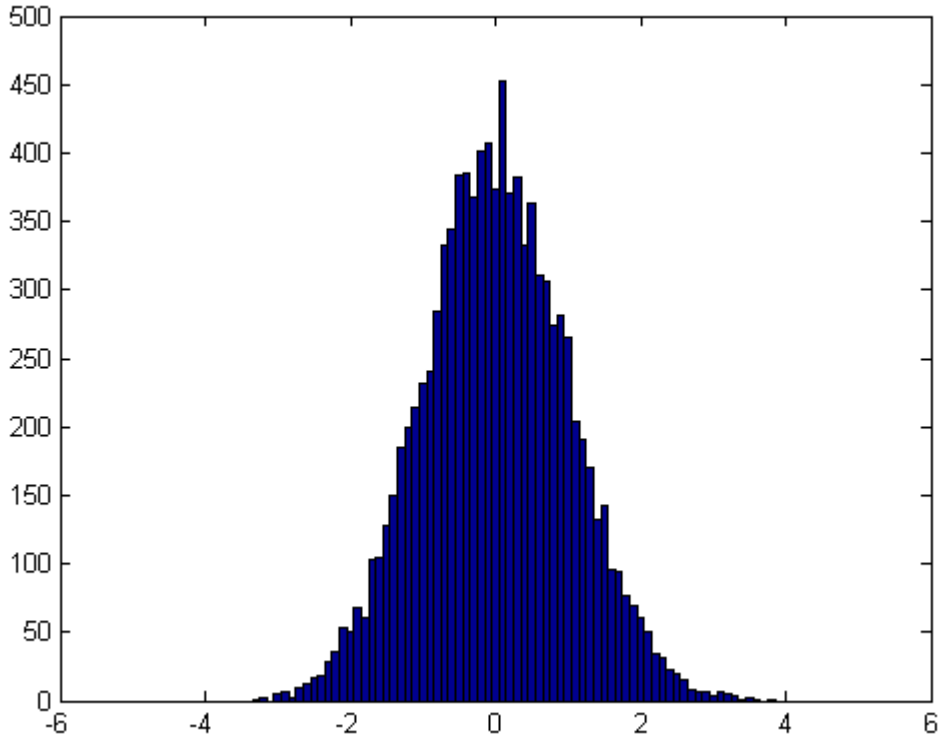

What is the probability that the Cuba Crisis would have ended in nuclear war?

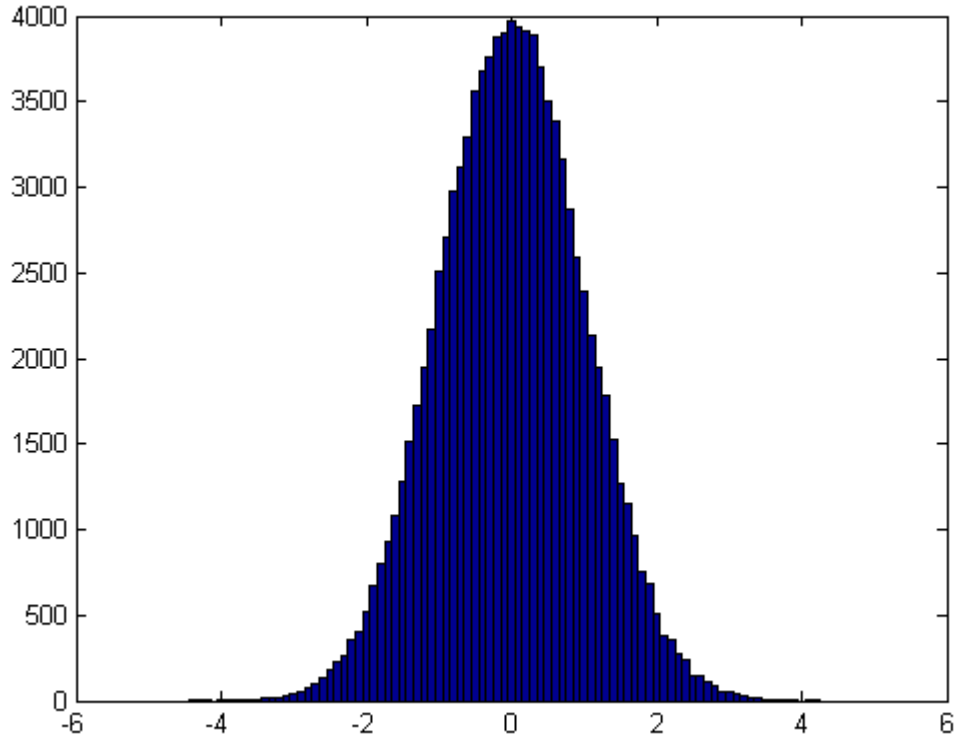
$$p(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

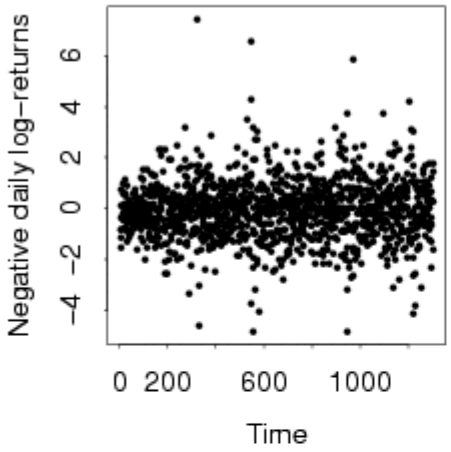


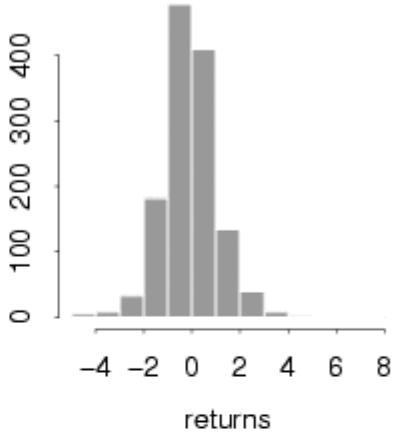

10
9
8
7
6
5
4
3
2
1
0
-6
-4
-2
0
2
4
6

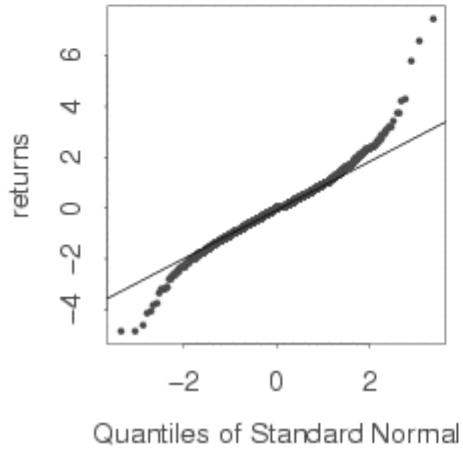

50
45
40
35
30
25
20
15
10
5
0
-6
-4
-2
0
2
4
6

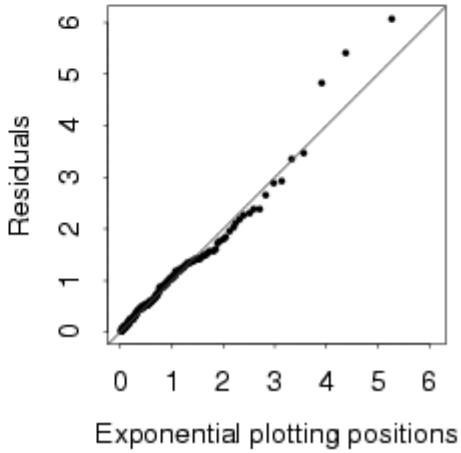

500
450
400
350
300
250
200
150
100
50
0
-6
-4
-2
0
2
4
6


4000
3500
3000
2500
2000
1500
1000
500
0
-6
-4
-2
0
2
4
6


Negative daily log−returns
−4 −2 0 2 4 6
0 200 600 1000
Time


0 100 200 300 400
−4 −2 0 2 4 6 8
returns


returns
−4 −2 0 2 4 6
−2 0 2
Quantiles of Standard Normal


Residuals
0 1 2 3 4 5 6
0 1 2 3 4 5 6
Exponential plotting positions

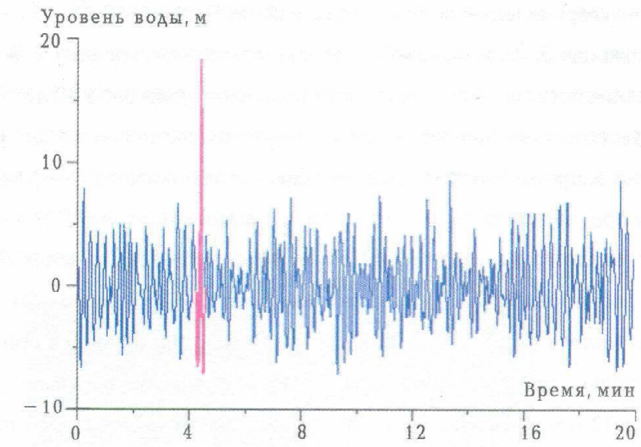


Рис. 1.9. «Новогодняя волна», зарегистрированная в Северном море 1 января 1995 г. [106]

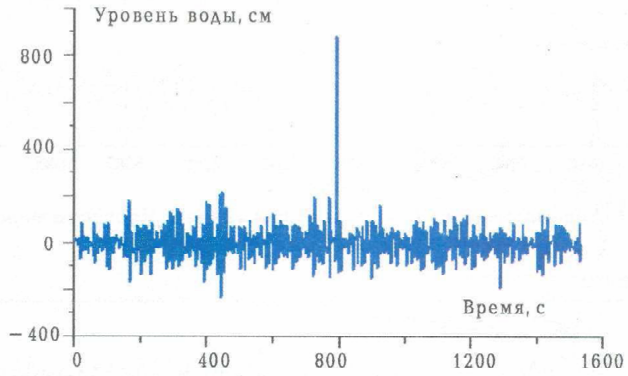
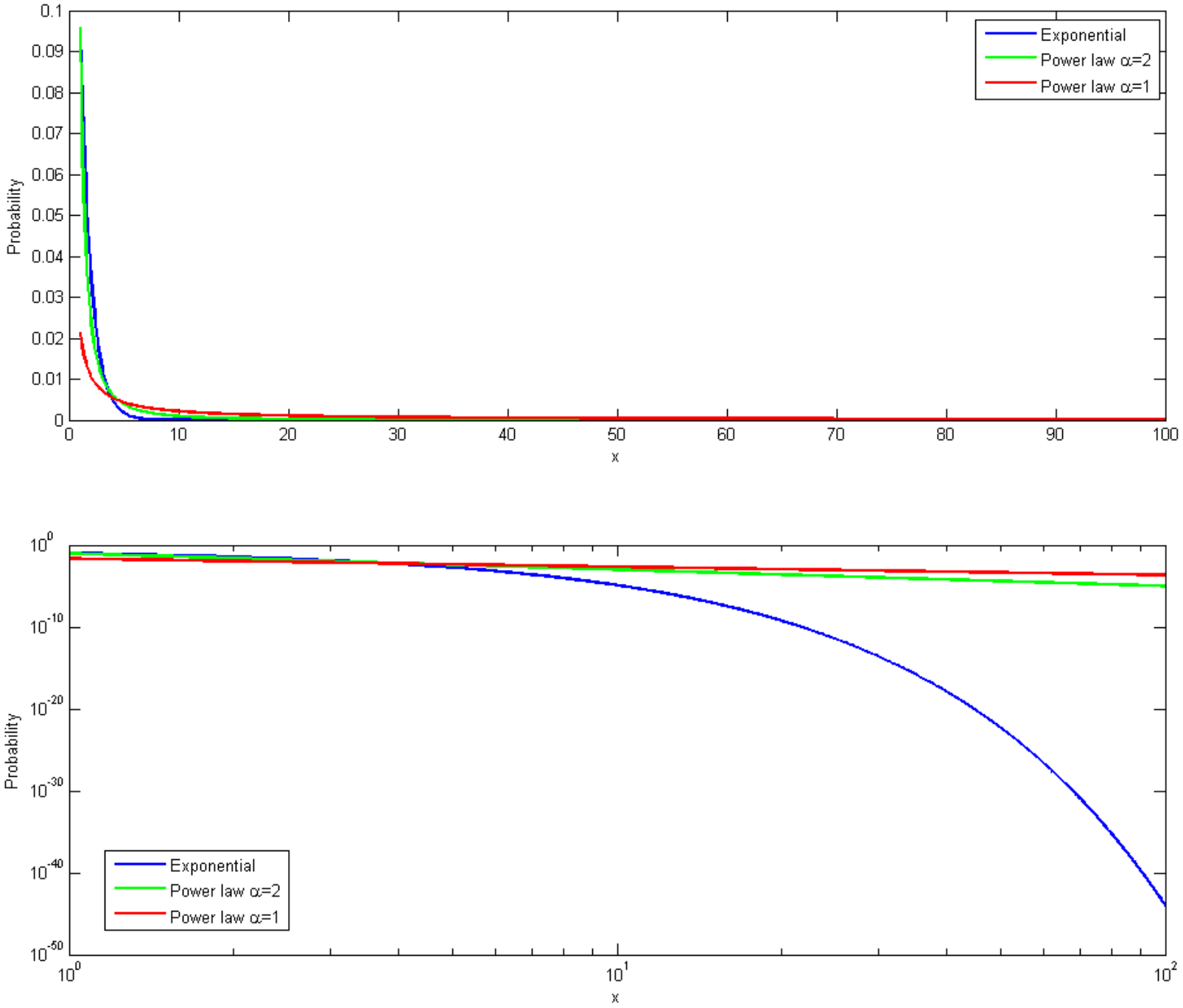
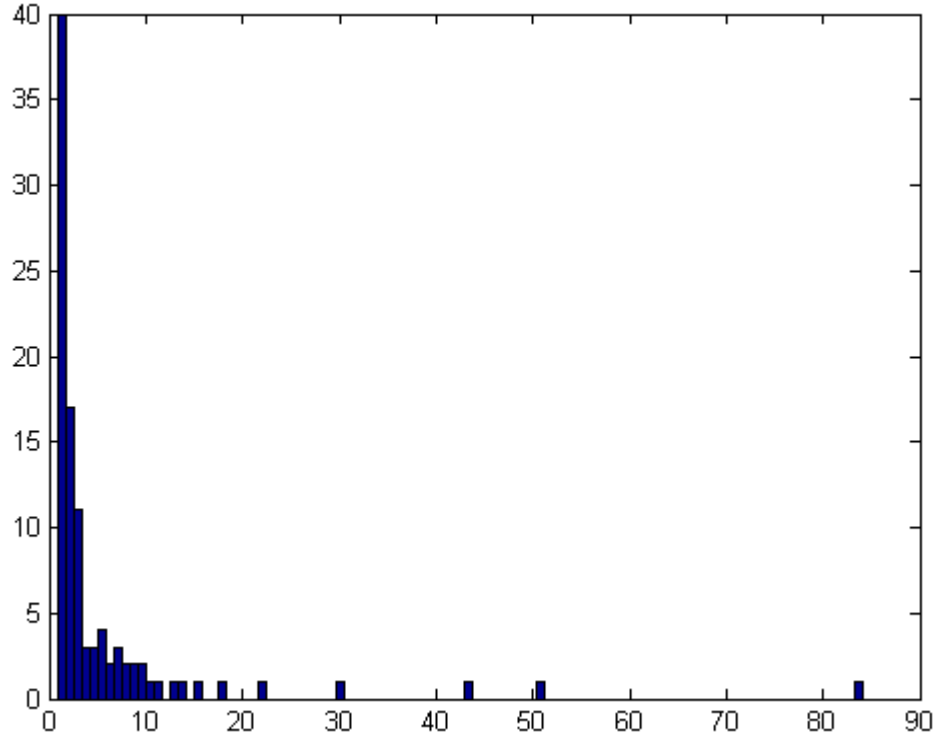
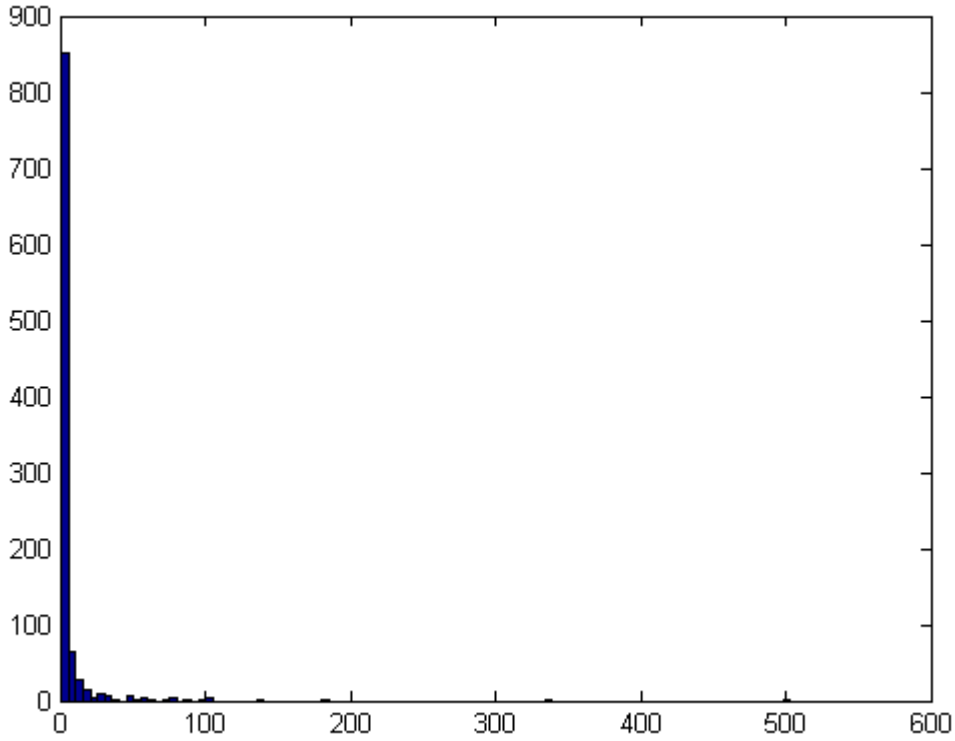


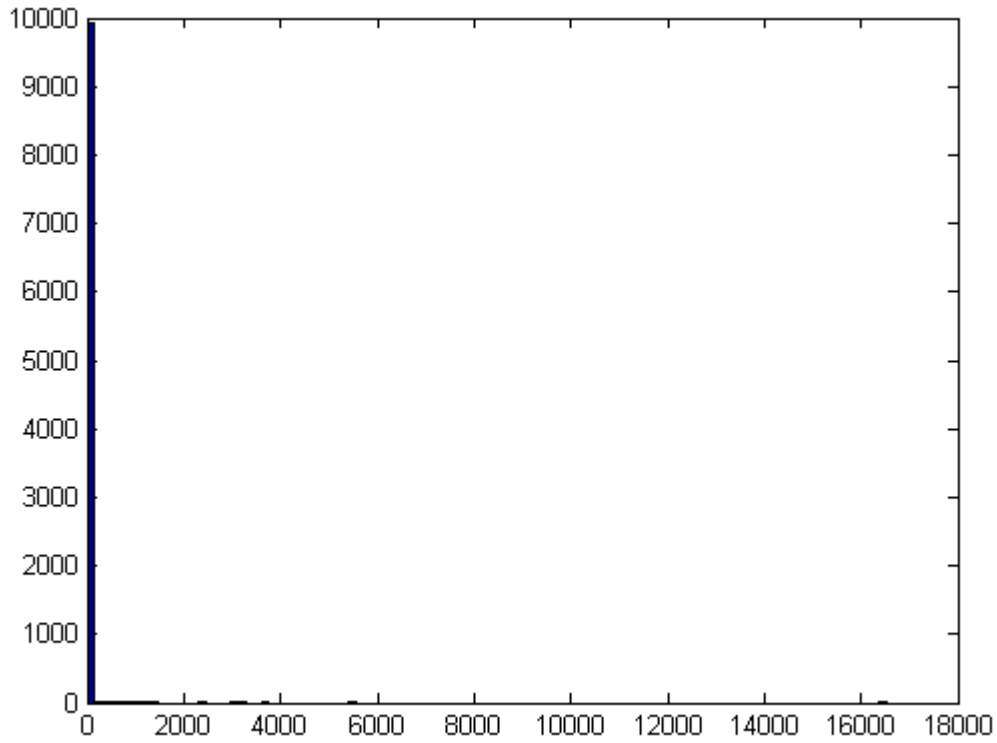
Рис. 1.10. Аномальная волна, зарегистрированная с буя в Черном море 22 ноября 2001 г. [12, 30]

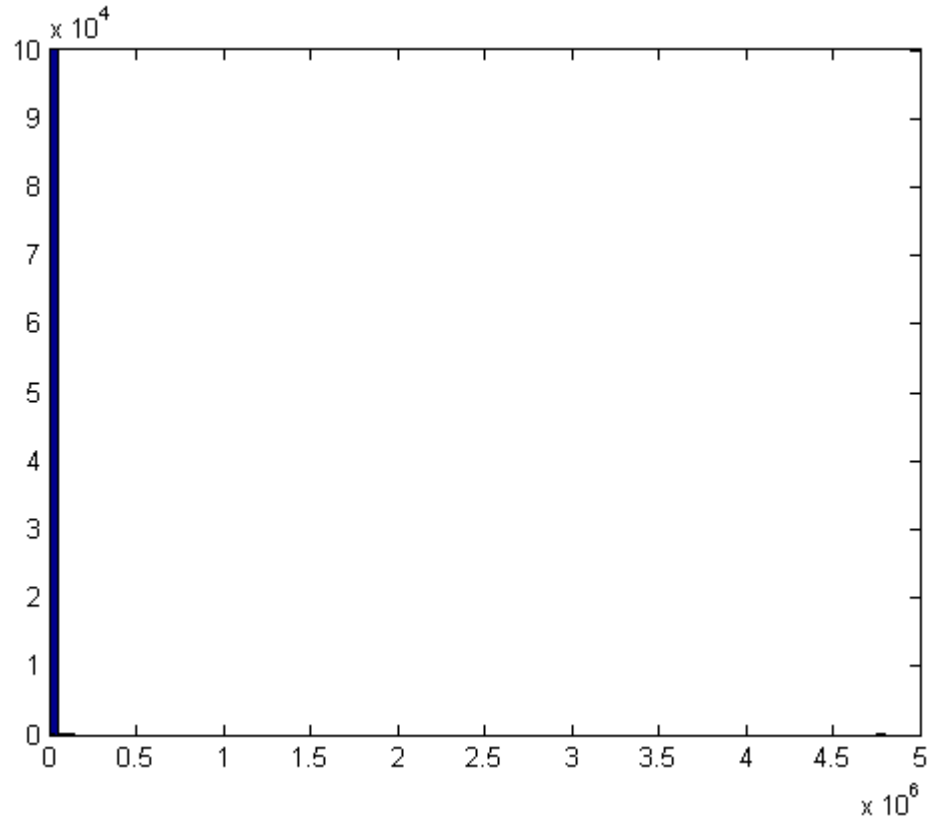

Exponential
Power law α=2
Power law α=1
Probability
x
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
80
90
100
10^{0}
10^{-10}
10^{-20}
10^{-30}
10^{-40}
10^{-50}
10^{0}
10^{1}
10^{2}

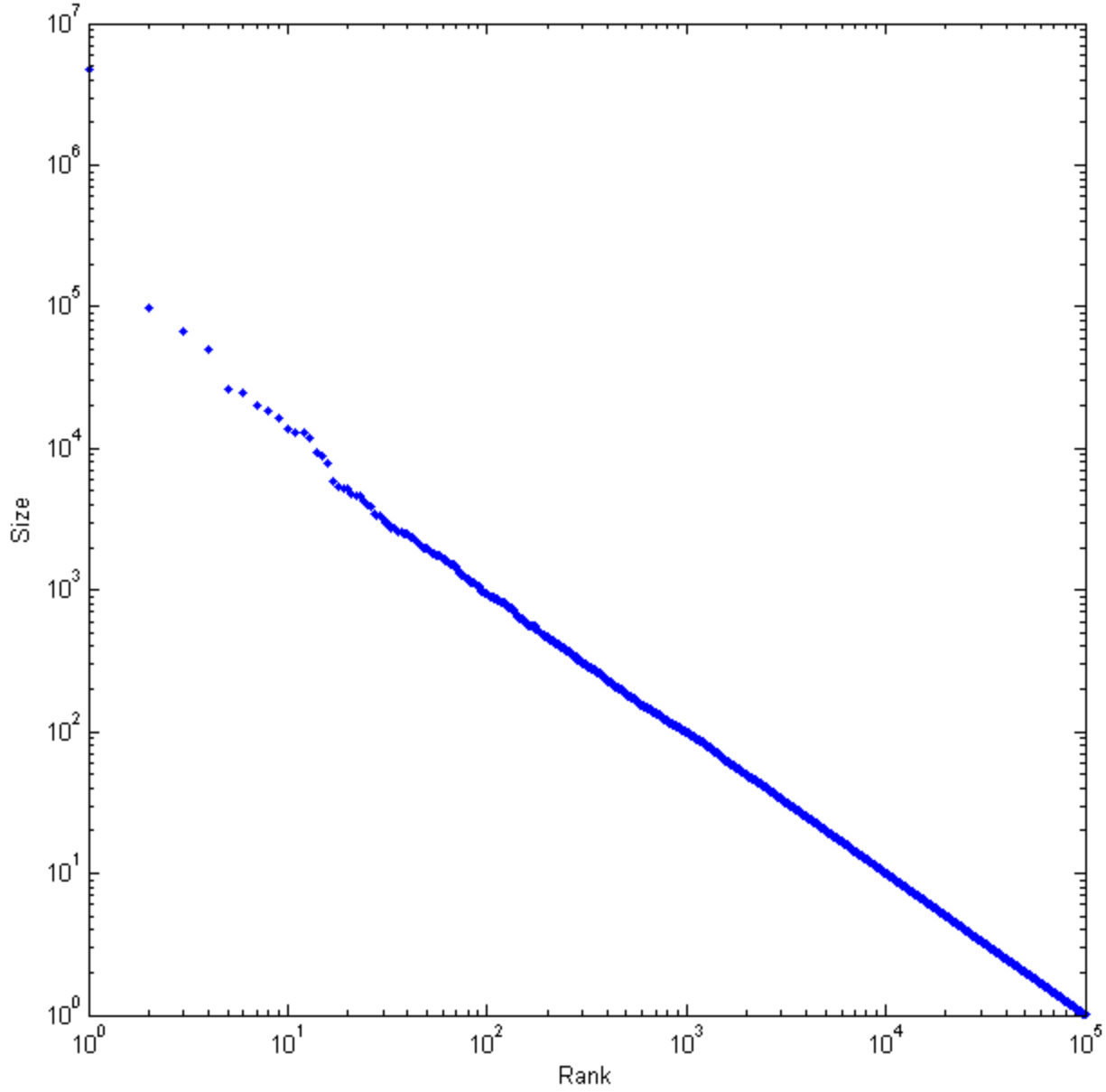
$$p(x) = \frac{\alpha - 1}{x_{\min}} \left(\frac{x}{x_{\min}} \right)^{-\alpha}$$

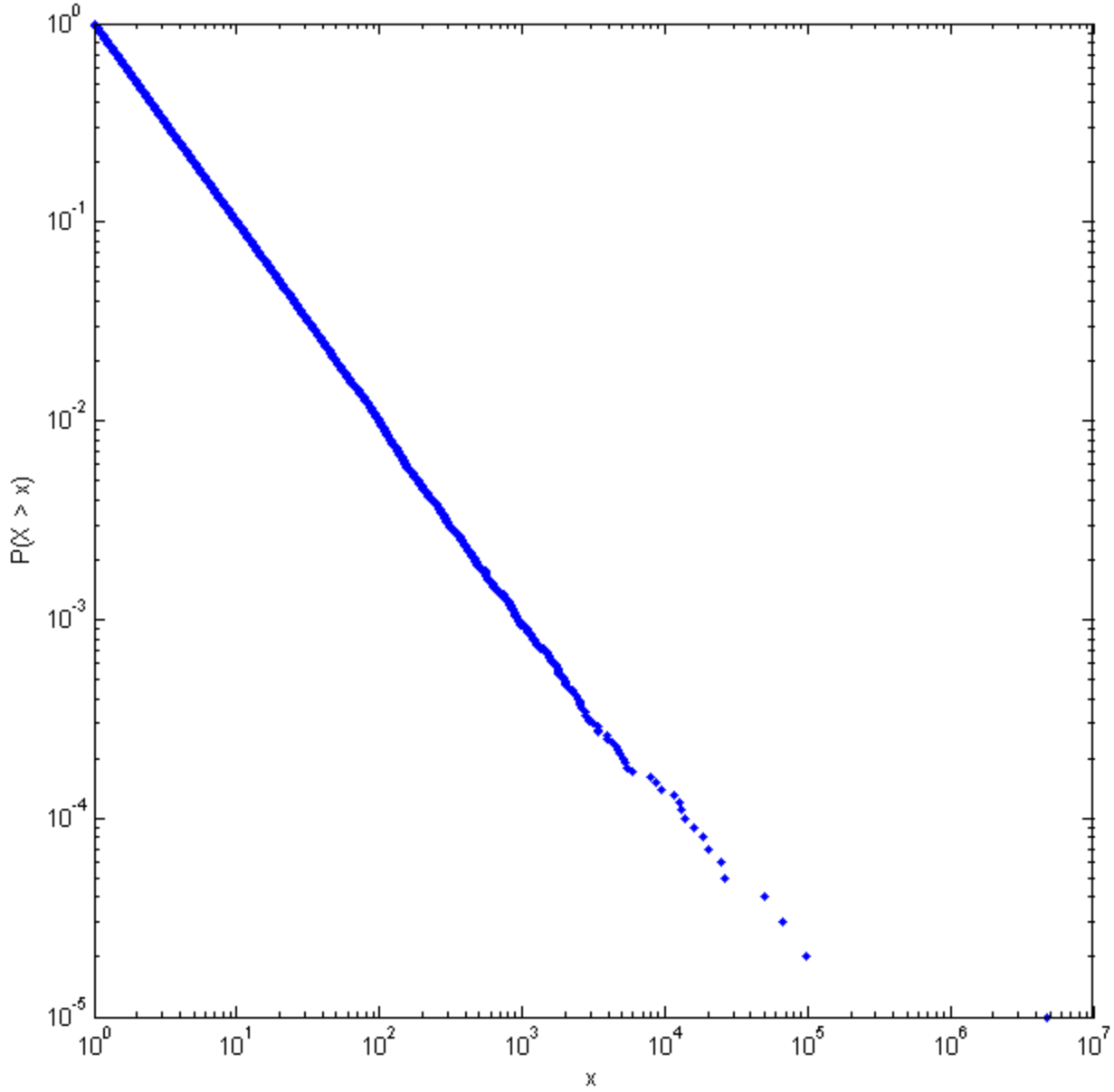


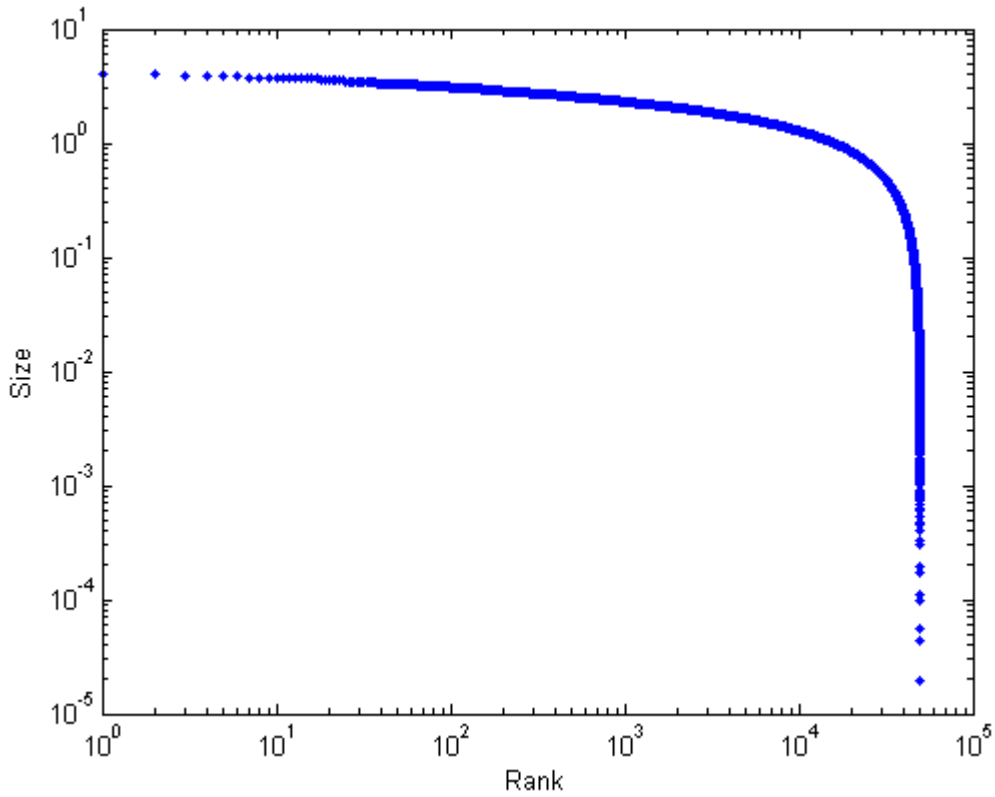

900
800
700
600
500
400
300
200
100
0
0
100
200
300
400
500
600

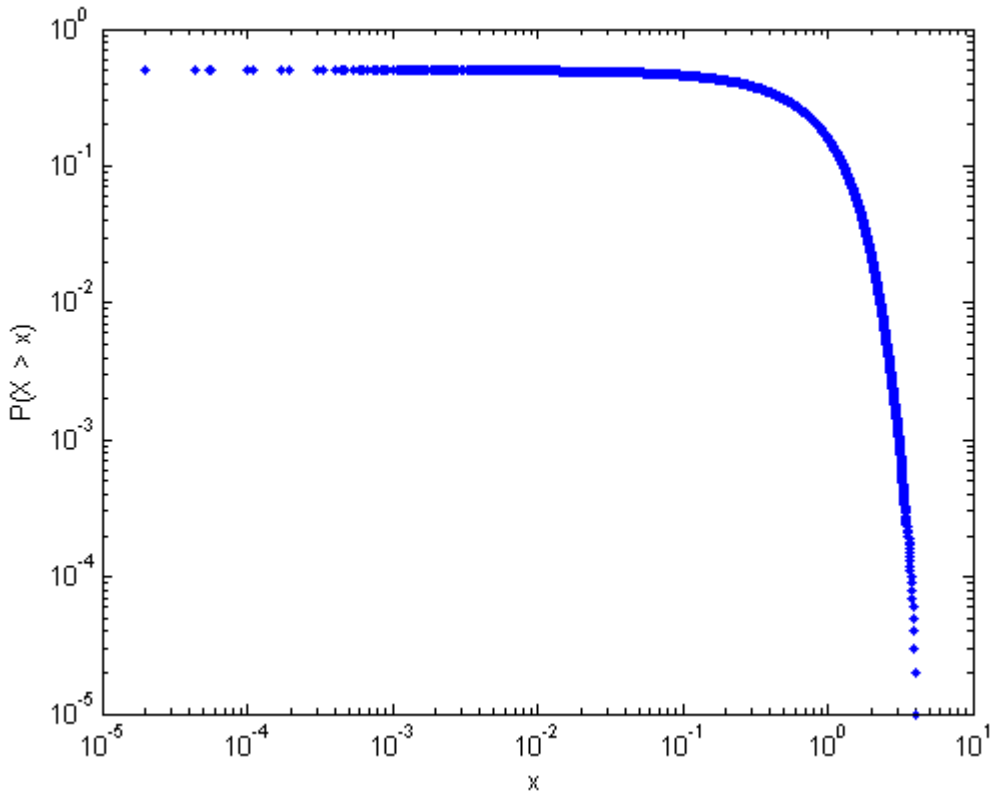

10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

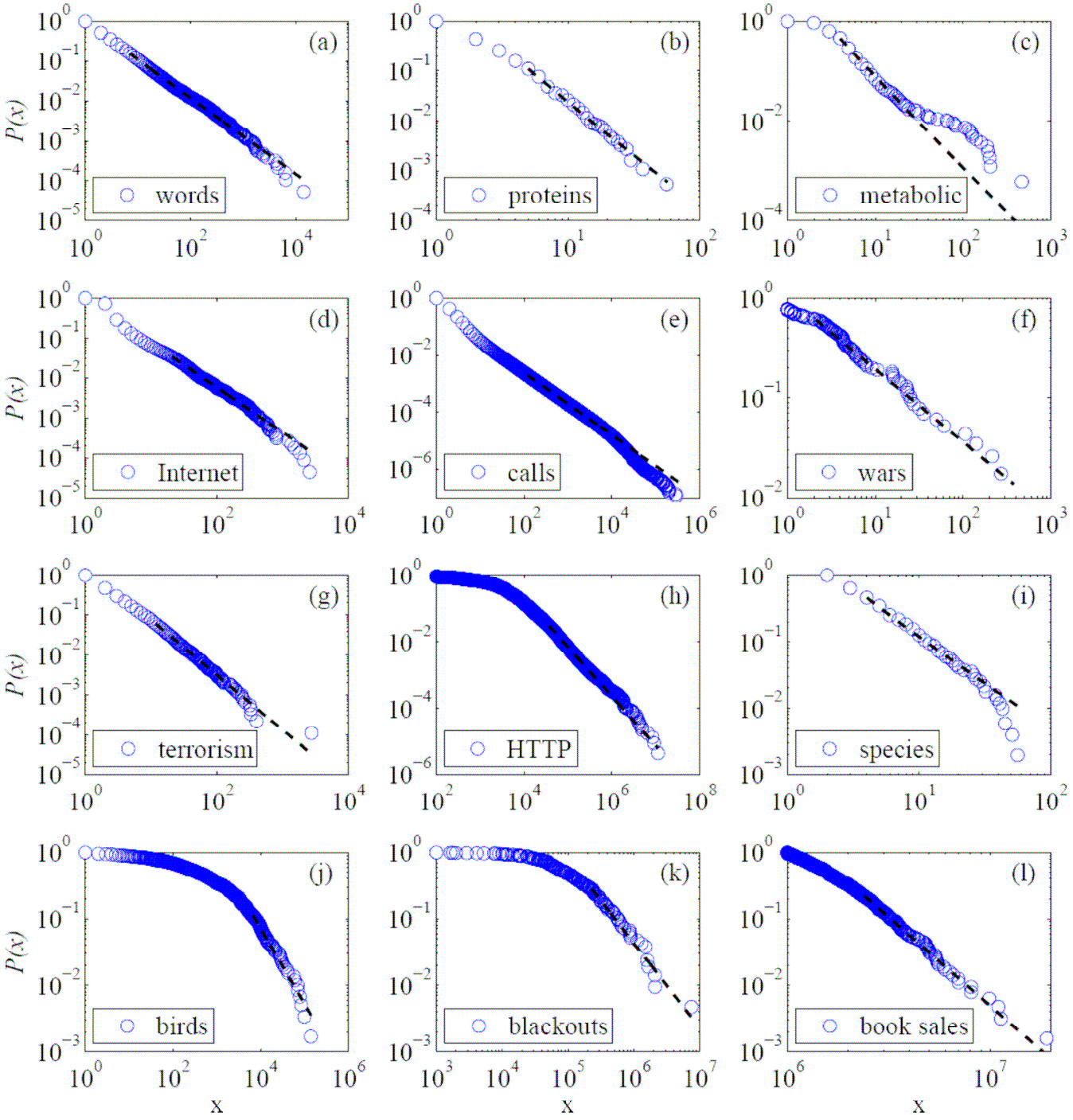

x 10^4
10
9
8
7
6
5
4
3
2
1
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
x 10^6


Size
Rank
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7


P(X > x)
x
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
10^{7}


Size
Rank
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}


10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
P(X > x)
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
x

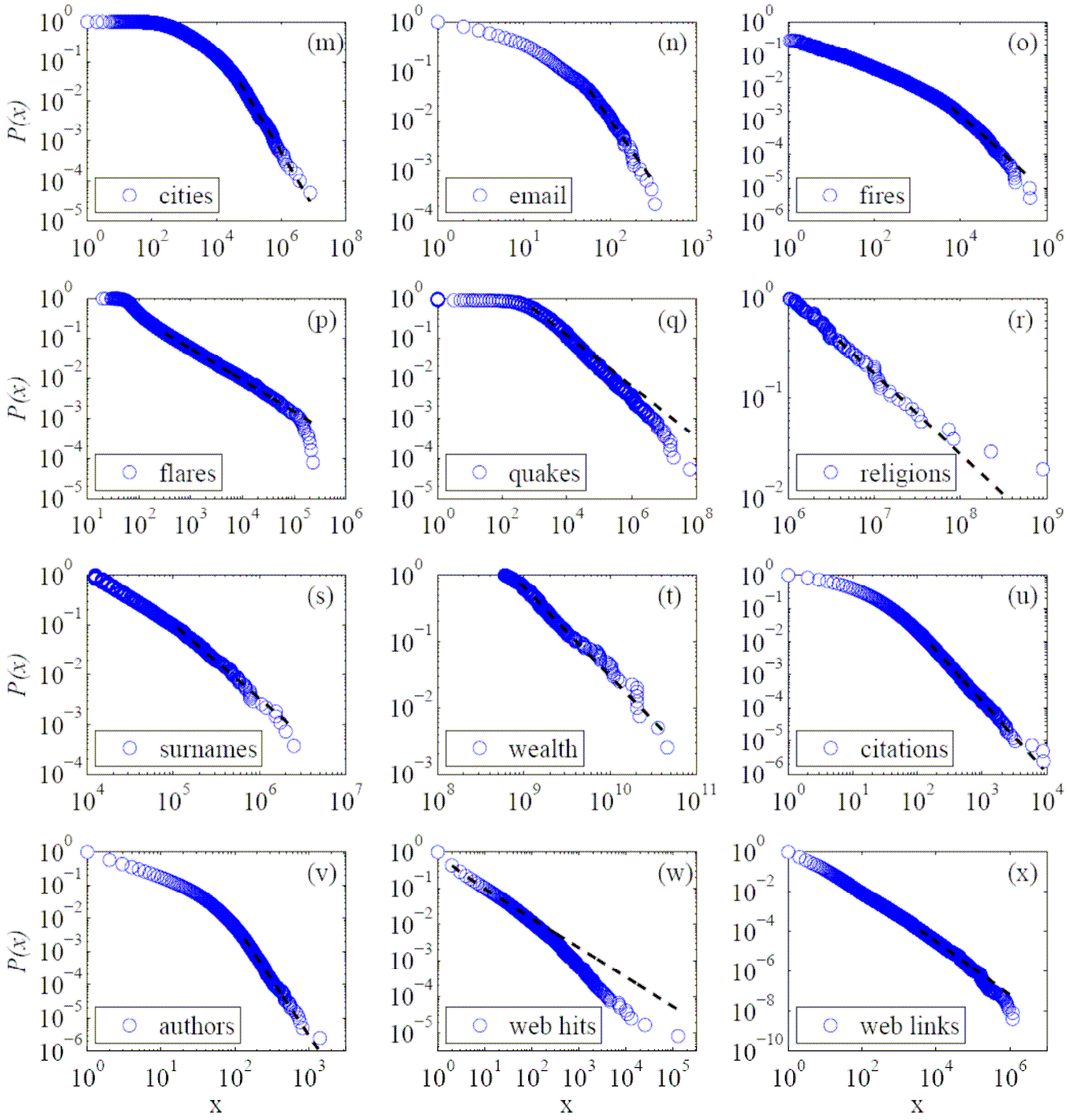


(a) The frequency of occurrence of unique words in the novel Moby Dick by Herman Melville. (b) The degree distribution of proteins in the protein interaction network of the yeast *S. cerevisiae*. (c) The degree distribution of metabolites in the metabolic network of the bacterium E. coli.

(d) The degree distribution of autonomous systems (groups of computers under single administrative control) on the Internet. (e) The number of calls received by US customers of the long-distance telephone carrier AT&T. (f) The intensity of wars from 1816–1980 measured as the number of battle deaths per 10 000 of the combined populations of the warring nations.

(g) The severity of terrorist attacks worldwide from February 1968 to June 2006, measured by number of deaths. (h) The number of bytes of data received in response to HTTP (web) requests from computers at a large research laboratory. (i) The number of species per genus of mammals during the late Quaternary period.

(j) The frequency of sightings of bird species in the United States. (k) The number of customers affected by electrical blackouts in the United States. (l) The sales volume of bestselling books in the United States.

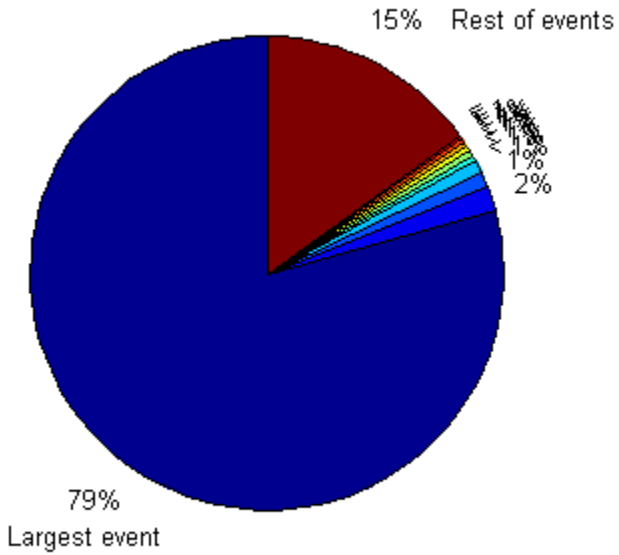


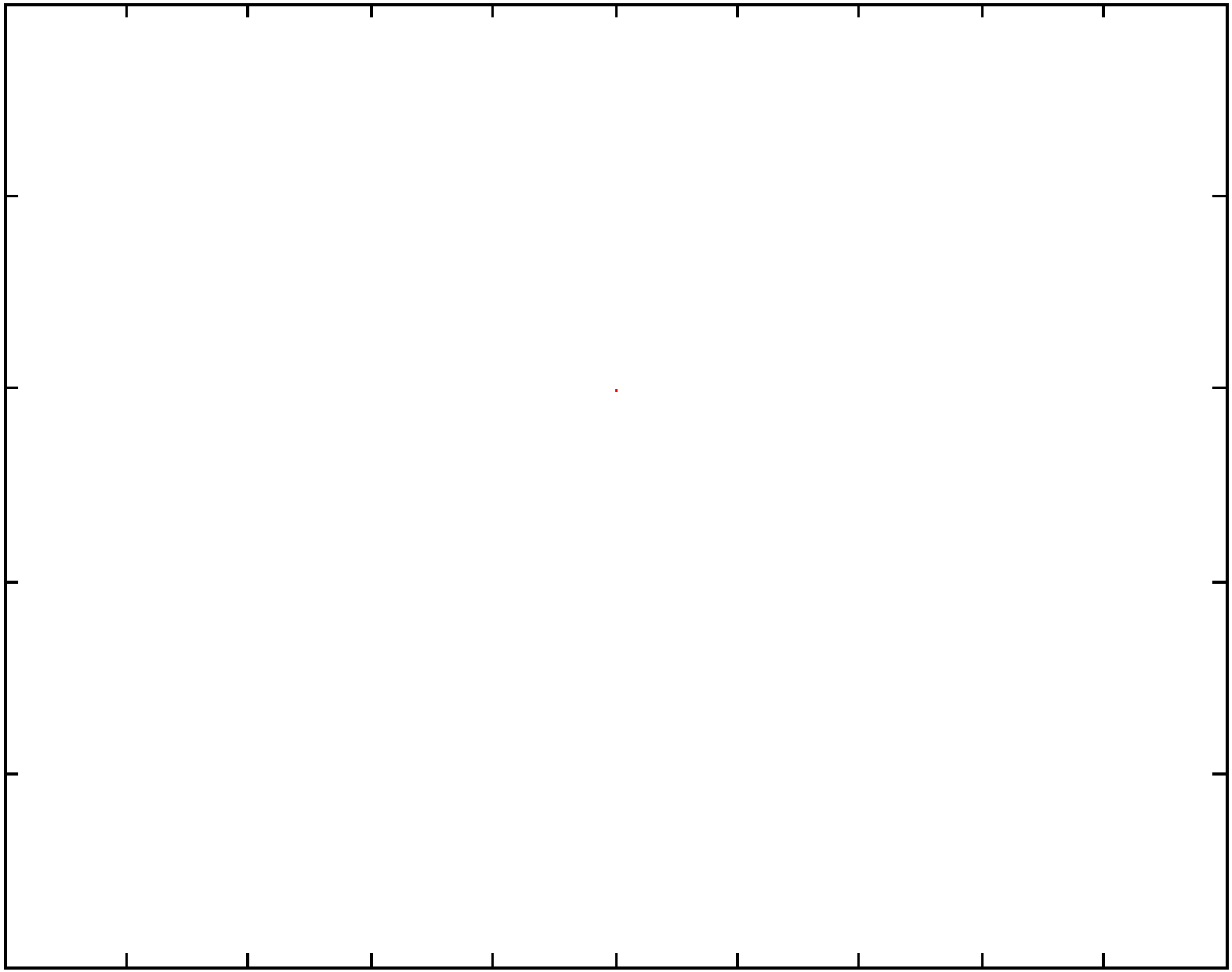
(m) The populations of cities in the United States. (n) The sizes of email address books at a university. (o) The number of acres burned in California forest fires.

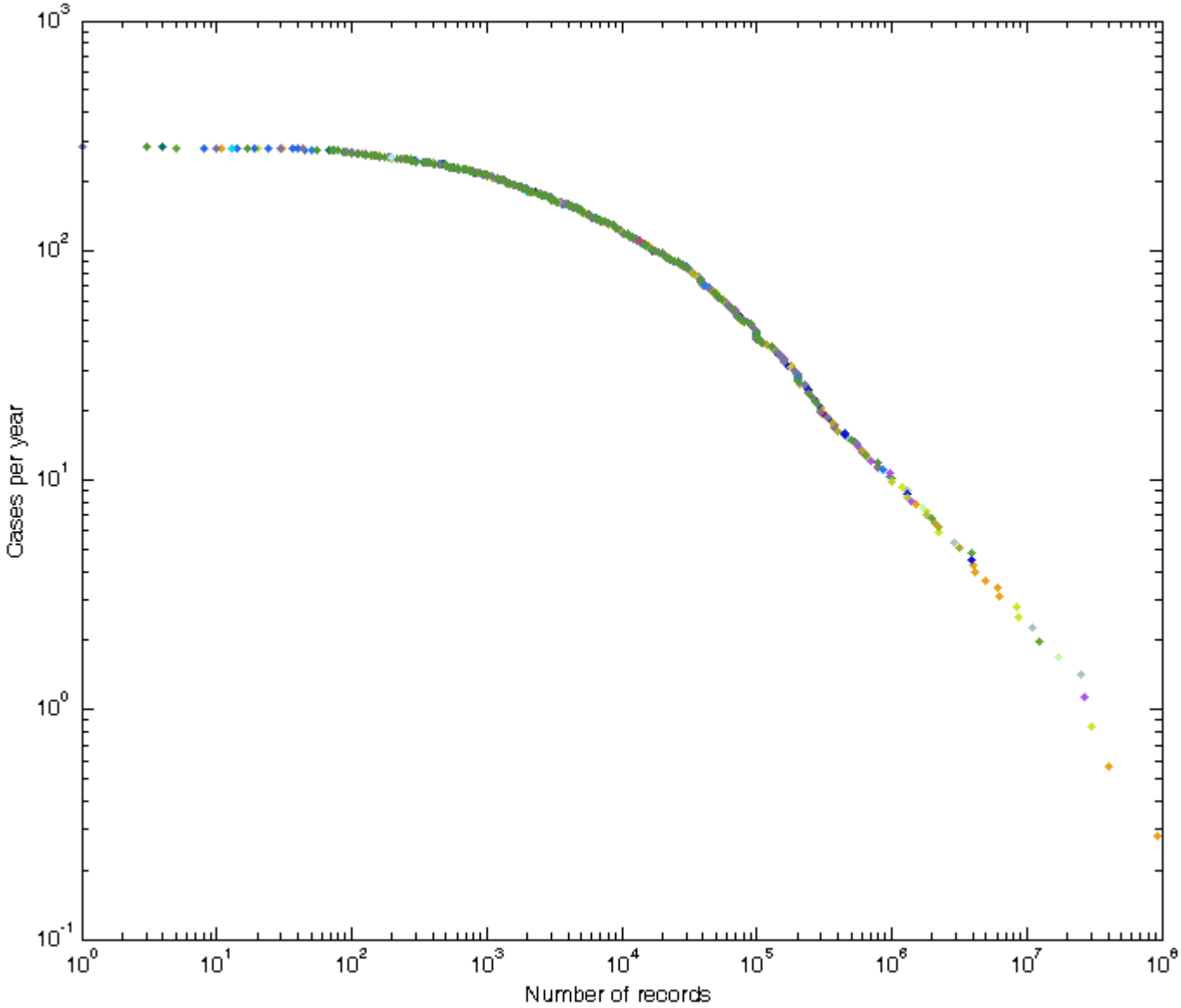
(p) The intensities of solar flares. (q) The intensities of earthquakes. (r) The numbers of adherents of religious sects.

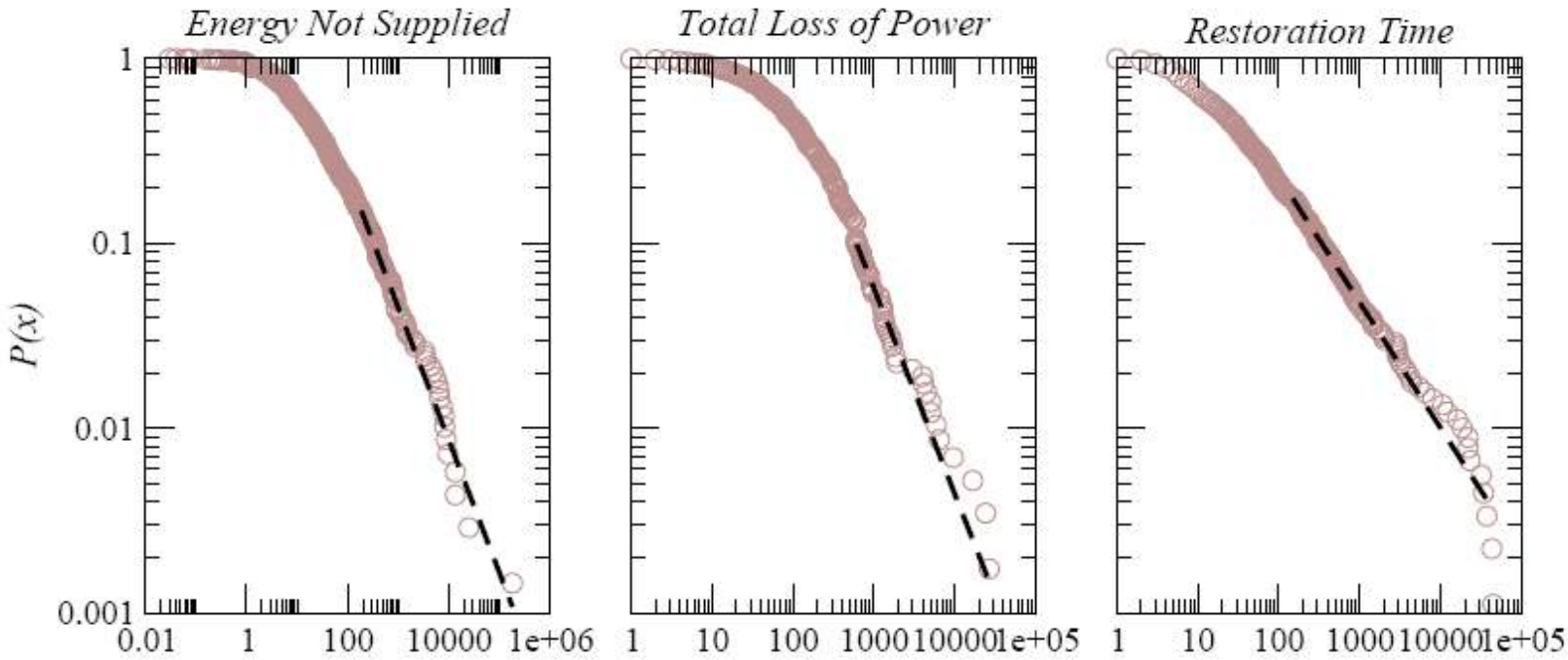
(s) The frequencies of surnames in the United States. (t) The net worth in US dollars of the richest people in America. (u) The numbers of citations received by published academic papers.

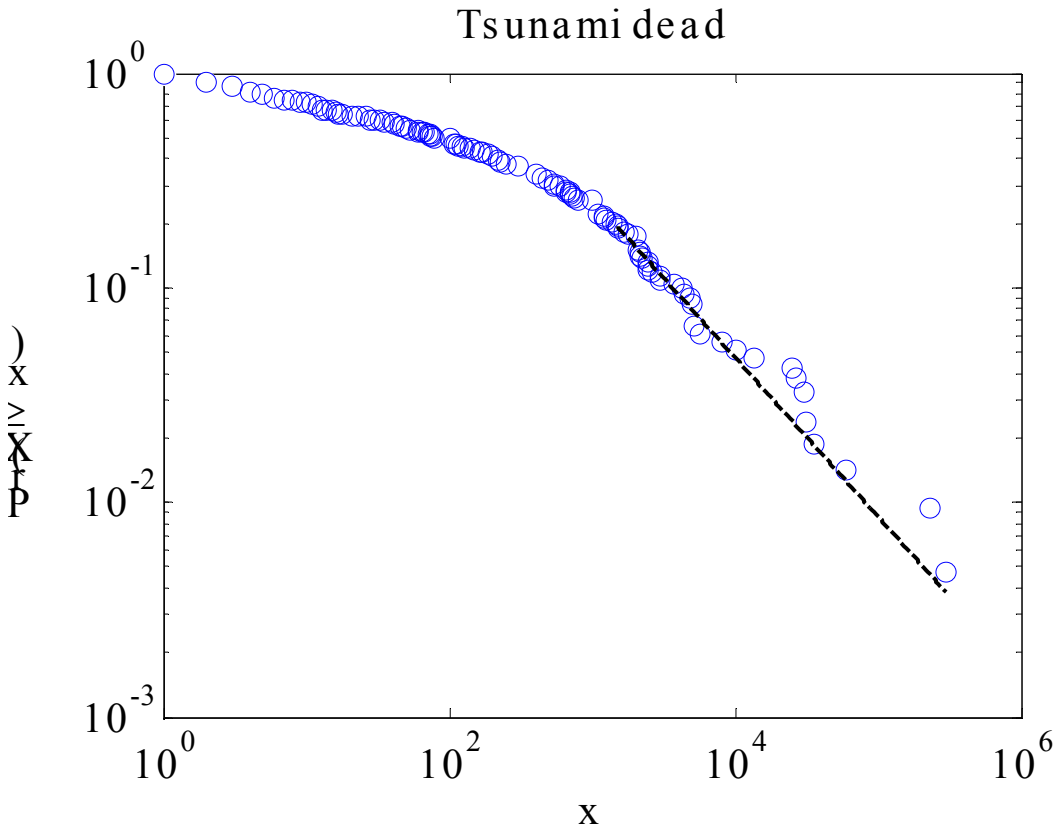
(v) The numbers of papers authored by mathematicians. (w) The numbers of hits on web sites from AOL users. (x) The numbers of hyperlinks to web sites.

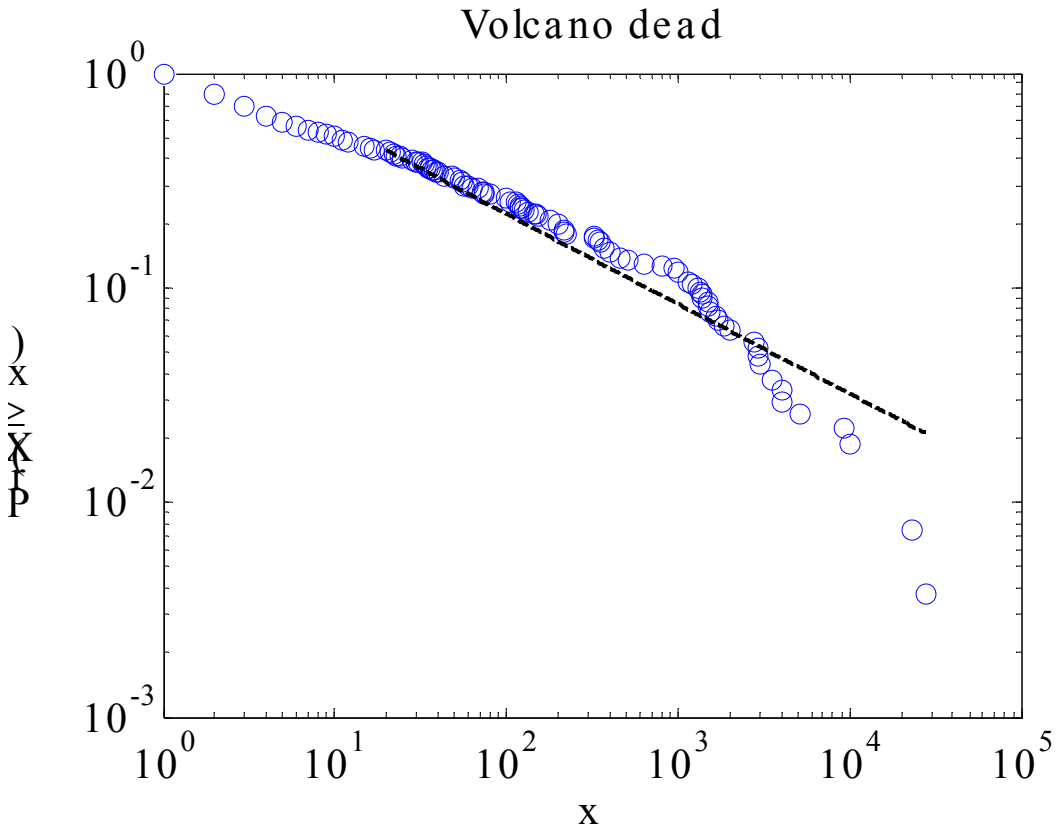

15%
Rest of events
1%
2%
79%
Largest event

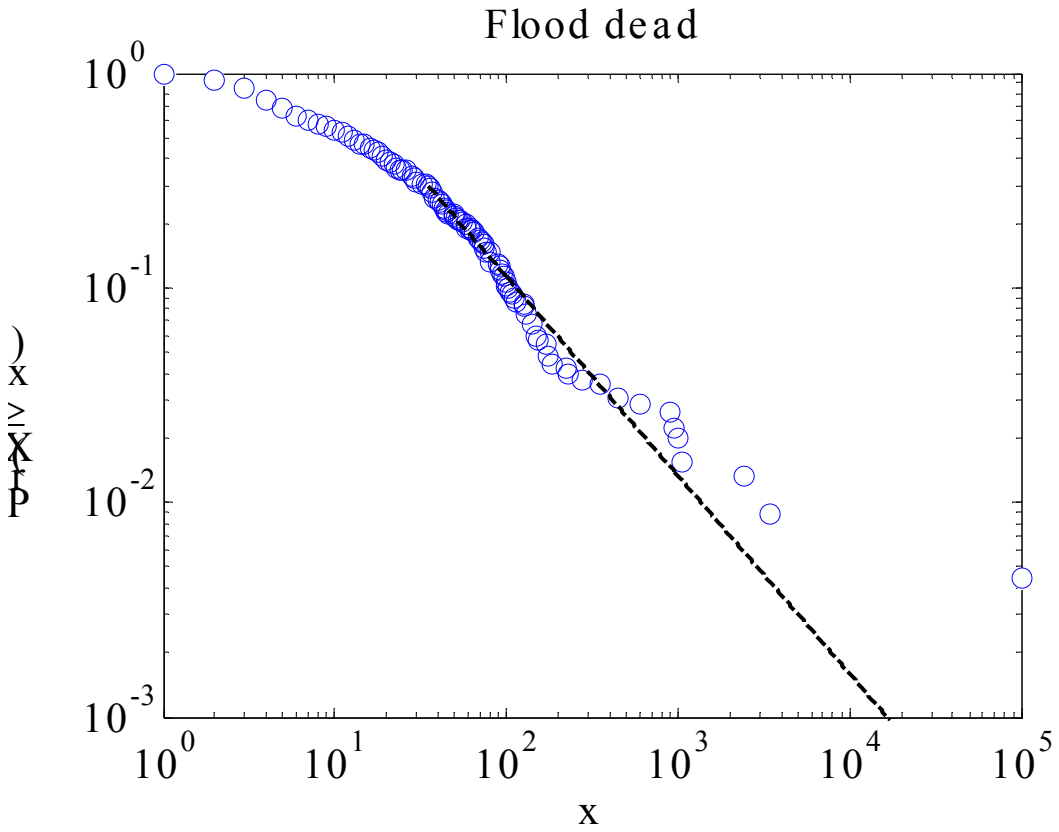


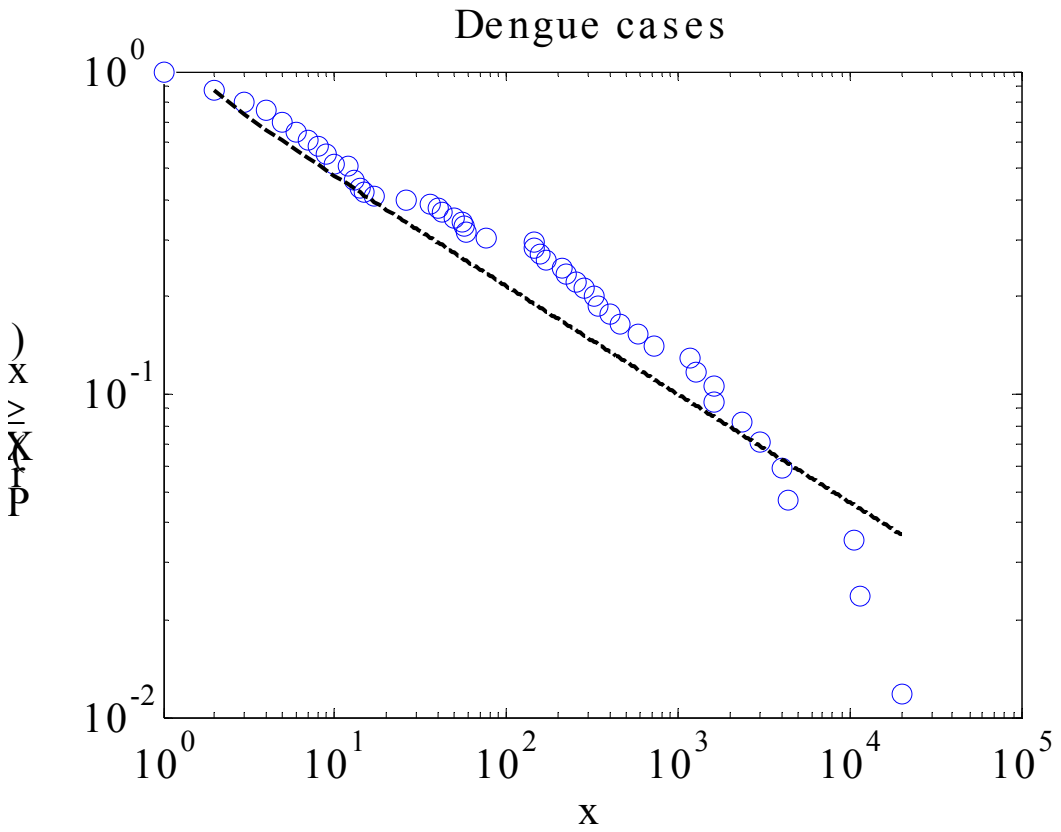

Cases per year
Number of records
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
10^{7}
10^{8}


Energy Not Supplied
Total Loss of Power
Restoration Time
P(x)
1
0.1
0.01
0.001
0.01
1
100
10000
1e+06
1
10
100
1000
10000
1e+05
1
10
100
1000
10000
1e+05


Tsunami dead
10^0
10^{-1}
10^{-2}
10^{-3}
10^0
10^2
10^4
10^6
x
P(X ≥ x)


Volcano dead
10^0
10^{-1}
10^{-2}
10^{-3}
10^0
10^1
10^2
10^3
10^4
10^5
x
P(X ≥ x)


Flood dead
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
x
P(X ≥ x)


Dengue cases
10^0
10^{-1}
10^{-2}
10^0
10^1
10^2
10^3
10^4
10^5
x
)
x
≥
X
(
P

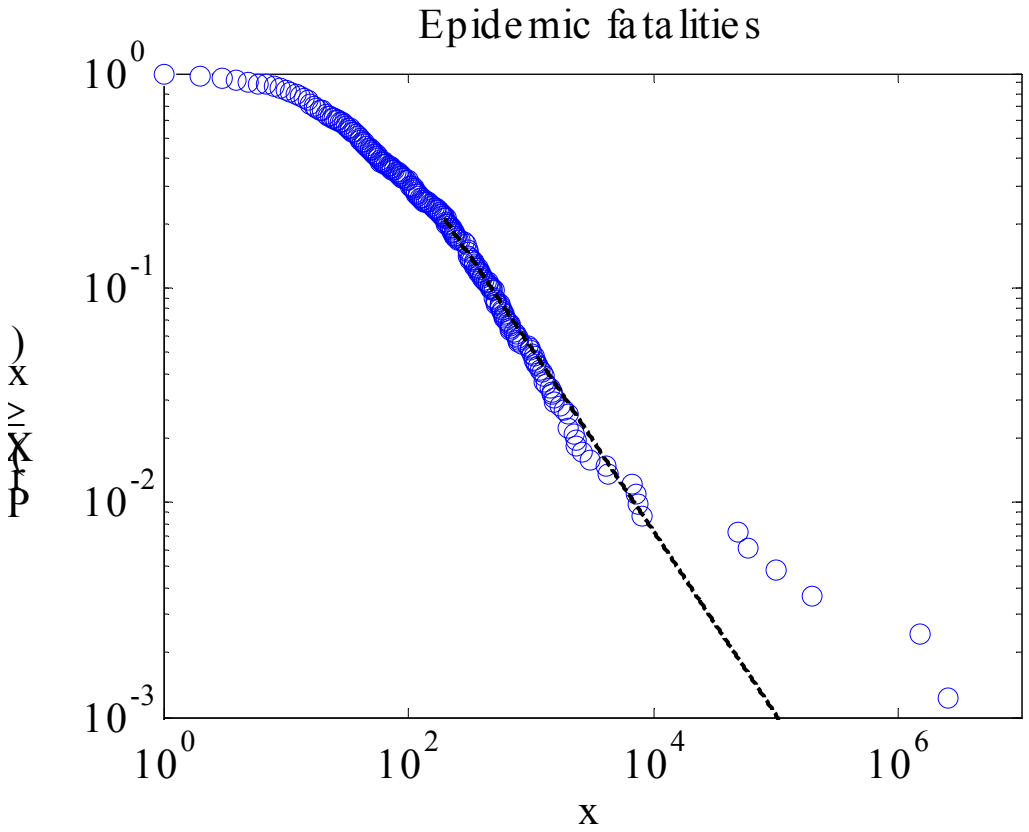
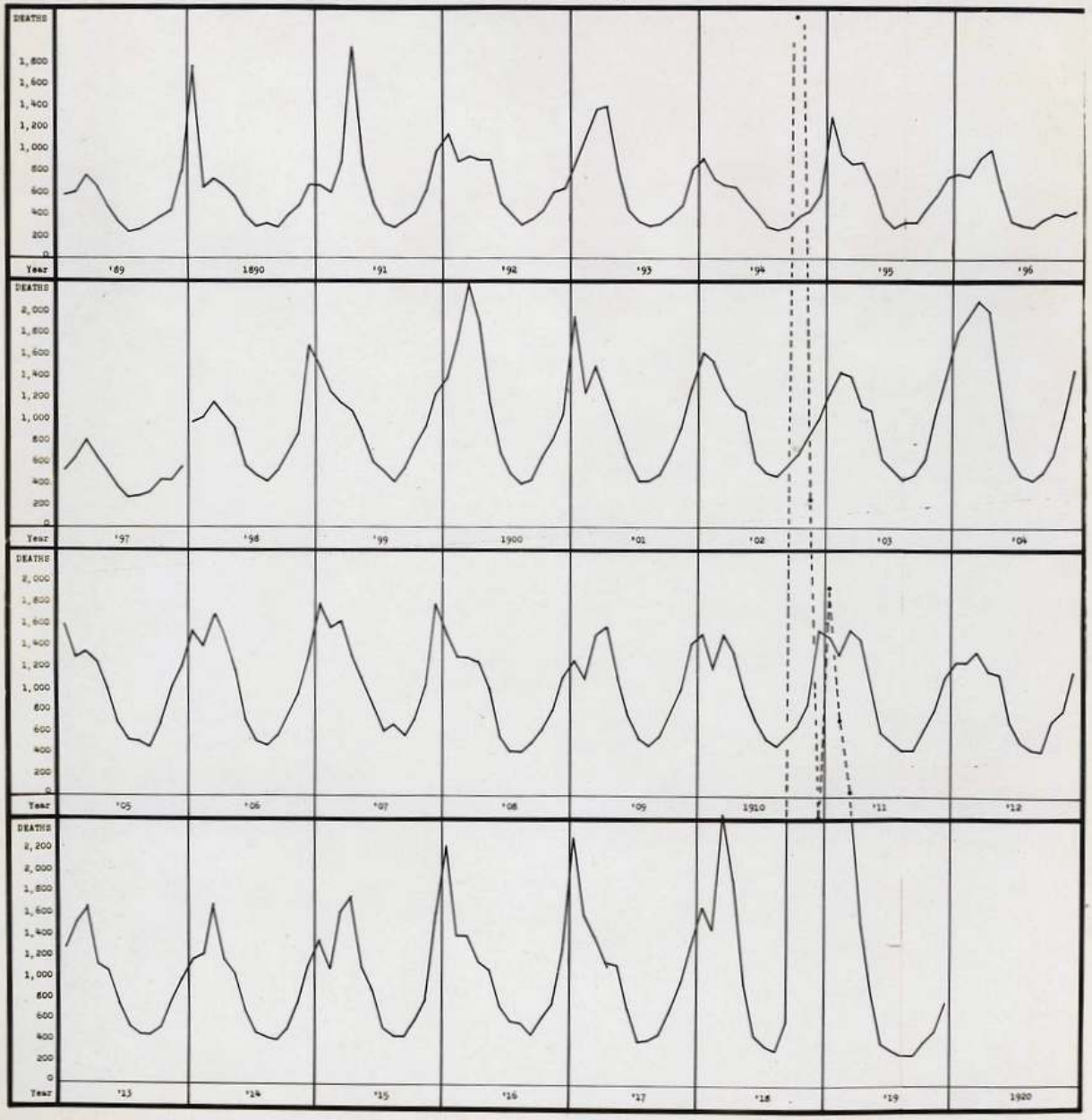
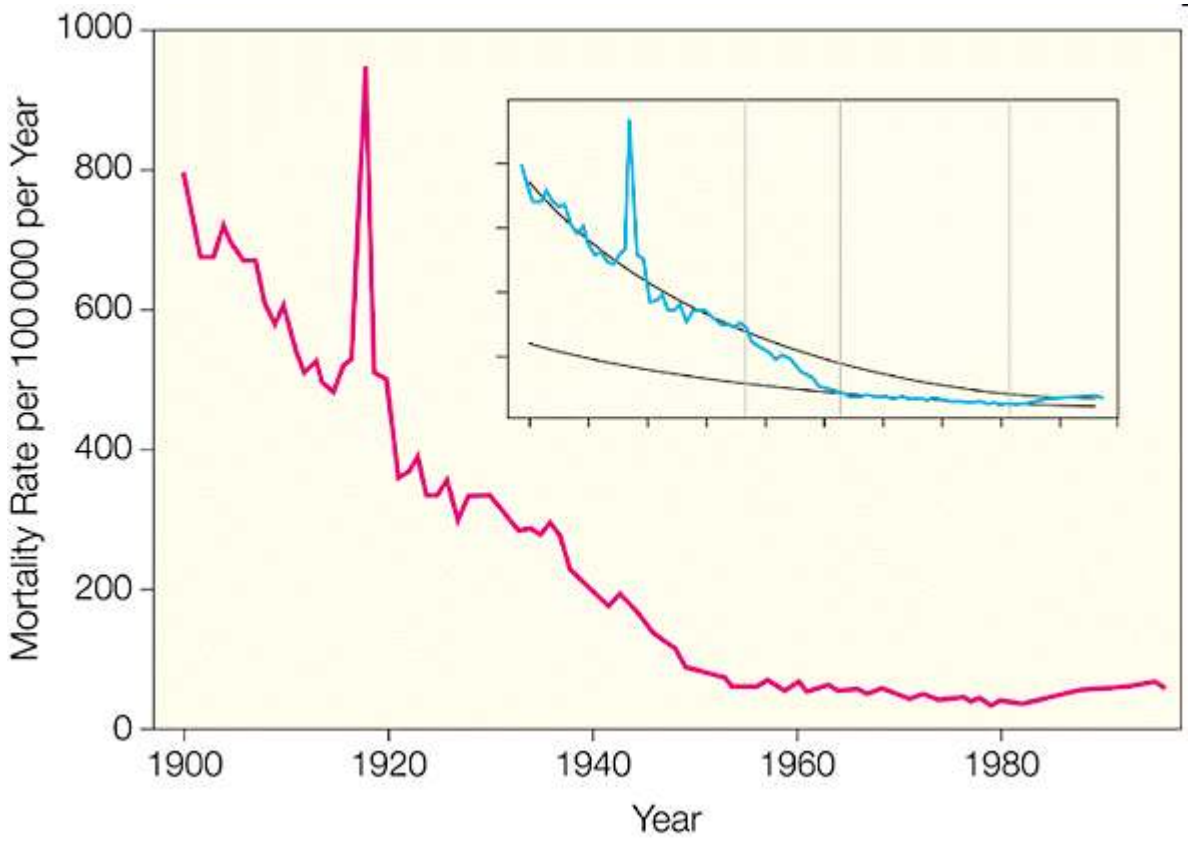

Epidemic fatalities
10^0
10^{-1}
10^{-2}
10^{-3}
10^0
10^2
10^4
10^6
x
P(X ≥ x)

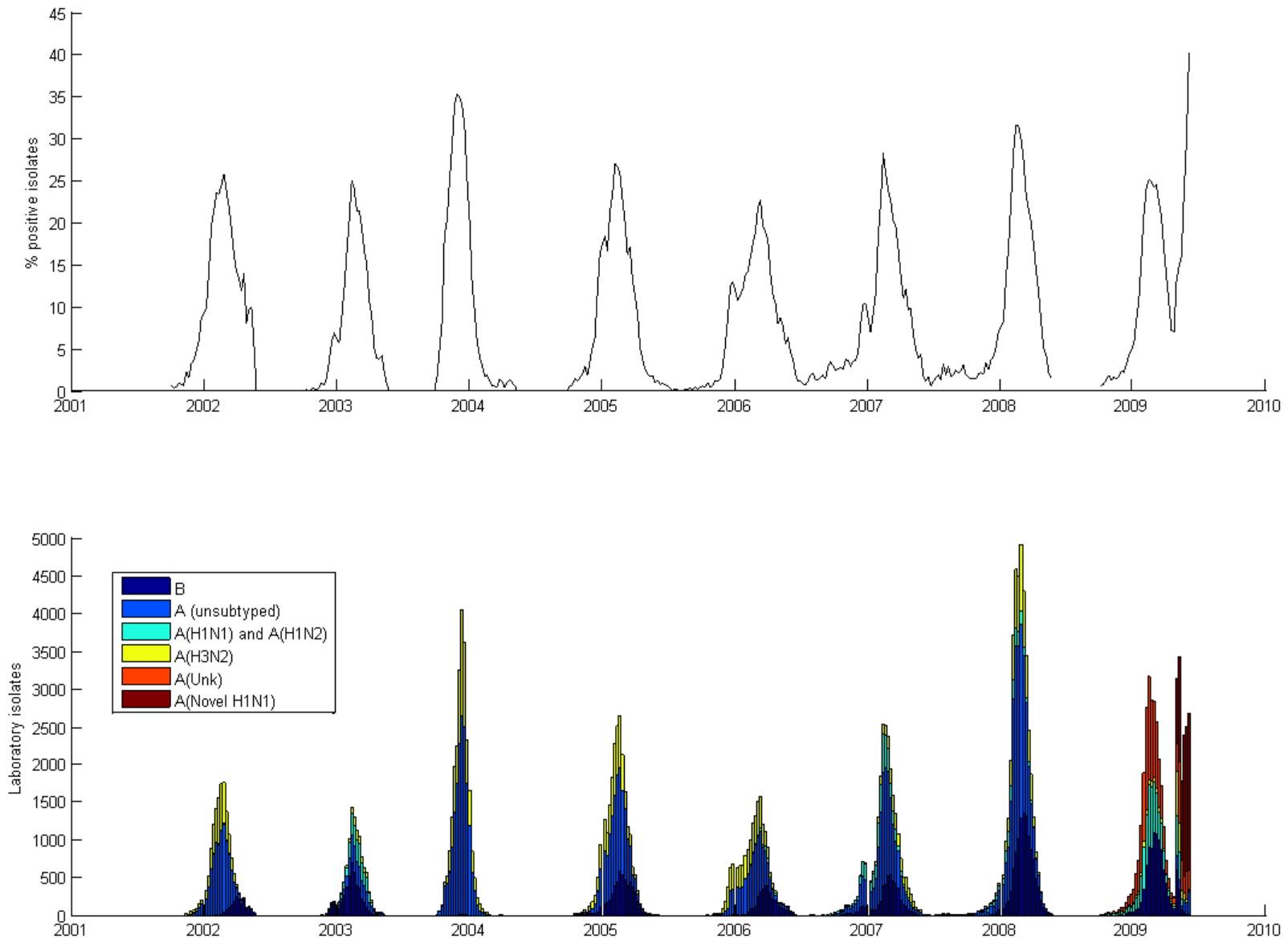
FIGURE IV

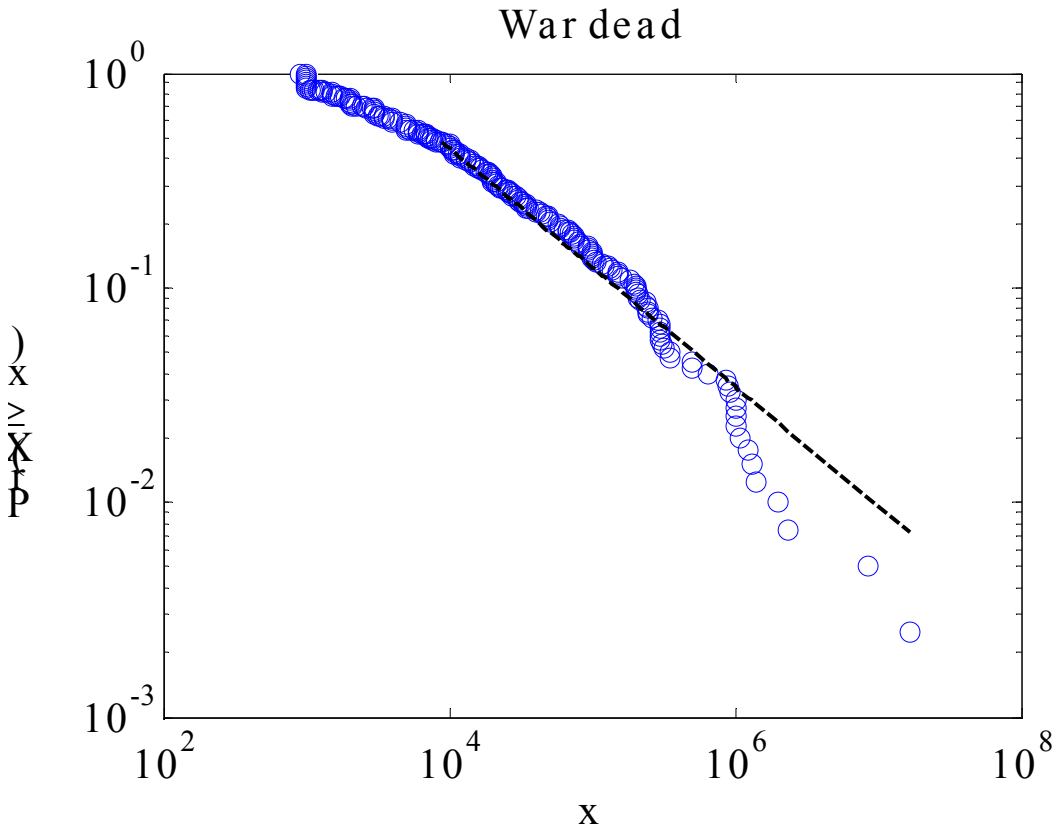
DEATHS FROM INFLUENZA, LOBAR AND BRONCHOPNEUMONIA AND ACUTE BRONCHITIS, NEW YORK CITY, 1889 - 1919.

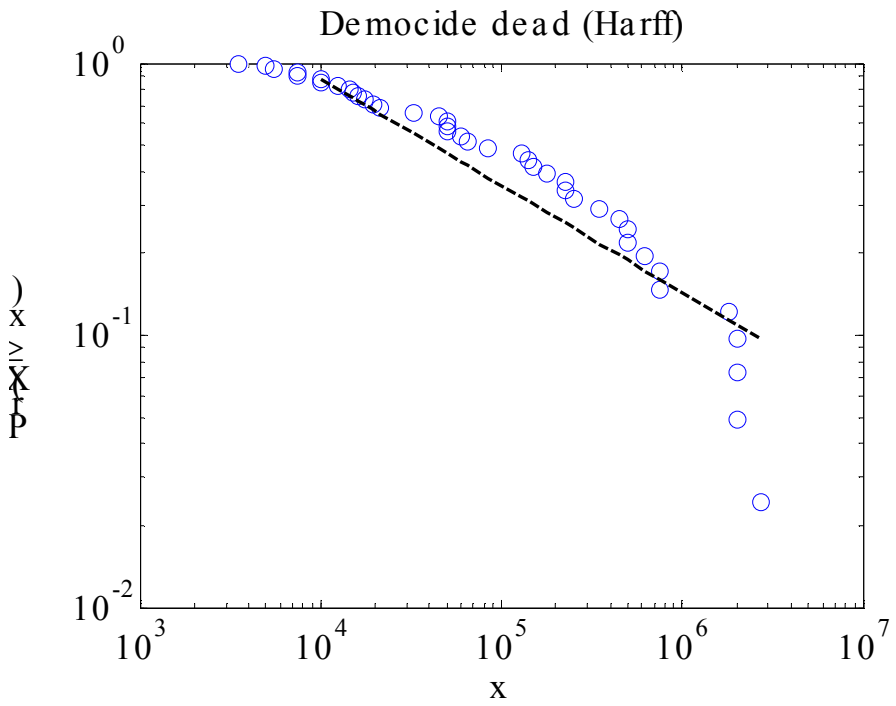
Plotted by months. Brooklyn and other boroughs annexed in 1897.

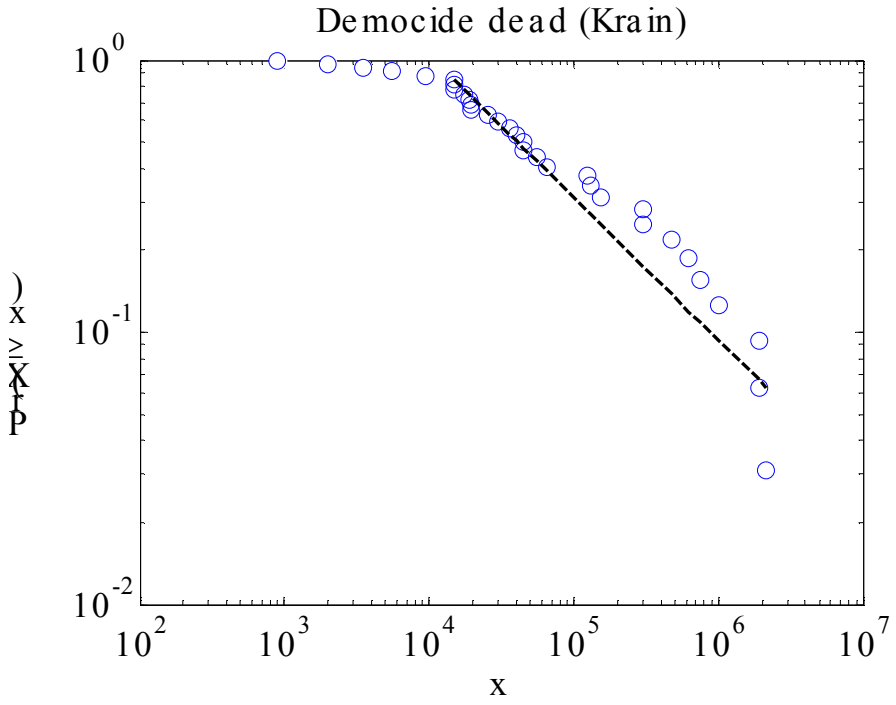


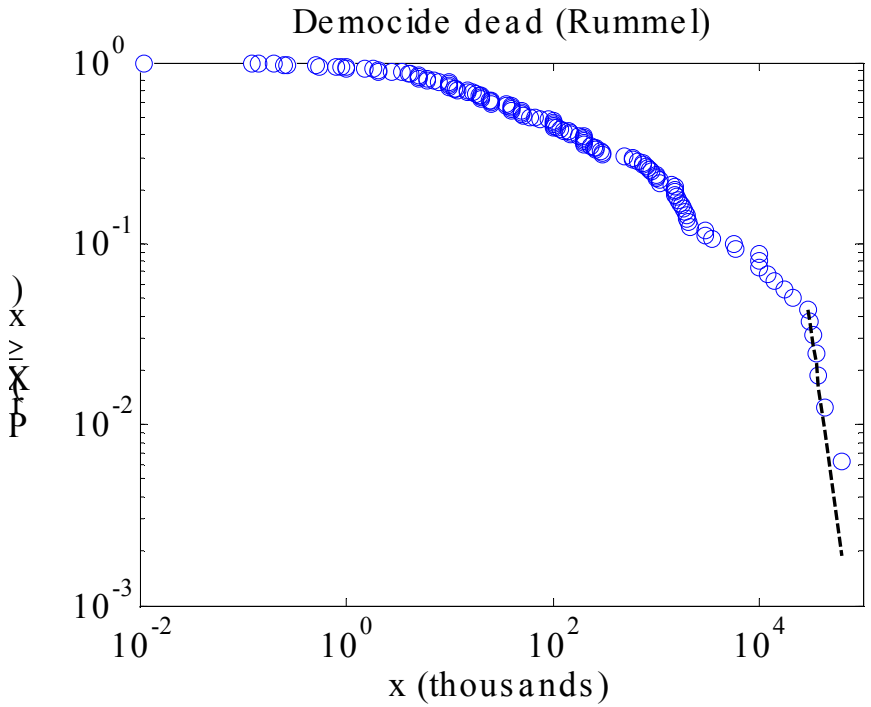

1000
800
600
400
200
0
Mortality Rate per 100 000 per Year
1900
1920
1940
1960
1980
Year

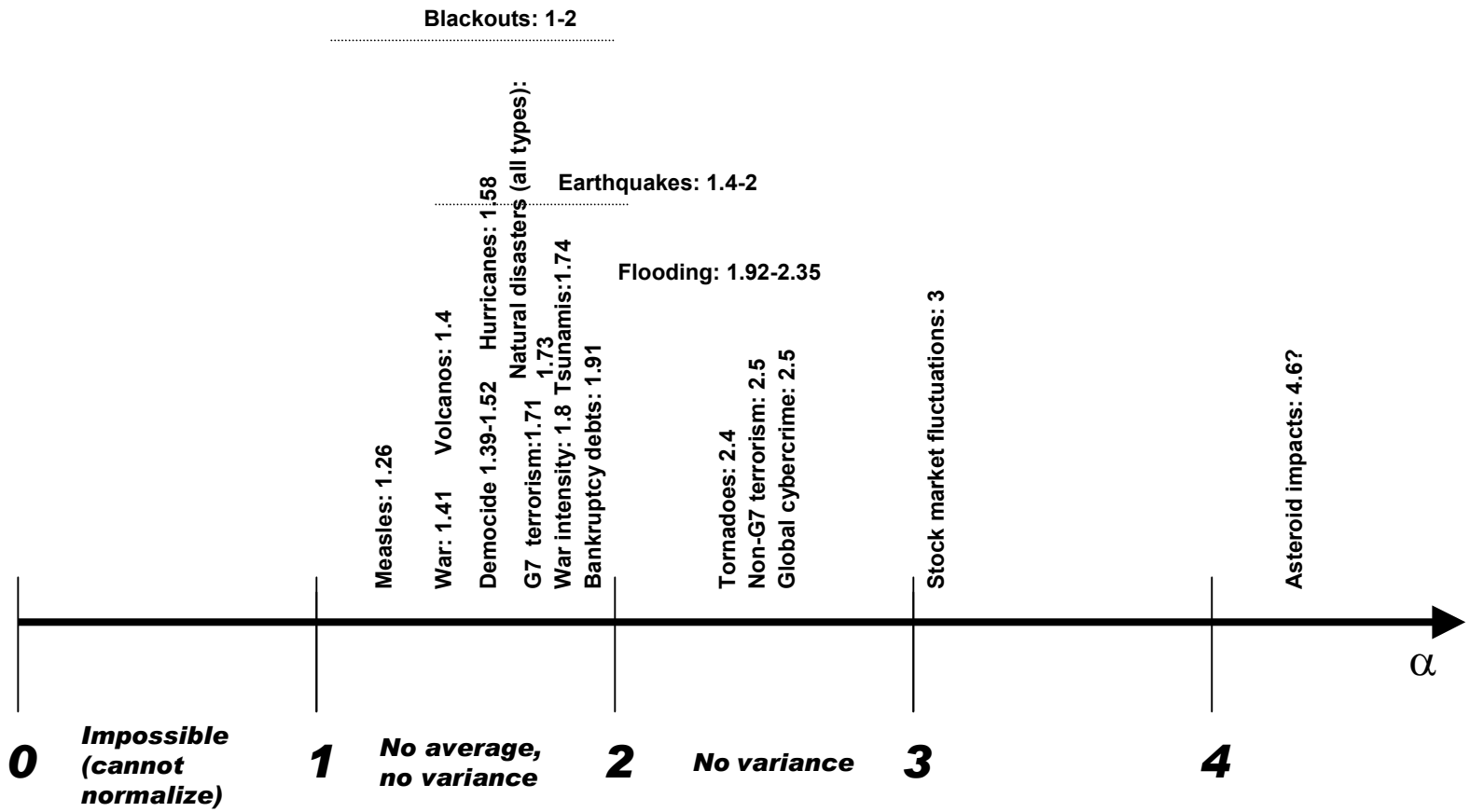

% positive isolates
0
5
10
15
20
25
30
35
40
45
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Laboratory isolates
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
B
A (unsubtyped)
A(H1N1) and A(H1N2)
A(H3N2)
A(Unk)
A(Novel H1N1)


War dead
10^0
10^{-1}
10^{-2}
10^{-3}
10^2
10^4
10^6
10^8
x
P(X ≥ x)

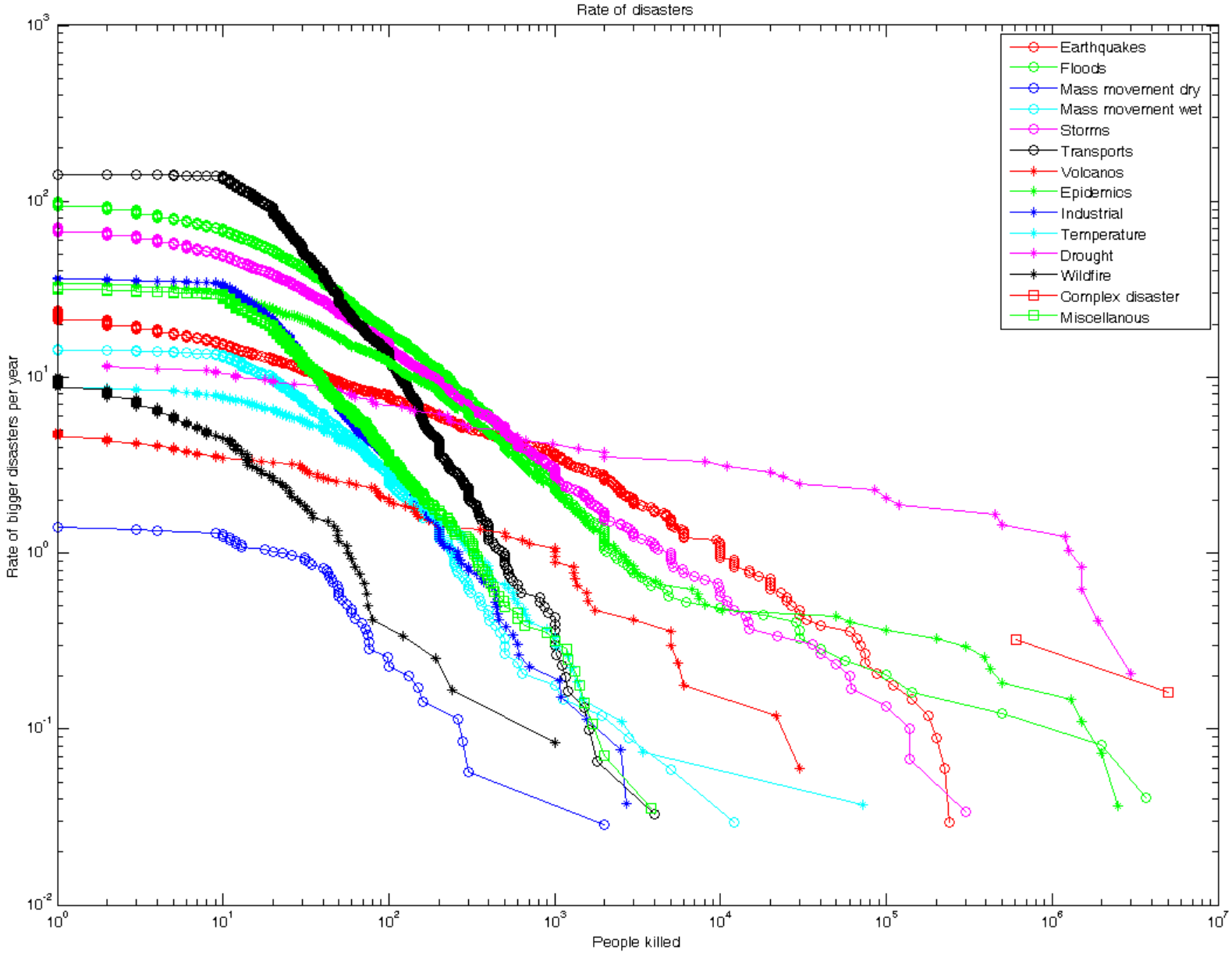

Democide dead (Harff)
10^0
10^{-1}
10^{-2}
10^3
10^4
10^5
10^6
10^7
x
)
x
≥
X
P

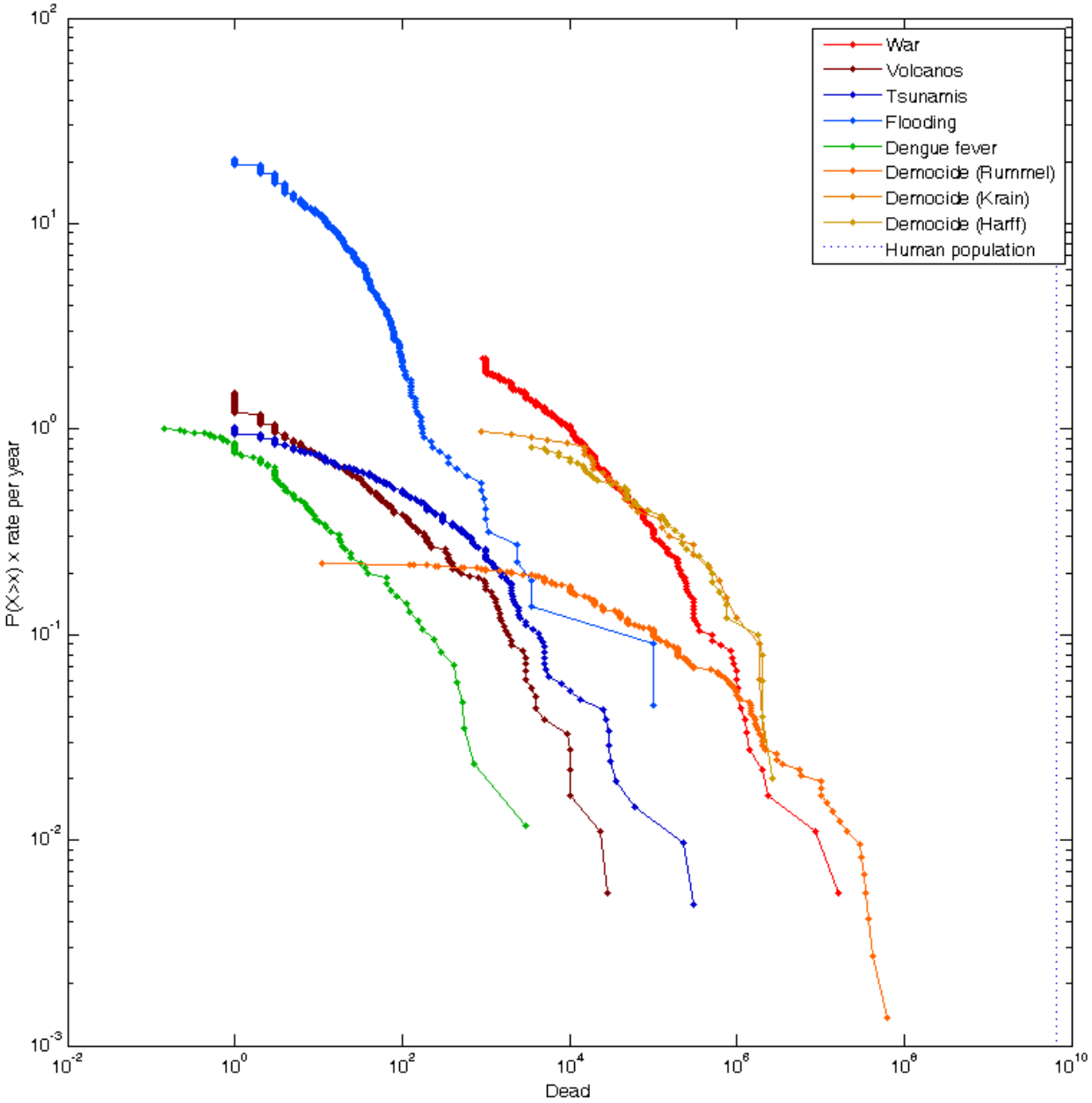

Democide dead (Krain)
10^0
10^{-1}
10^{-2}
10^2
10^3
10^4
10^5
10^6
10^7
x
)
x
≥
X
P


Democide dead (Rummel)
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^0
10^2
10^4
x (thousands)
)
x
≥
X
P



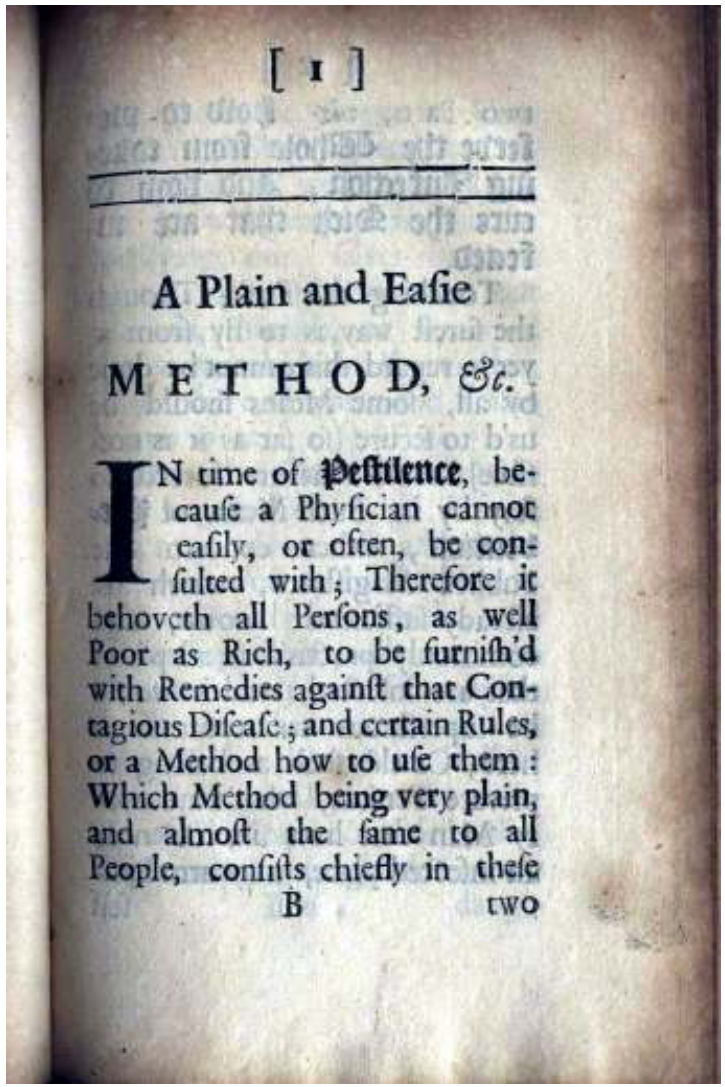
$$P(x) \sim Cx^{-\alpha}$$


Rate of disasters
Rate of bigger disasters per year
People killed
Earthquakes
Floods
Mass movement dry
Mass movement wet
Storms
Transports
Volcanos
Epidemics
Industrial
Temperature
Drought
Wildfire
Complex disaster
Miscellanous


War
Volcanos
Tsunamis
Flooding
Dengue fever
Democide (Rummel)
Democide (Krain)
Democide (Harff)
Human population
P(X>x) x rate per year
Dead
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-2}
10^{0}
10^{2}
10^{4}
10^{6}
10^{8}
10^{10}

"London within ye bills hath 696 thousand people in 108 thousand houses. In pestilential years, which are one in twenty, there dye one sixth of ye people in ye plague and one fifth of all diseases. The people which ye next plague of London will sweep away will be probably 120 thousand."

-Sir William Petty, 1667



[1]

A Plain and Easie

METHOD, &c.

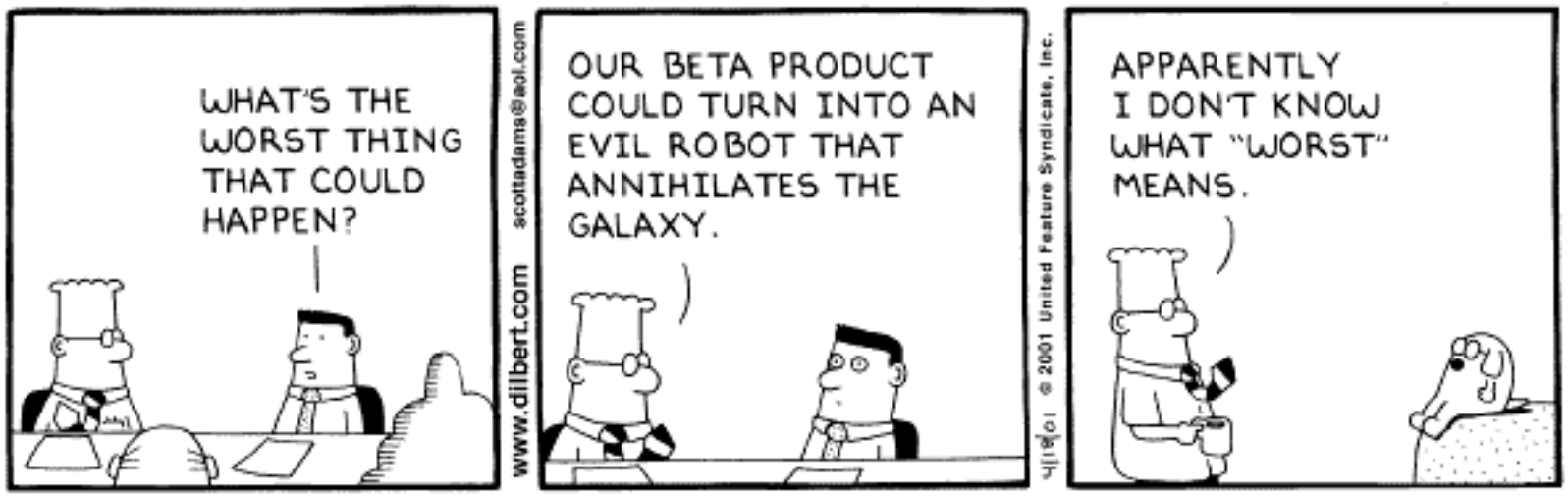
IN time of Pestilence, because a Physician cannot easily, or often, be consulted with; Therefore it behoveth all Persons, as well Poor as Rich, to be furnish'd with Remedies against that Contagious Disease; and certain Rules, or a Method how to use them: Which Method being very plain, and almost the same to all People, consists chiefly in these

B two

A Plain and Easie Method FOR Preserving [by God's Blessing] Those that are WELL from the Infection of the PLAGUE, AND For Curing such as are Infected With it.

Written in the Year 1666 by Tho. Willis, M.D. late Sidney Professor in Oxford, and a Member of the Royal Society and College of Physicians in London.

Risks we lack experience with: black swans



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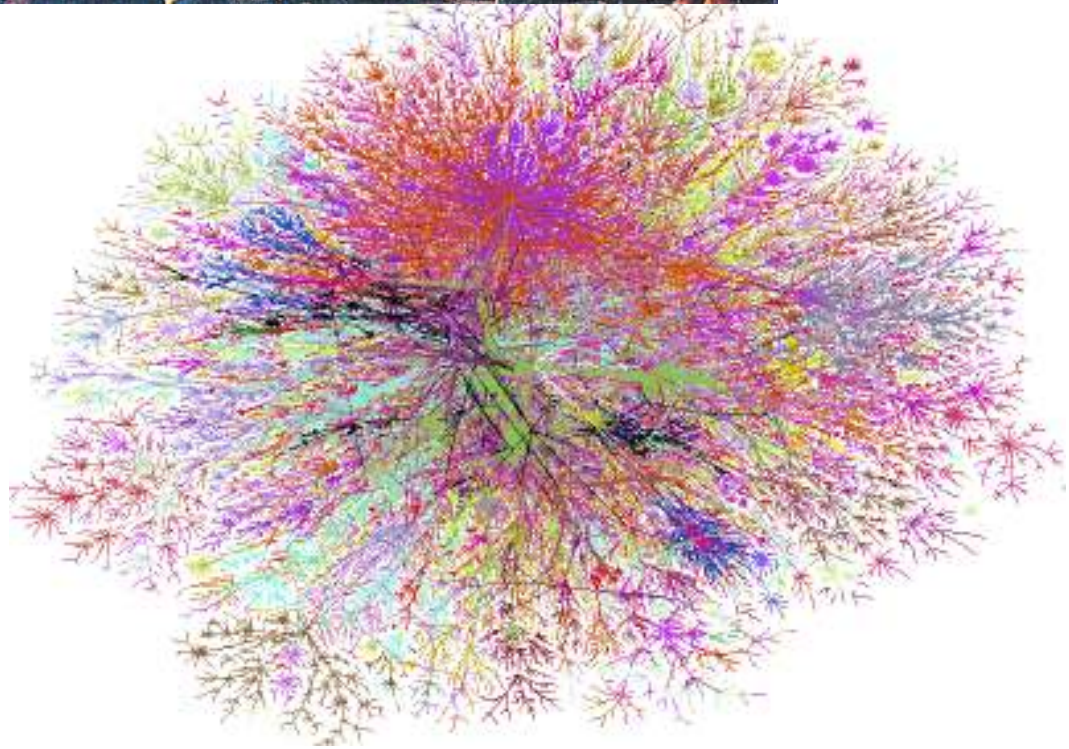
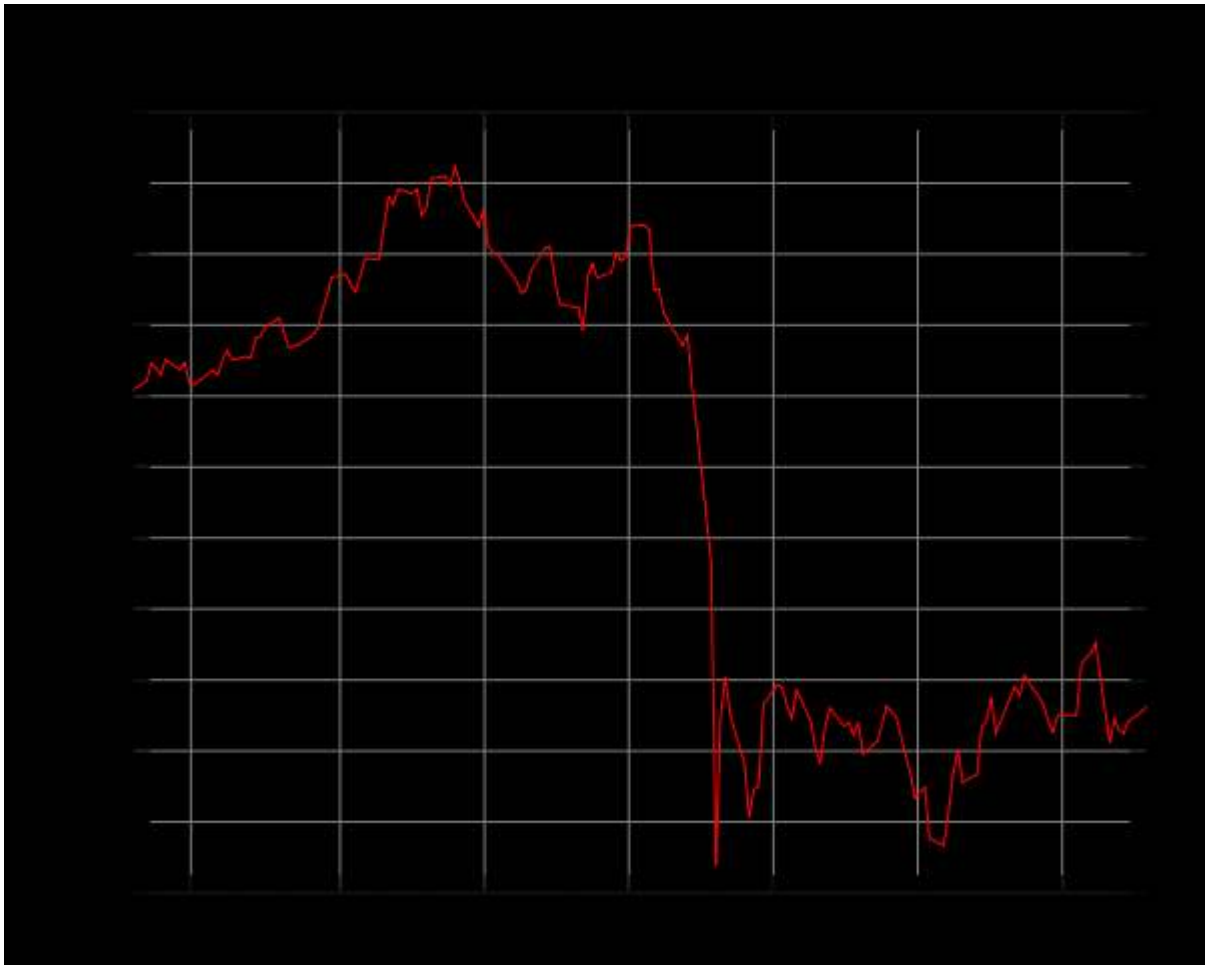
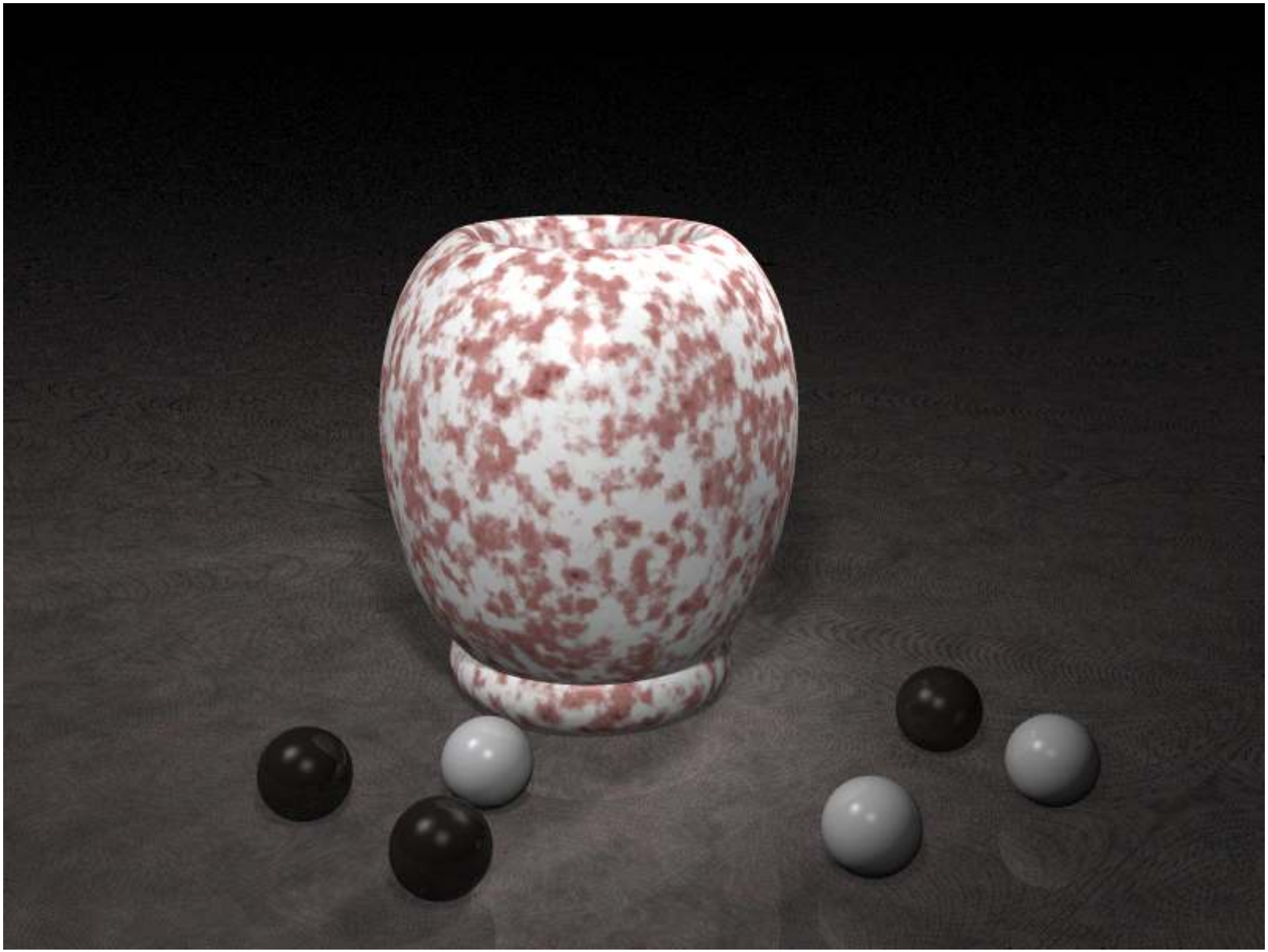
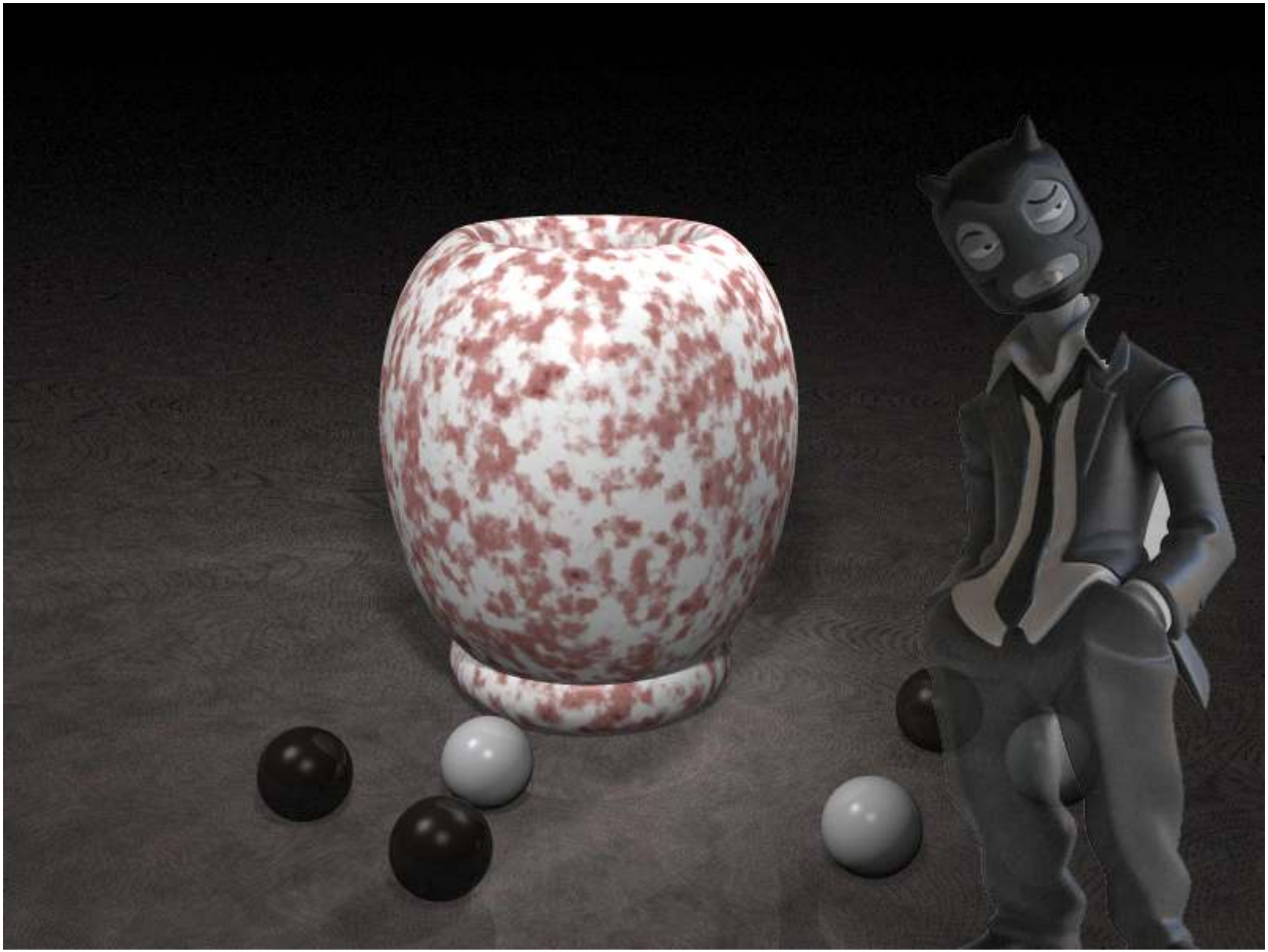


"The game of roulette is not subject ... to uncertainty. The sense in which I am using the term [uncertain] is that in which ... there is no scientific basis on which to form a calculable probability whatever."
— J M Keynes



Known knowns
Known unknowns
Unknown knowns
Unknown unknowns





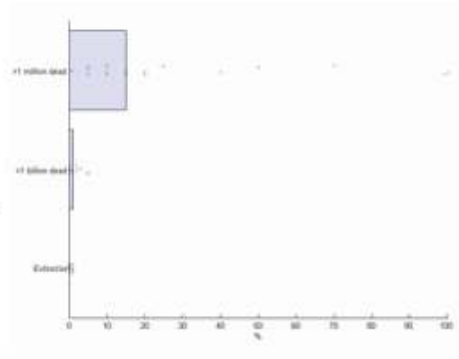
GCR conference survey

Total killed in all acts of nuclear terrorism.

>1 million dead: median 15%

>1 billion dead: median 1%

Extinction: median 0.03%

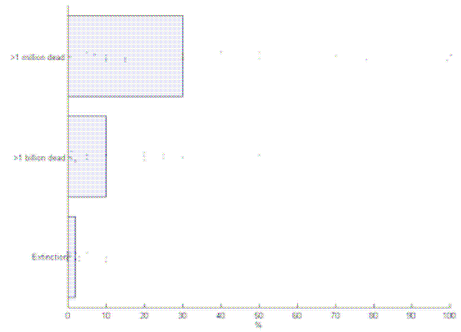


Number killed in the single biggest engineered pandemic.

>1 million dead: median 30%

>1 billion dead: median 10%

Extinction: median 2%

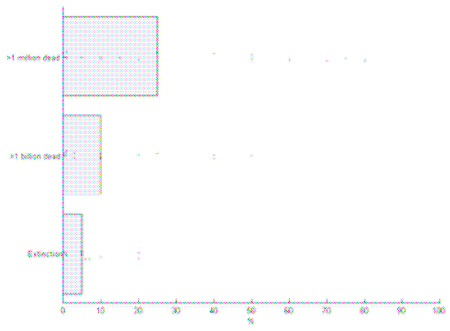


Number killed by molecular nanotech weapons.

>1 million dead: median 25%

>1 billion dead: median 10%

Extinction: median 5%

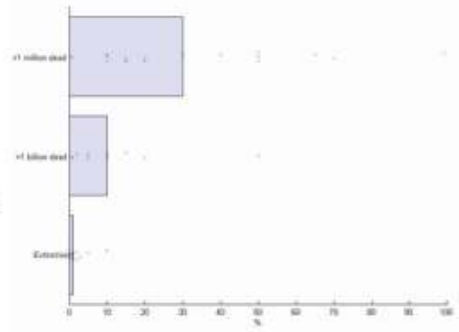


Total killed in all nuclear wars.

>1 million dead: median 30%

>1 billion dead: median 10%

Extinction: median 1%

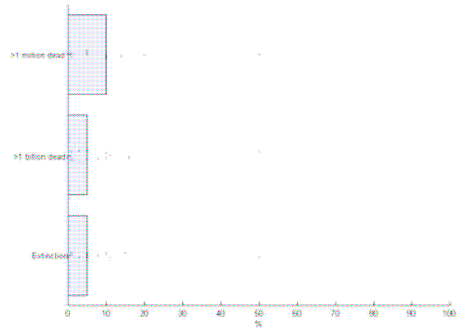


Total killed by superintelligent AI.

>1 million dead: median 10%

>1 billion dead: median 5%

Extinction: median 5%

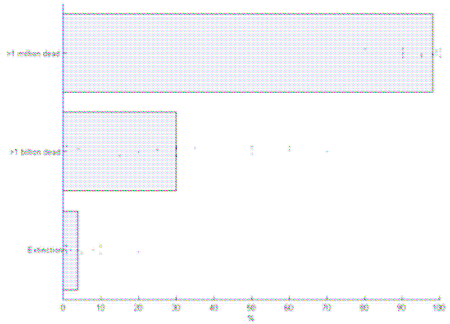


Total killed in all wars (including civil wars).

>1 million dead: median 98%

>1 billion dead: median 30%

Extinction: median 4%

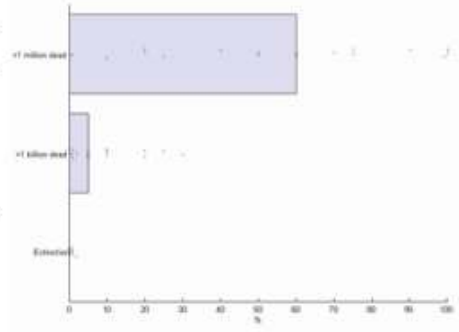


Number killed in the single biggest natural pandemic.

>1 million dead: median 60%

>1 billion dead: median 5%

Extinction: median 0.05%

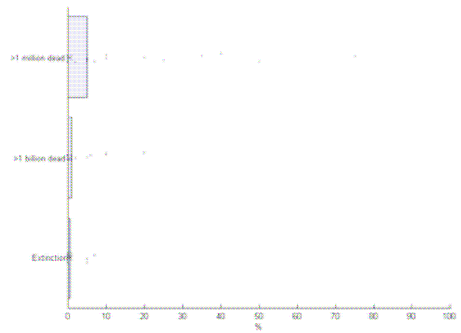


Number killed in the single biggest nanotech accident.

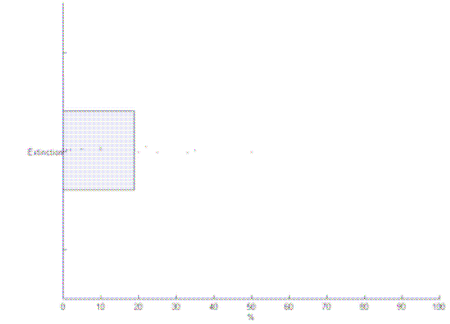
>1 million dead: median 5%

>1 billion dead: median 1%

Extinction: median 0.5%



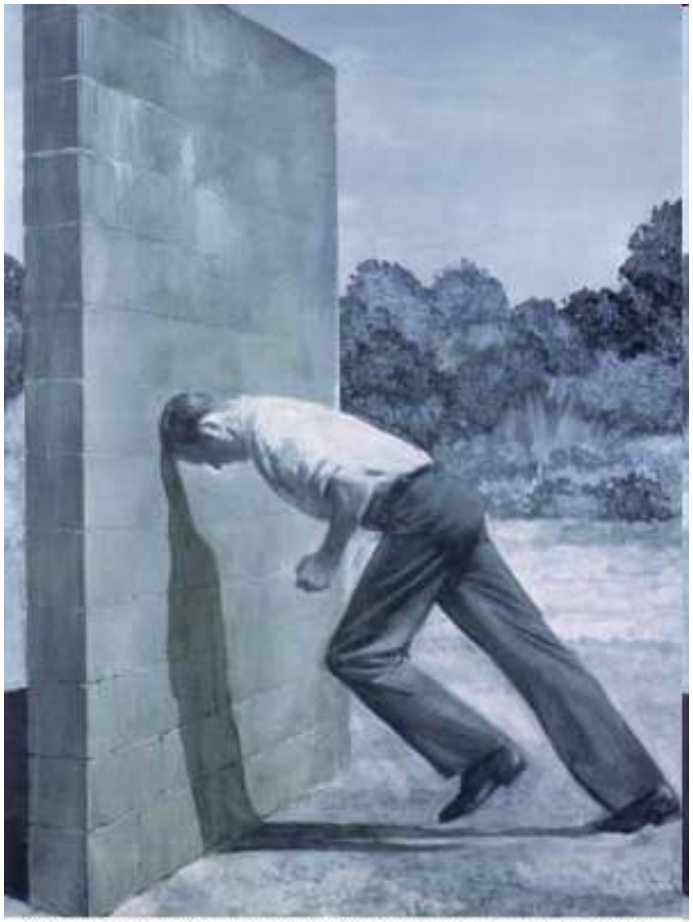
Total risk of extinction: median 19%



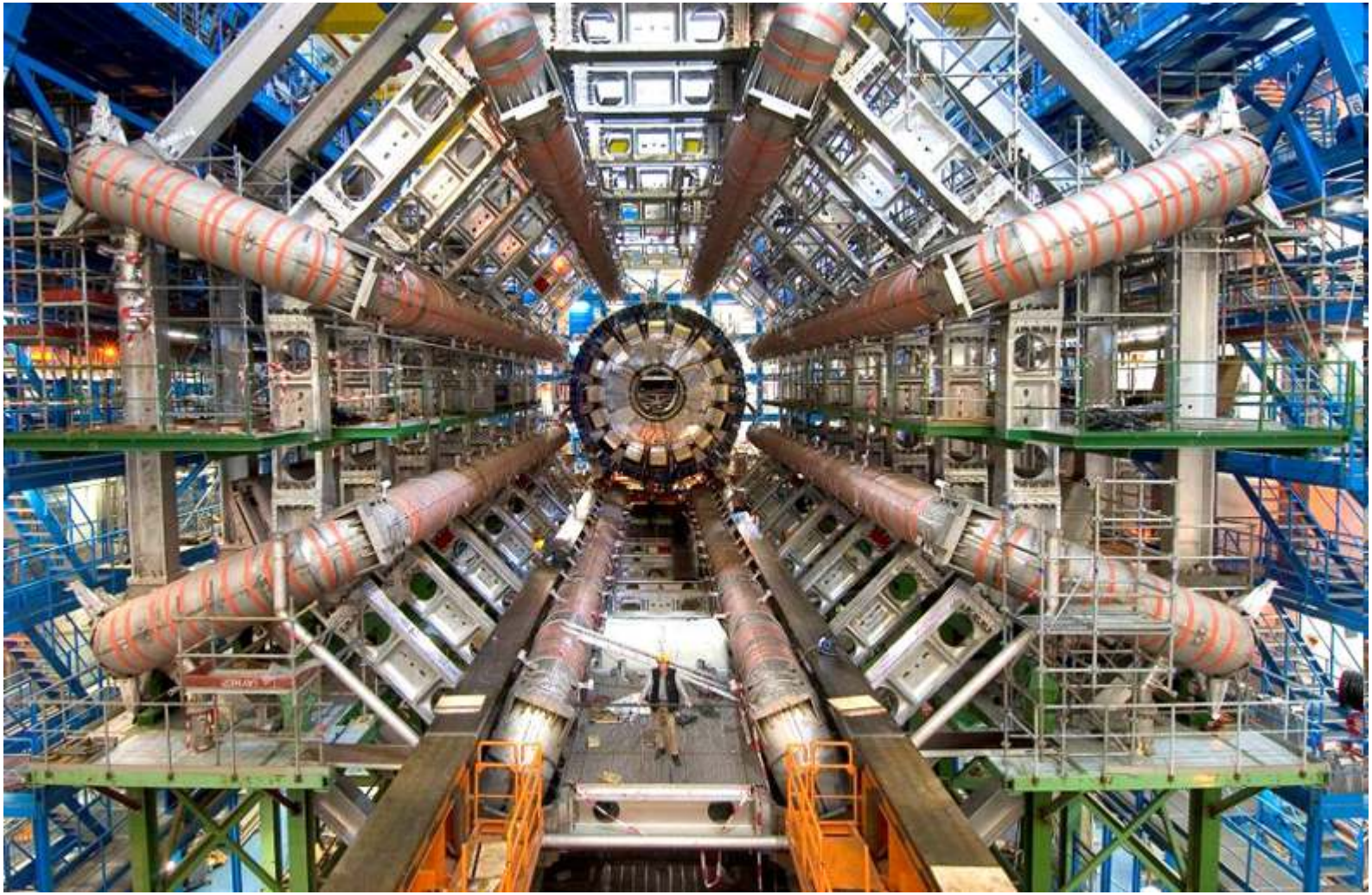
Risks we have no clue about: dragons

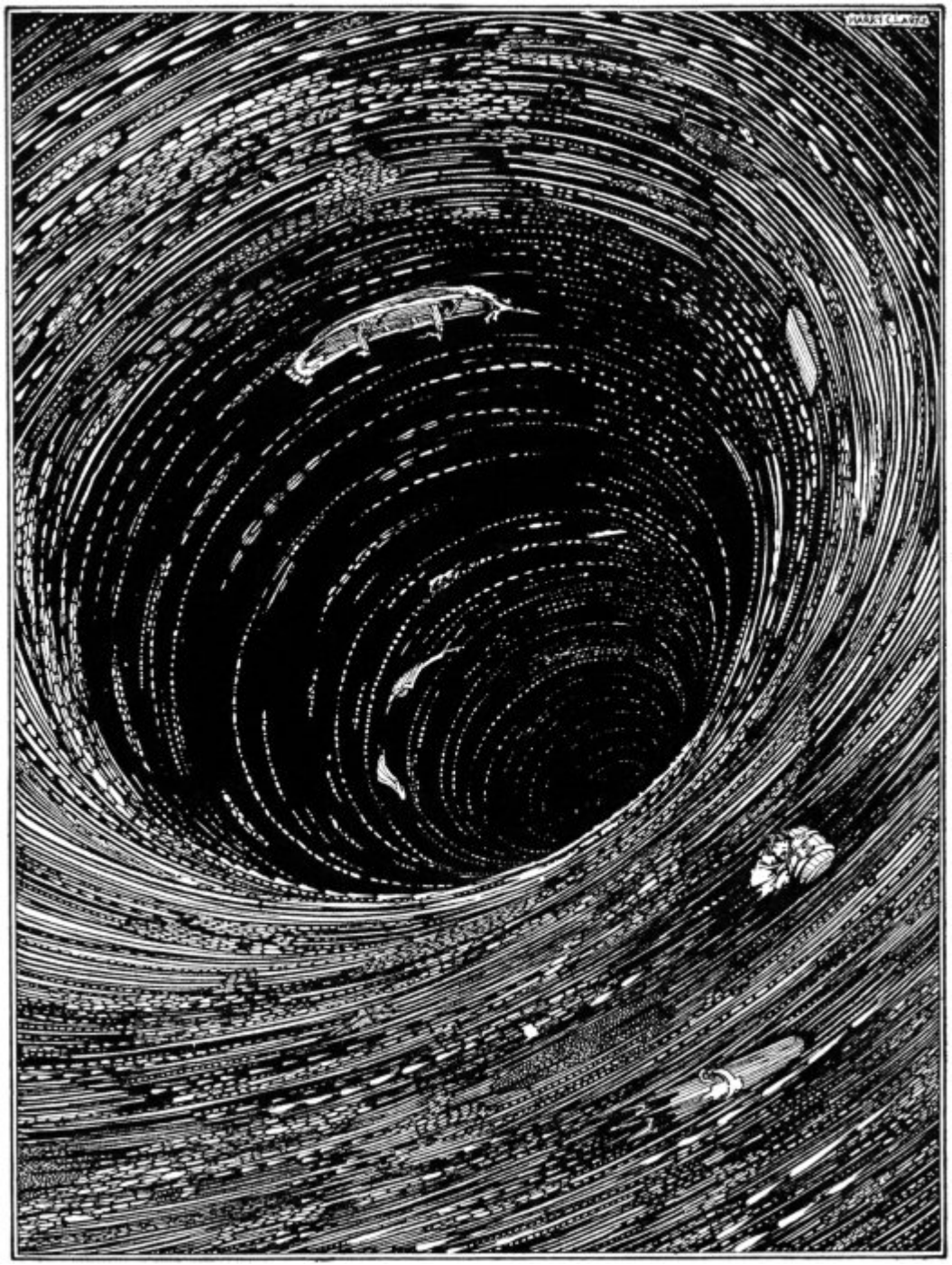
"It is pitch black. You are likely to be eaten by a grue."

-Infocom



A SHORT HISTORY OF MODERNIST PAINTING" (DETAIL) MARK TANSEY



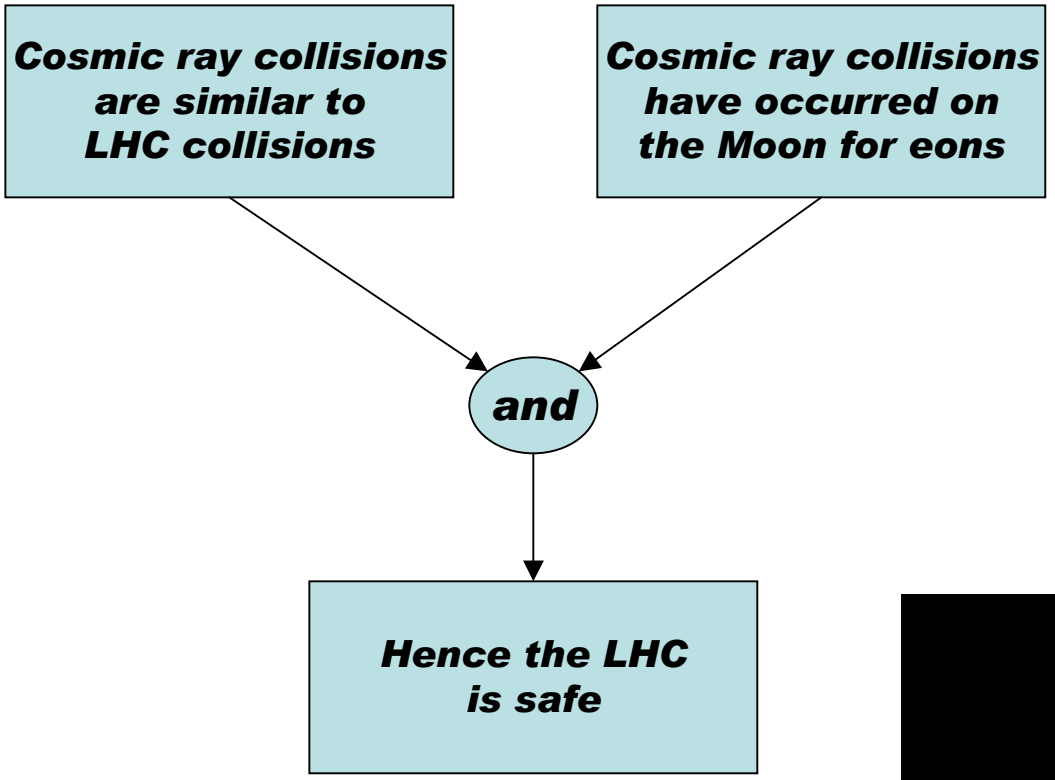


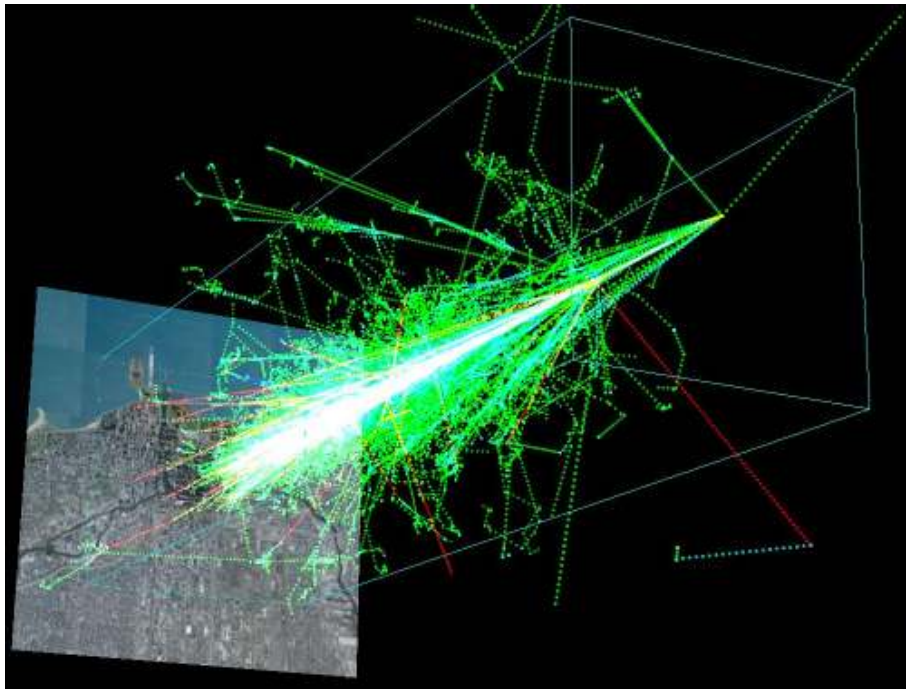
“Because of Werner Heisenberg's uncertainty principle, there is a tiny chance that anything will occur. There is a chance that firebreathing dragons will be produced by the LHC.“

- Michio Kaku

"Everyone knows that dragons don't exist. But while this simplistic formulation may satisfy the layman, it does not suffice for the scientific mind.“

-Stanislaw Lem, The Cyberiad (The Third Sally, The Dragons of Probability)


Cosmic ray collisions are similar to LHC collisions
Cosmic ray collisions have occurred on the Moon for eons
and
Hence the LHC is safe



Cosmic ray collisions are similar to LHC collisions

Hence they would produce the same kind of particles

Physics

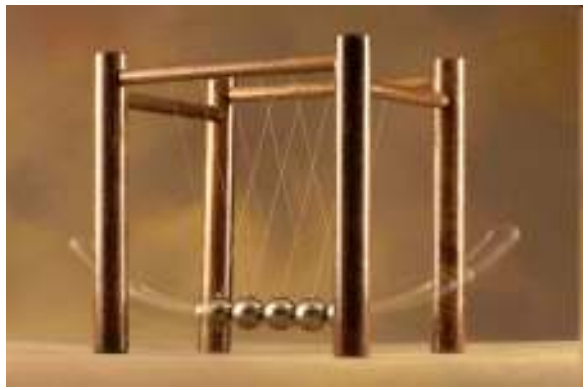
The particles would be slowed in interstellar space and enter stars

If the particles are dangerous, they need to absorb planets rapidly

They would absorb stars rapidly, producing a supernova rate

Data

Observed supernova rate constrains the density of dangerous particles



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Cosmic ray collisions are similar to LHC collisions

Hence they would produce the same kind of particles

Physics

The particles would be slowed in interstellar space and enter stars

If the particles are dangerous, they need to absorb planets rapidly

They would absorb stars rapidly, producing a supernova rate

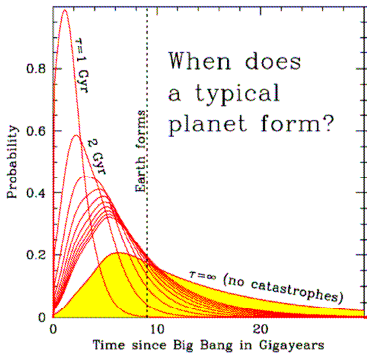
If the universe was very dangerous, observers would tend to be early

Data

Data

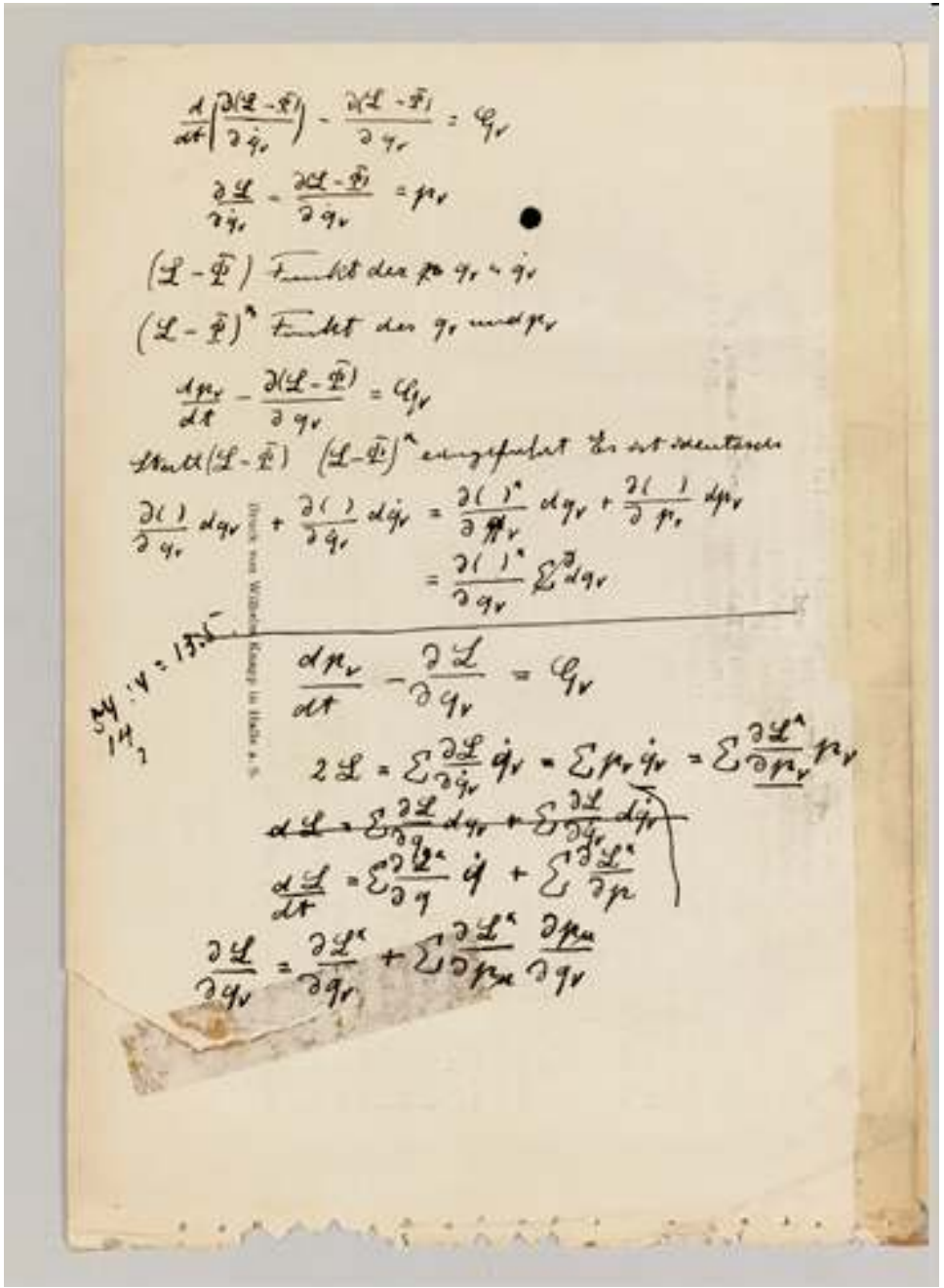
Observed supernova rate constrains the density of dangerous particles

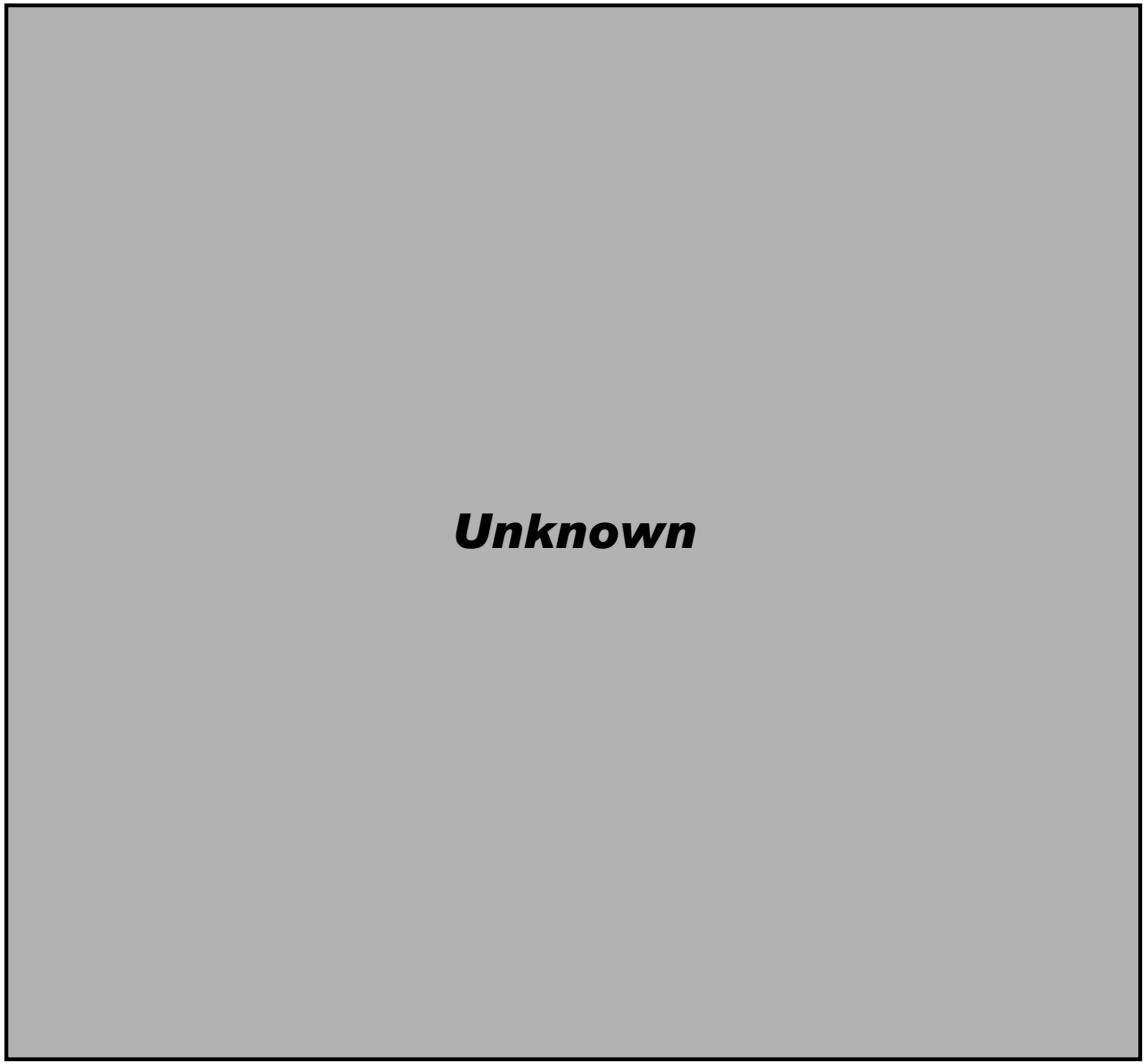
Anthropic correction



Hence the LHC is safe

How often are scientific arguments wrong?

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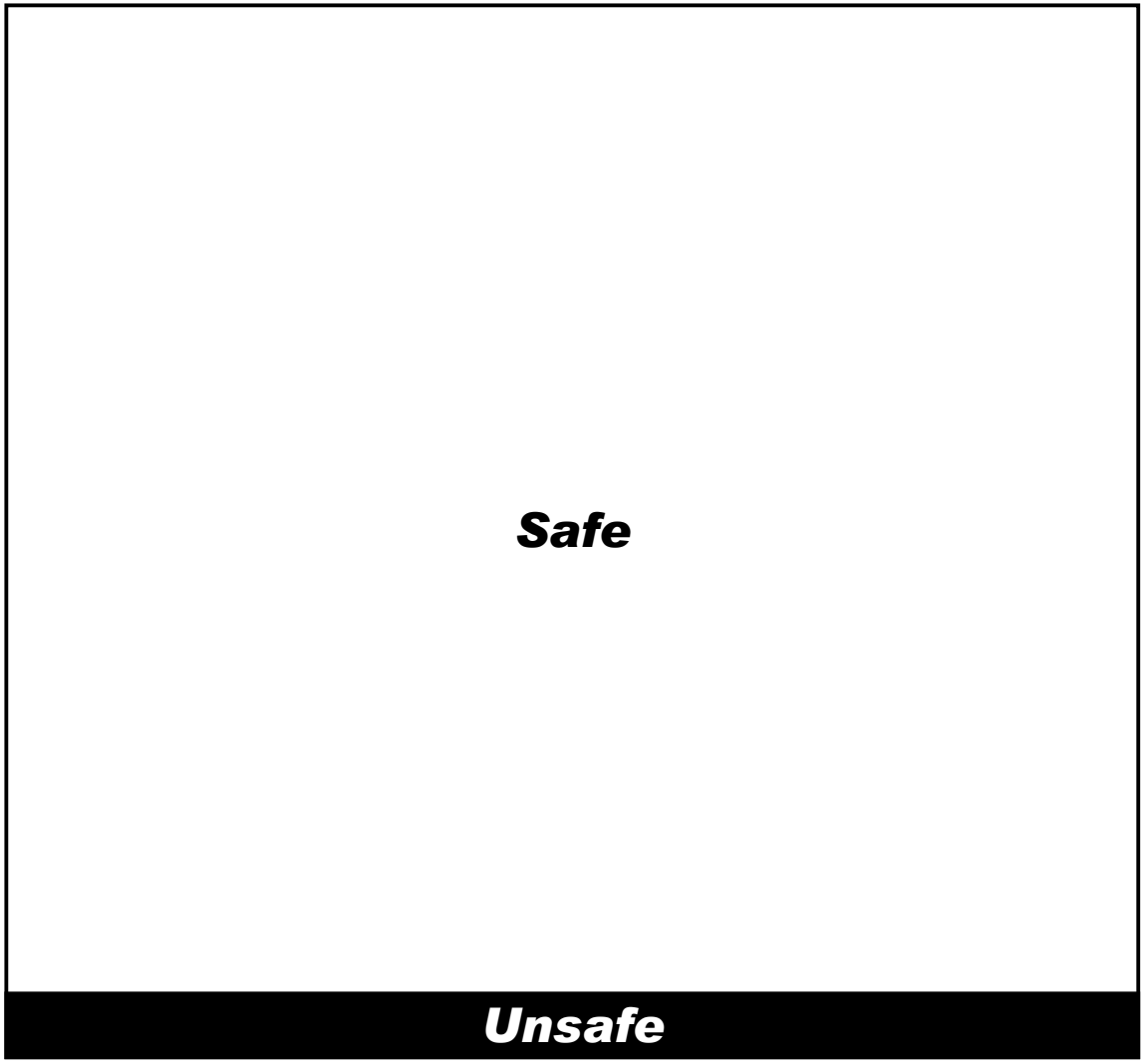
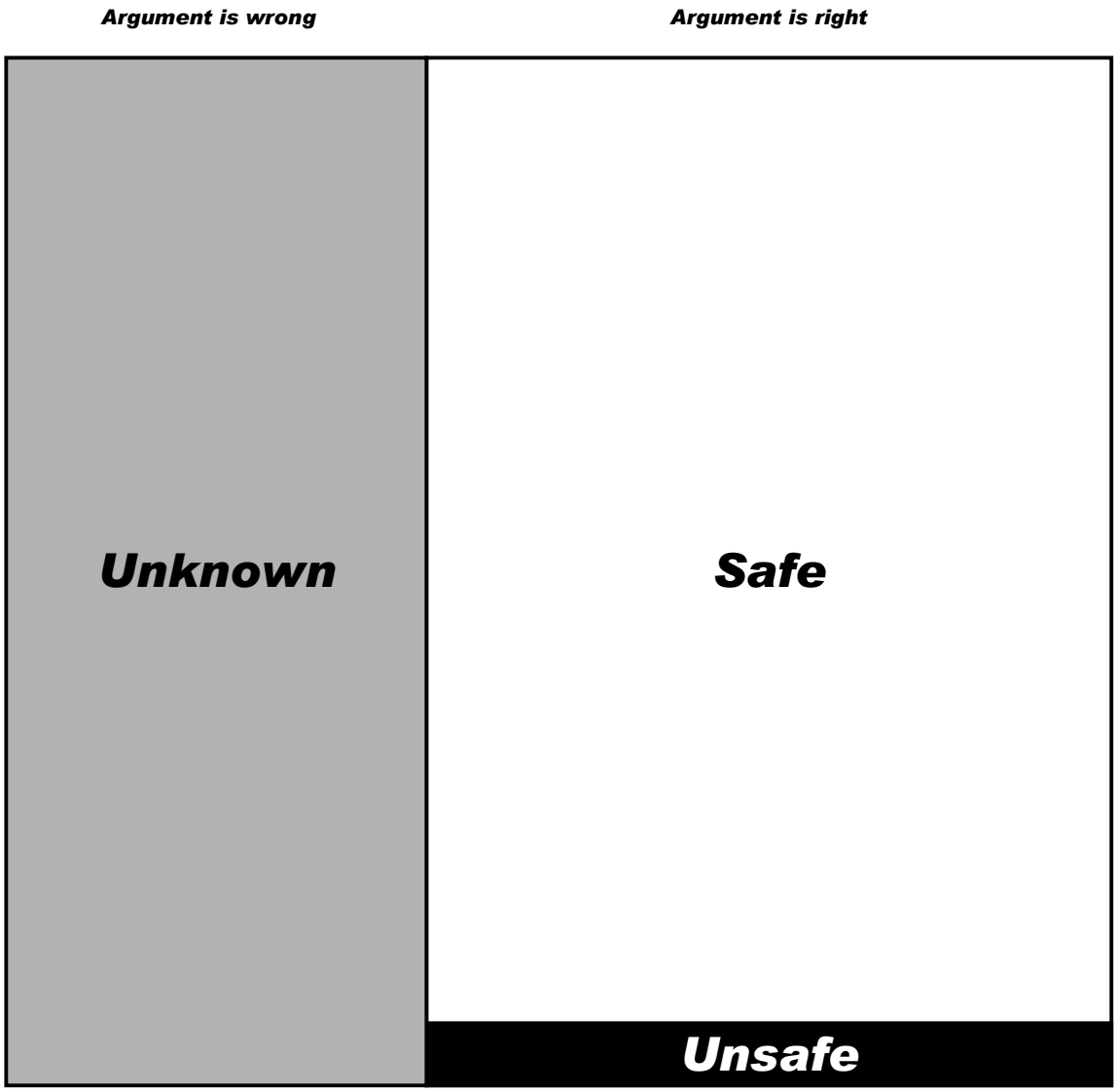

Safe
Unsafe


Argument is wrong
Argument is right
Unknown
Safe
Unsafe

Physics

Most BH models have Hawking radiation

Small black holes need to be stable if they are to be unsafe

Dangerous BHs need charge neutralization

Charge neutralisation is unlikely

Physics

And

And

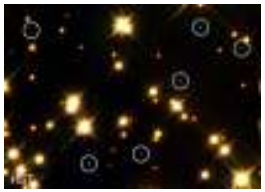
Physics?

Information preservation prevents small BHs from absorbing particles

Dangerous BHs would absorb white dwarves and neutron stars rapidly

Physics

Physics

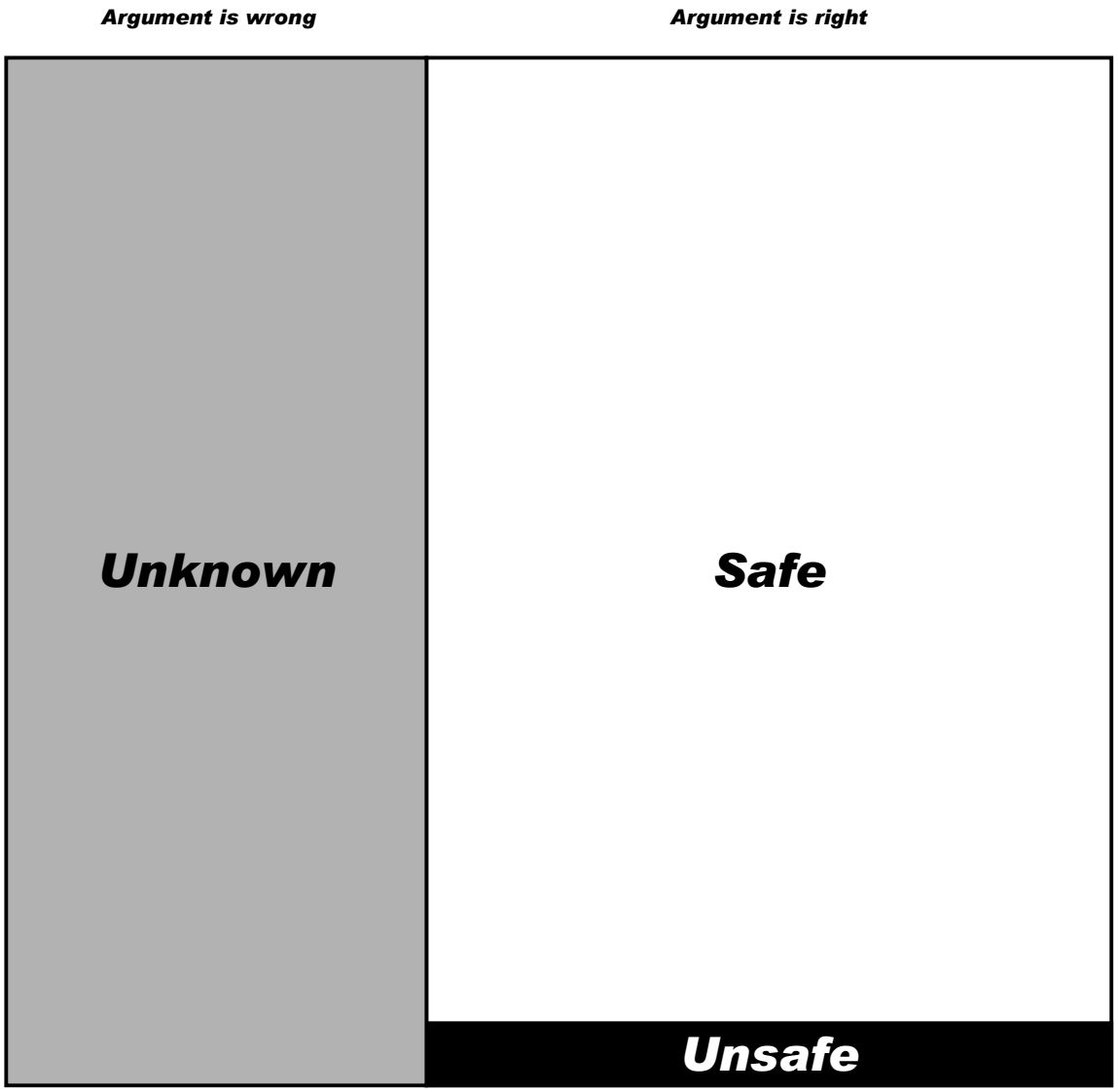


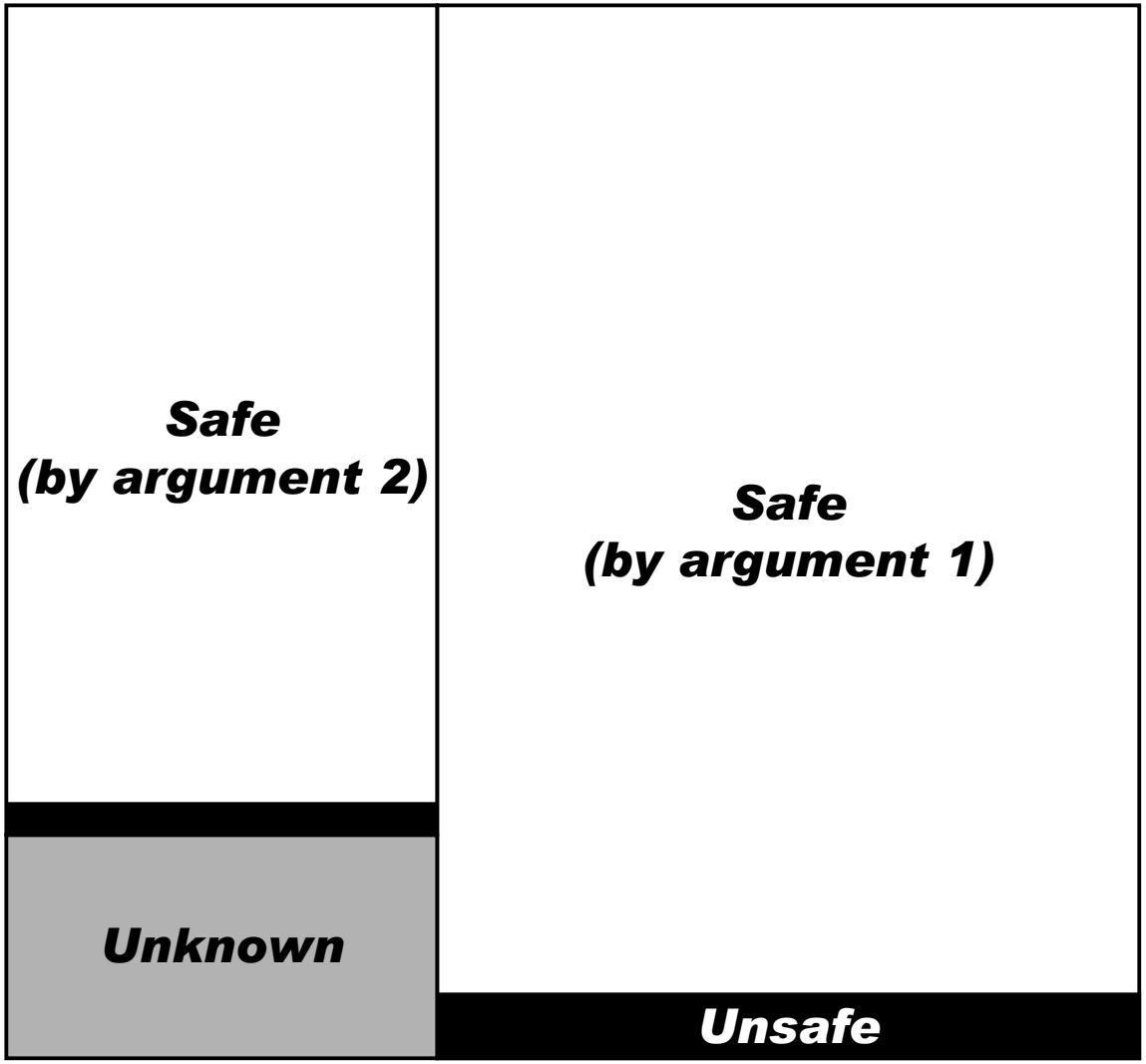
If black holes are stable, cosmic rays would produce them on dense stars

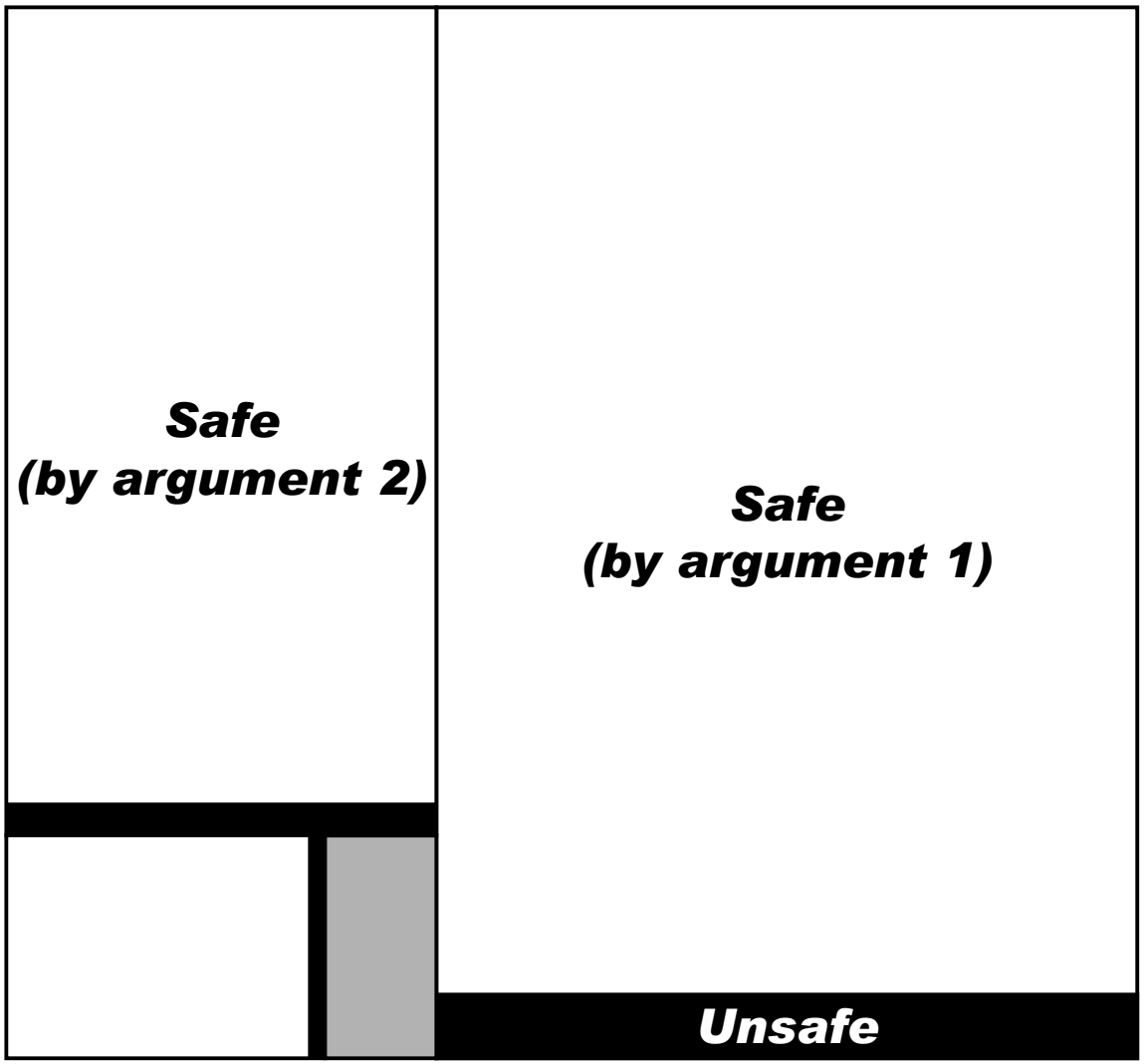
And

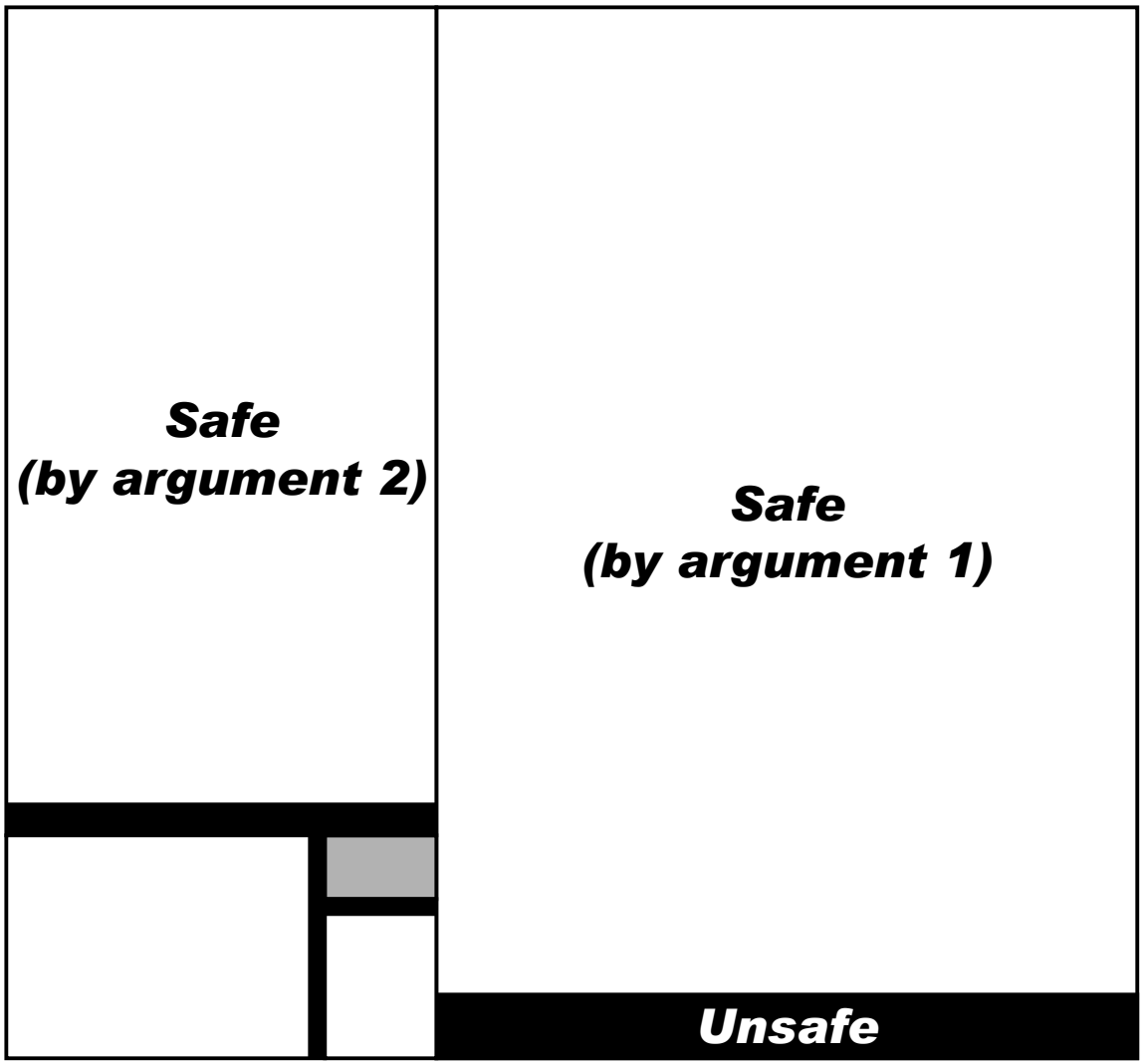
Hence the LHC is safe

We observe lots of white dwarves and neutron stars


Argument is wrong
Argument is right
Unknown
Safe
Unsafe


Safe
(by argument 2)
Safe
(by argument 1)
Unknown
Unsafe

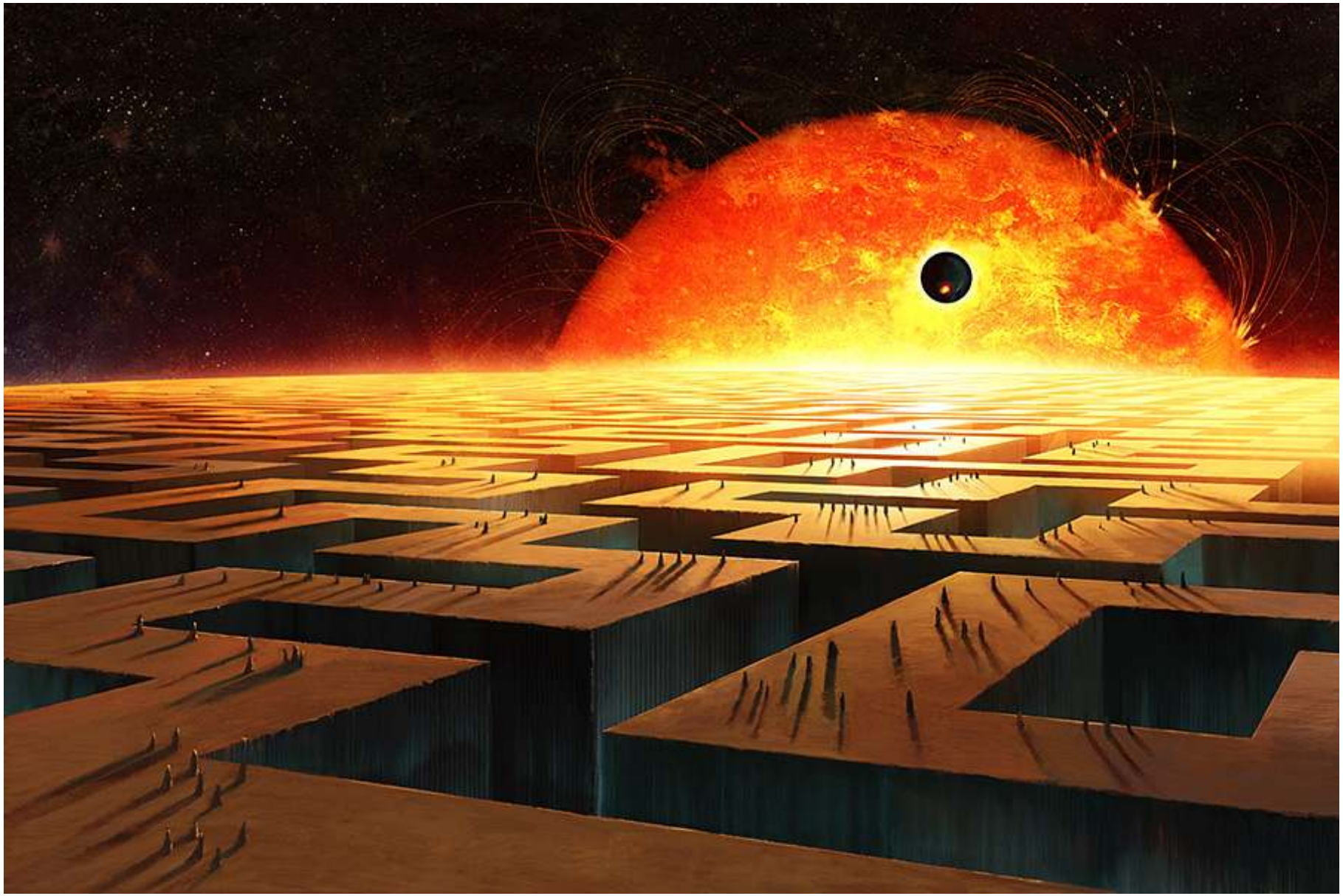

Safe
(by argument 2)
Safe
(by argument 1)
Unsafe

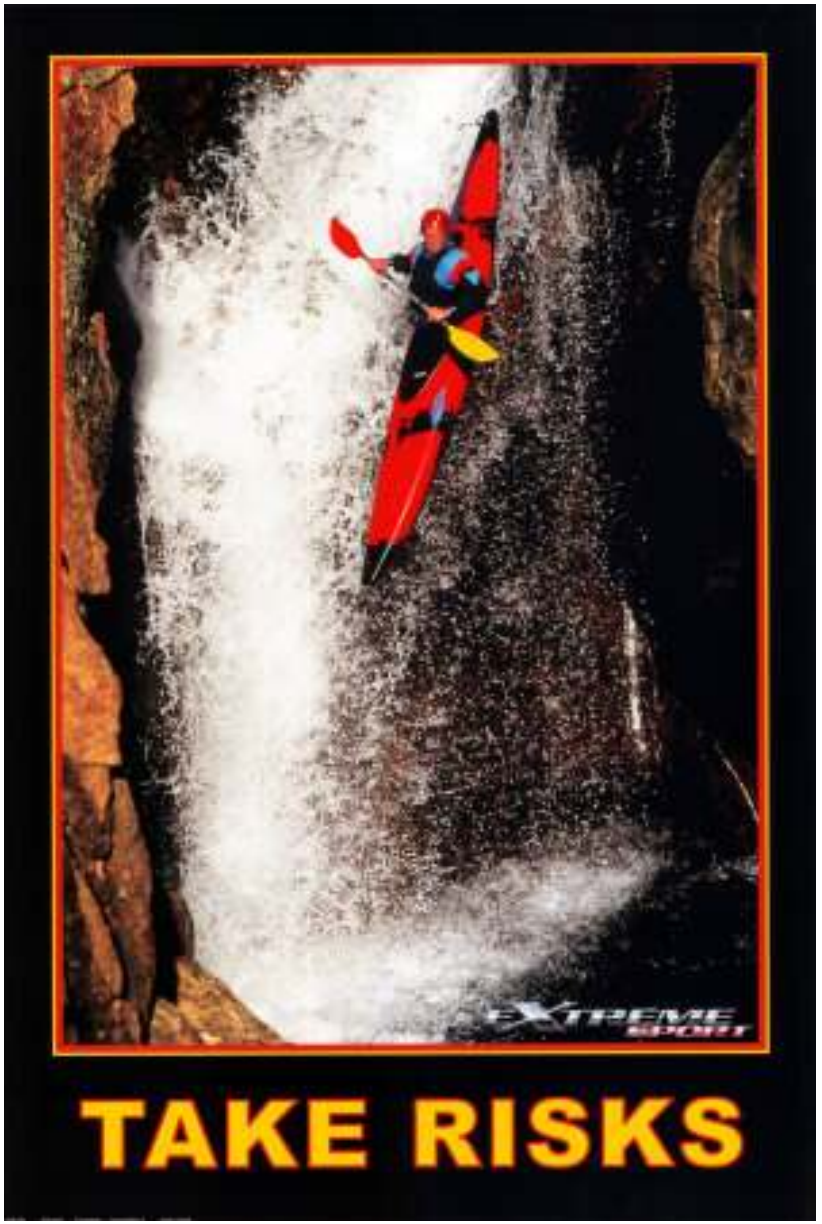

Safe
(by argument 2)
Safe
(by argument 1)
Unsafe

Dealing with pigs, swans and dragons

"If you're not confused, you're not paying attention."

-Tom Peters




EXTREME SPORT
TAKE RISKS