Intro
Theory
In Practice
Applications
AI Revolution

Deep Reinforcement Learning

Deep Learning — Unit 10

Dr. Jon Krohn
jon@untapt.com

December 16th, 2017

NYC DATA SCIENCE ACADEMY

Intro
Theory
In Practice
Applications
AI Revolution

Outline

1 Introduction

2 Essential Theory

3 Cart Pole Deep Q-Learning

4 Contemporary Applications

5 The AI Revolution

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Deep Learning Categories

1. supervised learning
2. unsupervised learning
3. reinforcement learning

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1. supervised learning
2. unsupervised learning
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Supervised Learning

- have x and y
- goal is to approximate function that predicts y with x
- e.g.: classification (MNIST digits, IMDB sentiment), regression

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Unsupervised Learning

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- goal is to learn data's underlying hidden structure
- e.g.: word vectors, GANs

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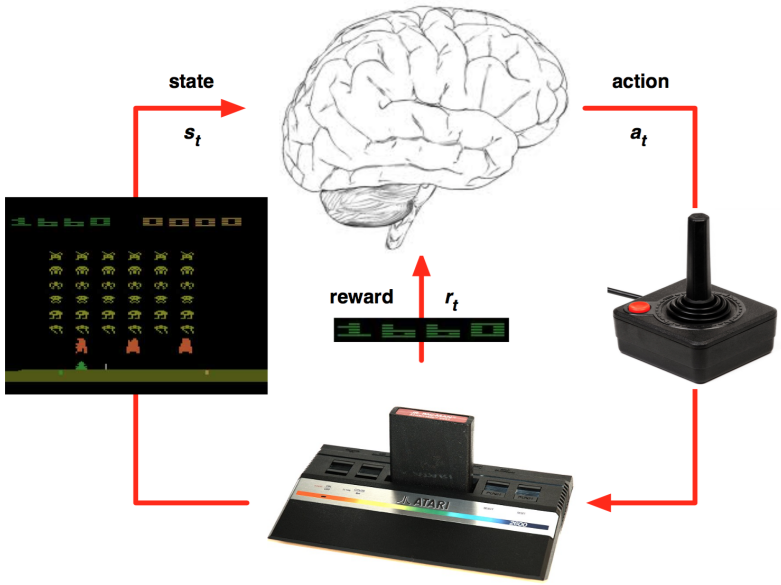
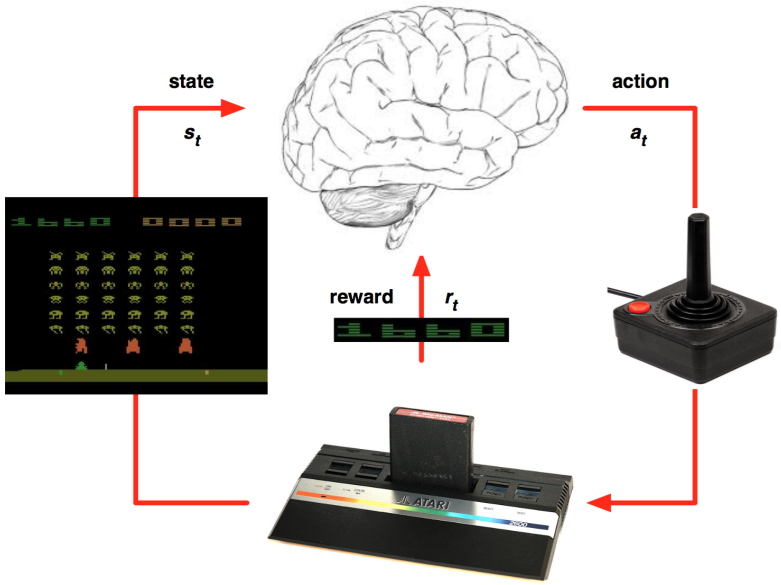
Reinforcement Learning



- an *agent* takes action in an *environment*
- environment returns *state*, i.e., *reward* at t, state at $t+1$
- repeat

Reinforcement Learning



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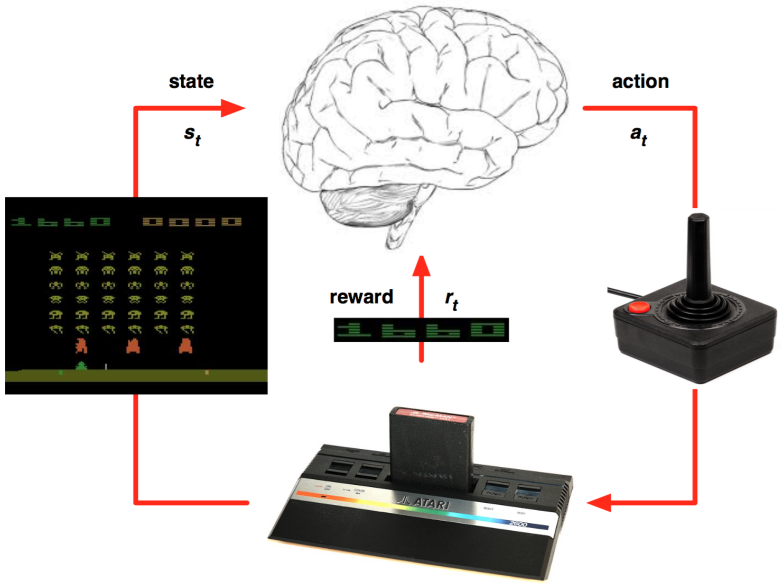

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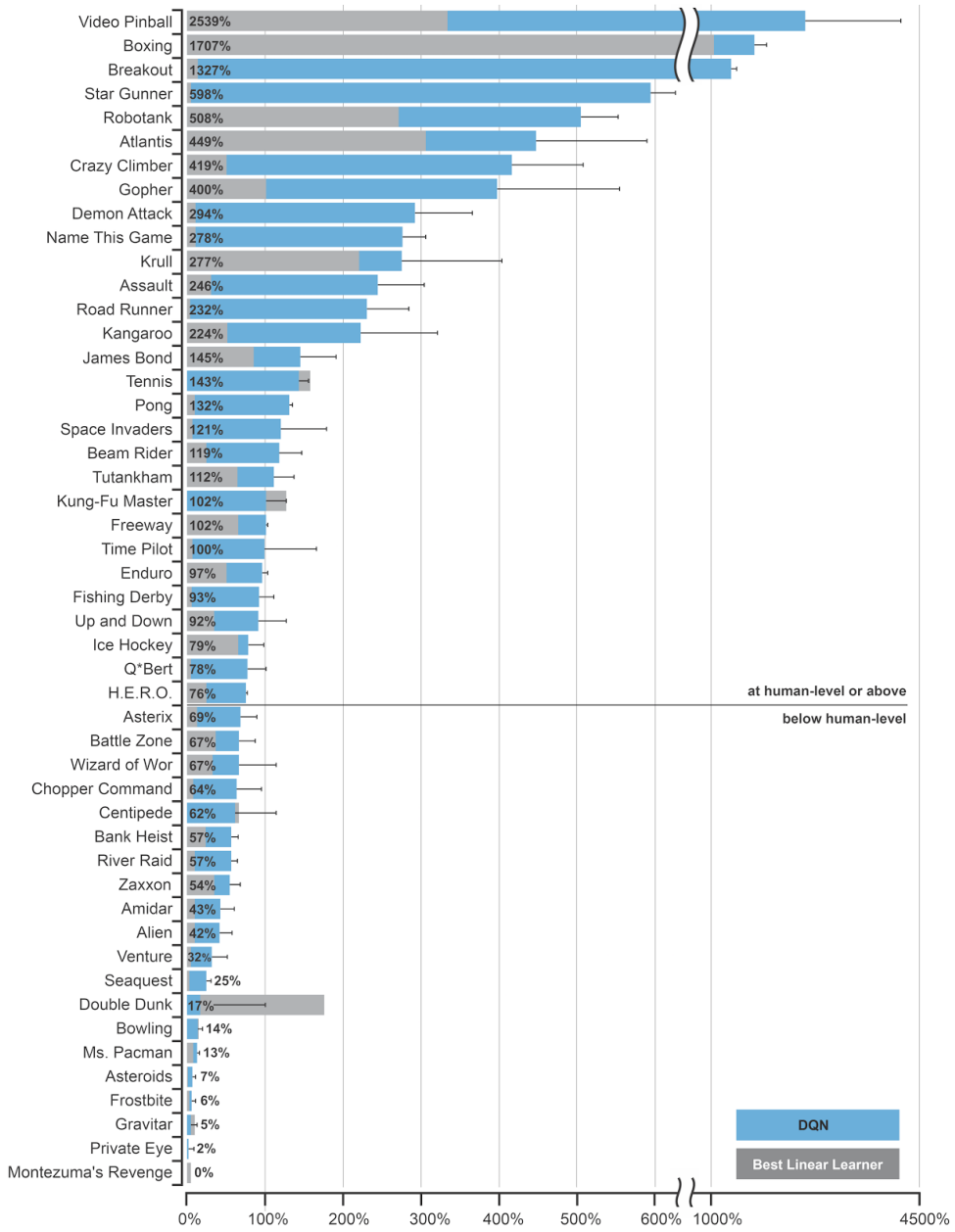
Deep Q-Learning

Mnih et al. (2015)



[Atari Games]

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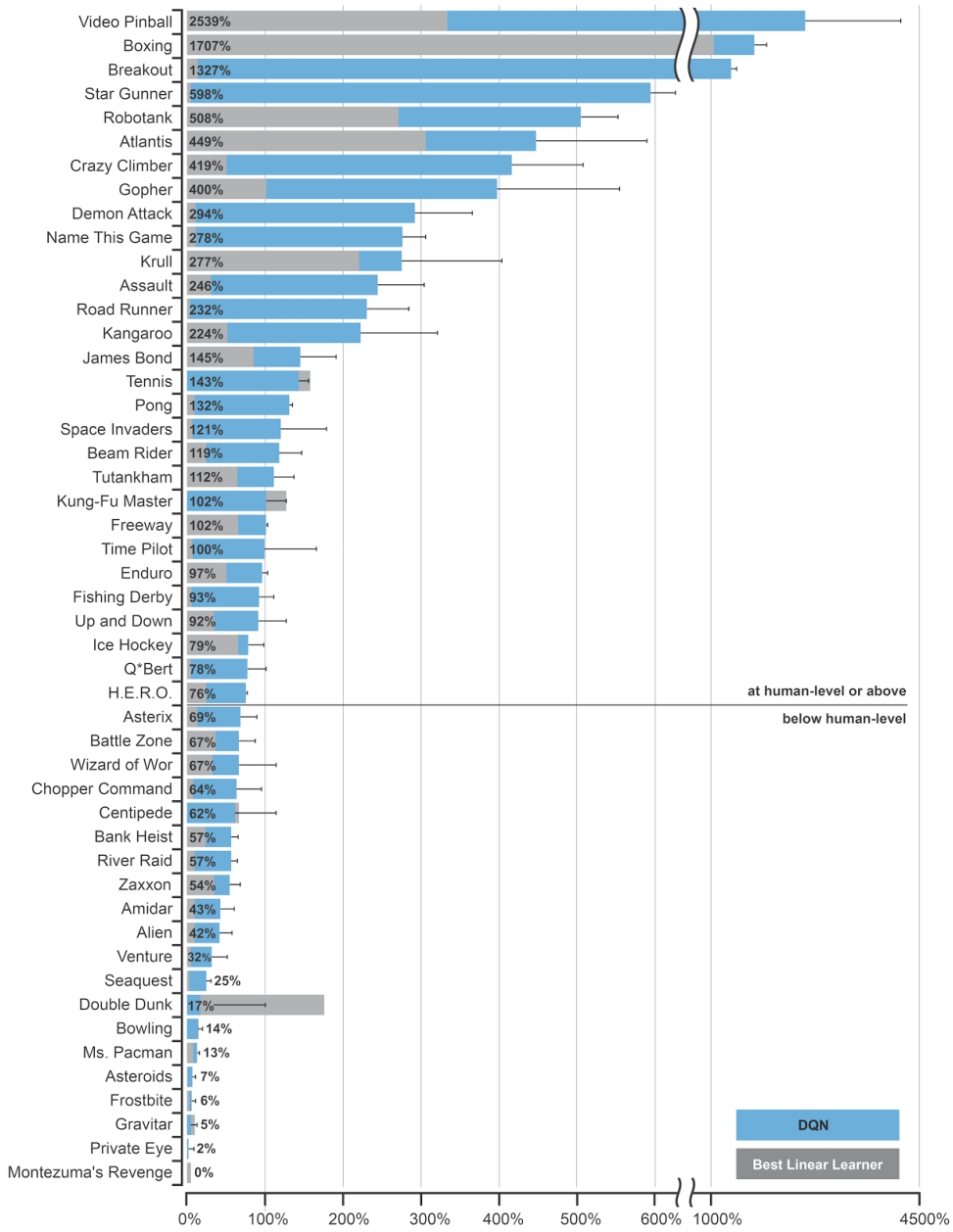

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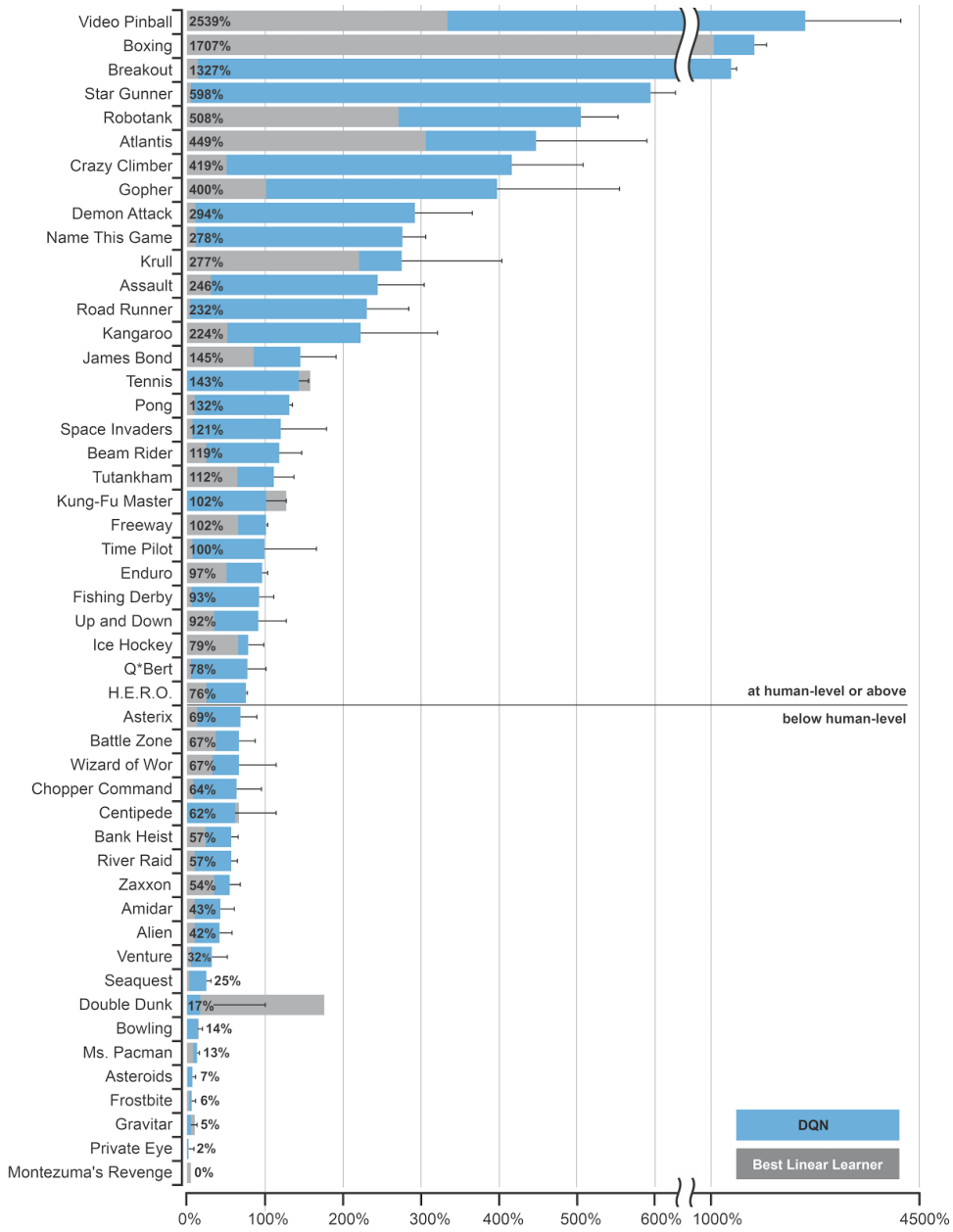

[Atari Games]

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Environments

[OpenAI Gym]

[Google DeepMind Lab]

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Essential Theory

1. Markov Decision Processes
2. Q-Learning
3. Policy Gradients
4. Actor-Critic Algorithm

[GitHub Content]

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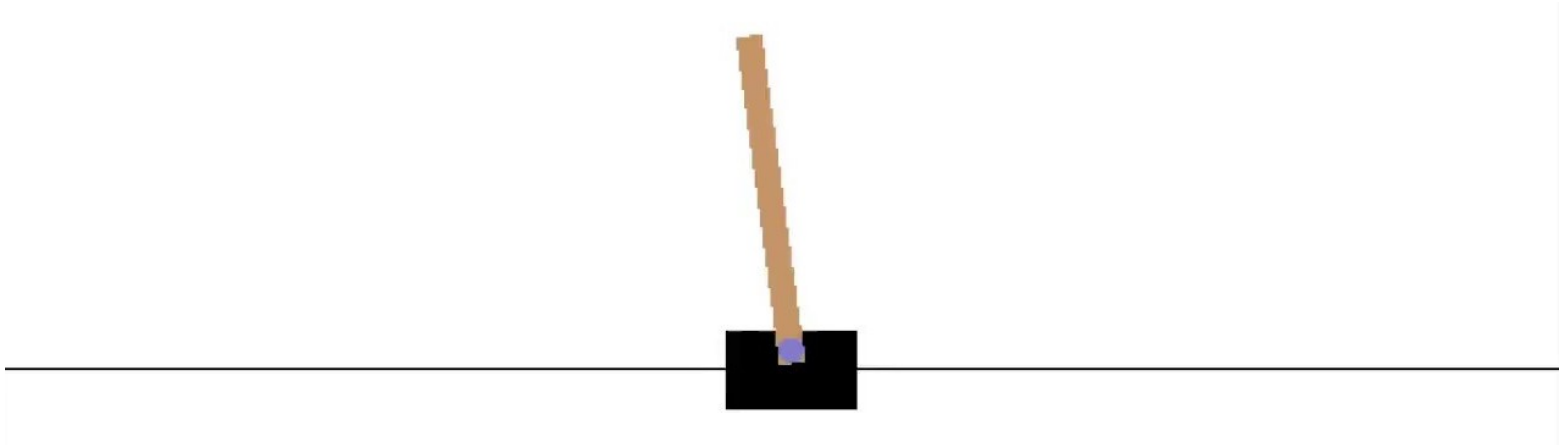
The Cartpole Game

OpenAI



1. cart position
2. cart velocity
3. pole angle
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The Cartpole Game

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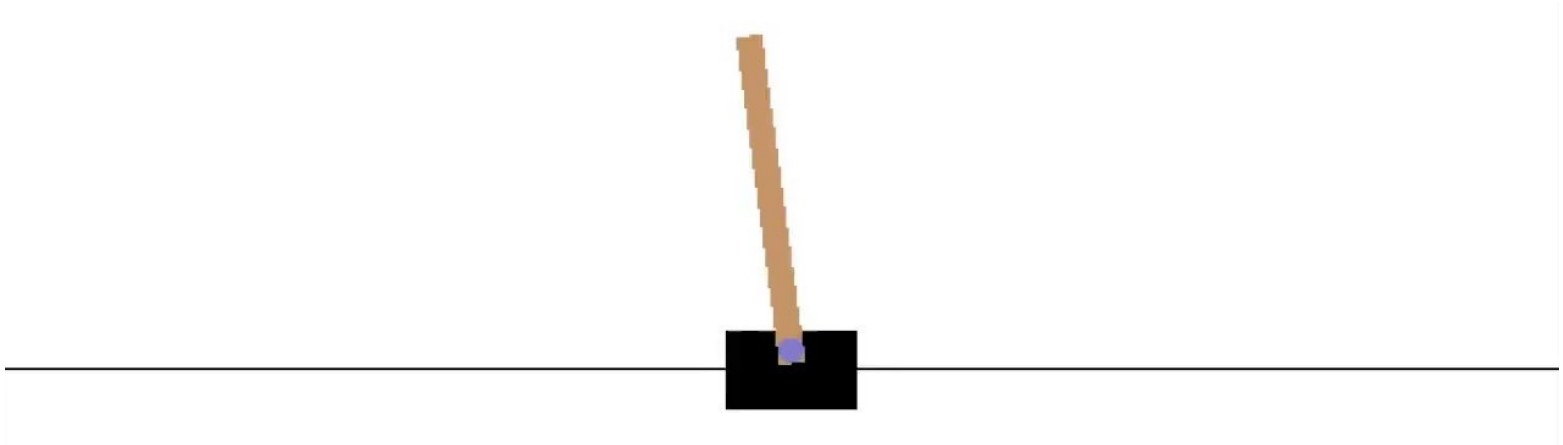

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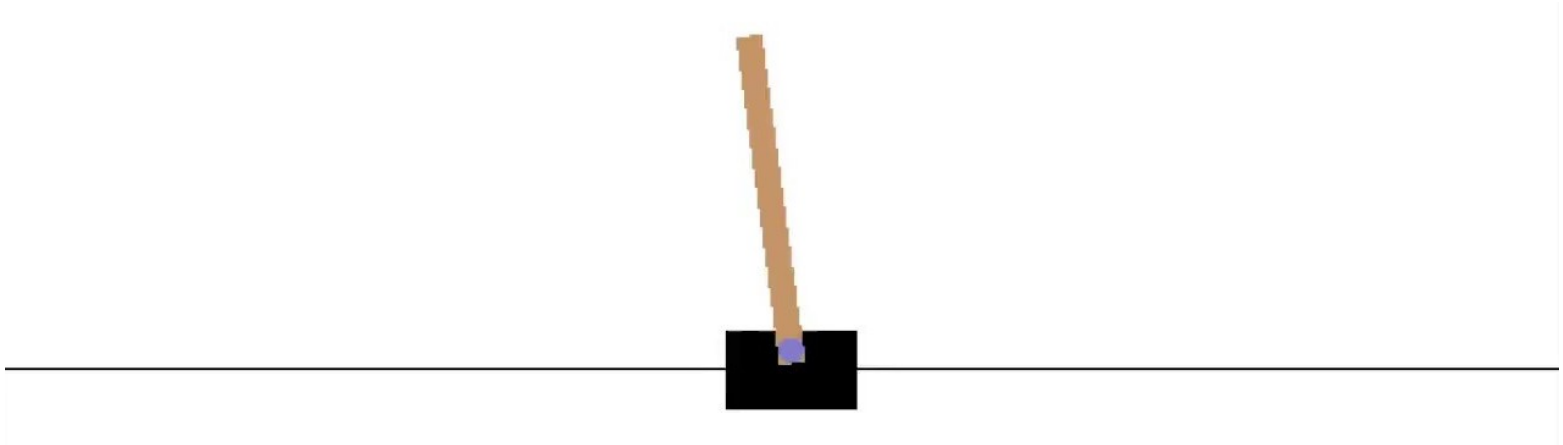

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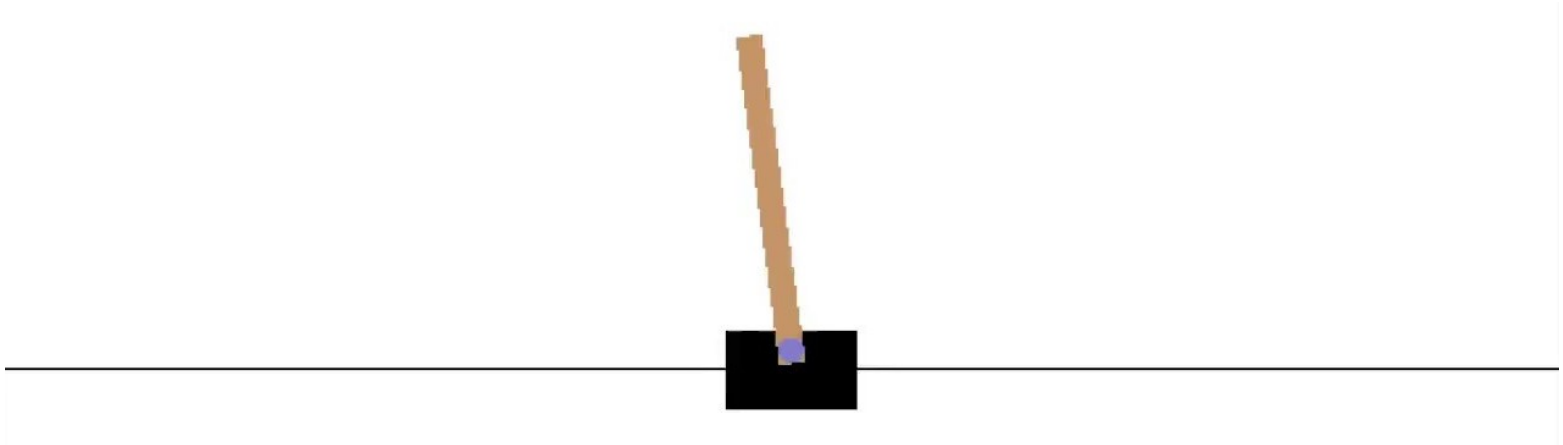

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[*cartpole* notebook]

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AlphaGO

Silver et al. (2016)

[AlphaGo Zero blog post]

Genetic Algorithms

[Mar/I/O]

Automated Experimentation

[OpenAI Lab]

Ready-Made Agents

[Coach]

Human Imitation Learning

Warneken & Tomasello (2006)

[videos]

Machine Imitation Learning

Finn, Levine & Abbeel

[videos]

Software 2.0

Karpathy (2017)

[Medium]

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Jeanne Calment

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Jeanne Calment

(1875-1997 — i.e., 122 years)

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Life in the Year 2138

The AI Revolution

Hasn't Even Begun

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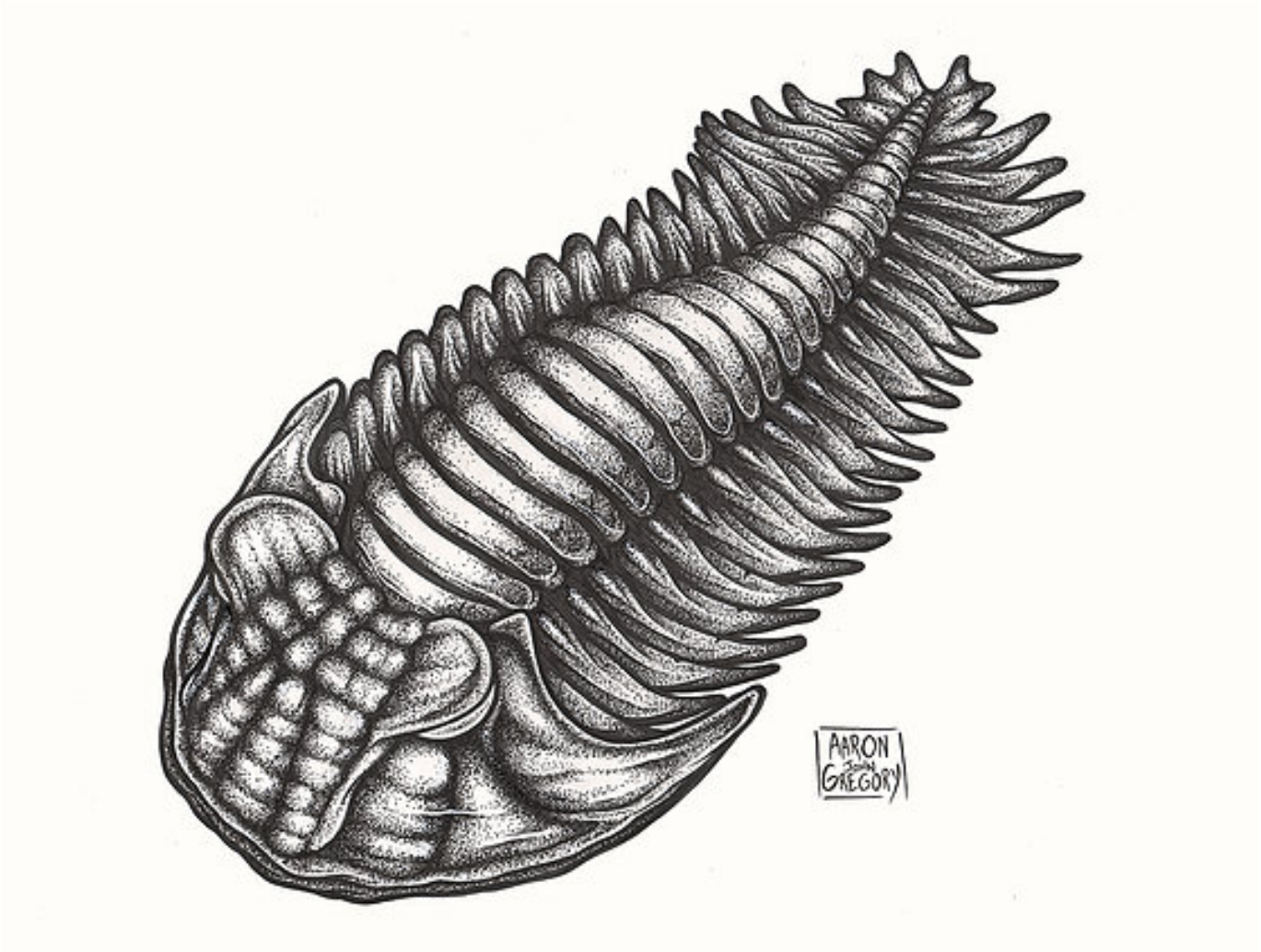
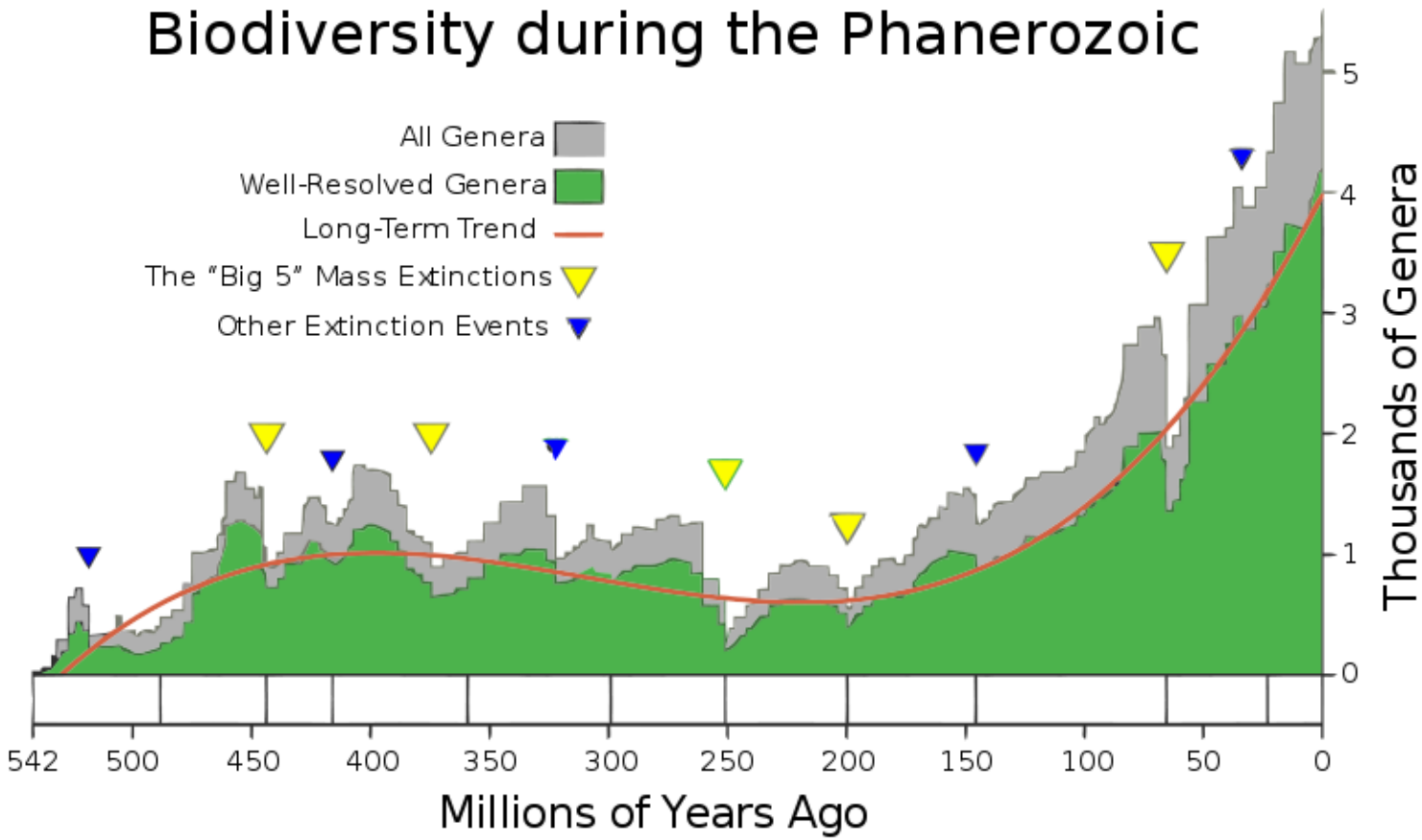

AARON
GREGORY



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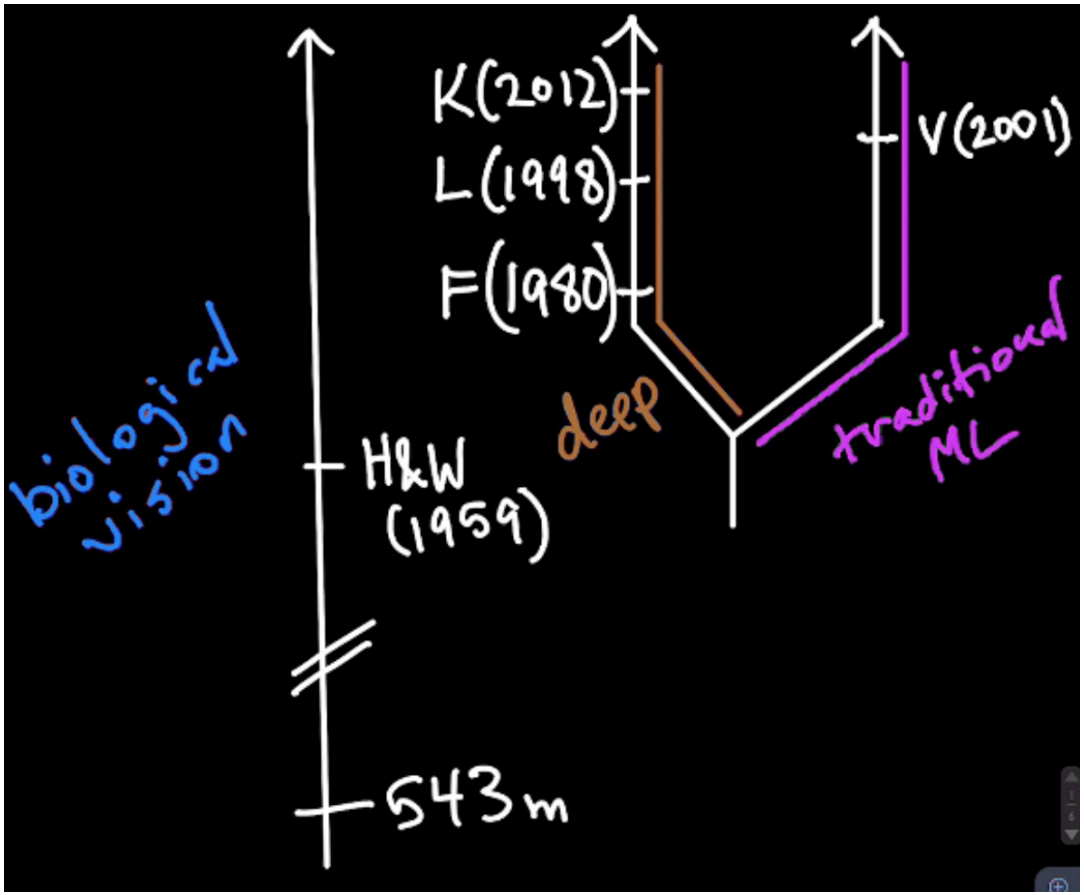

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1. data doubling every 18 months
2. processing power cost halving every two years
3. cheap sensors appearing everywhere
4. Deep Learning techniques refined in academia and in industry

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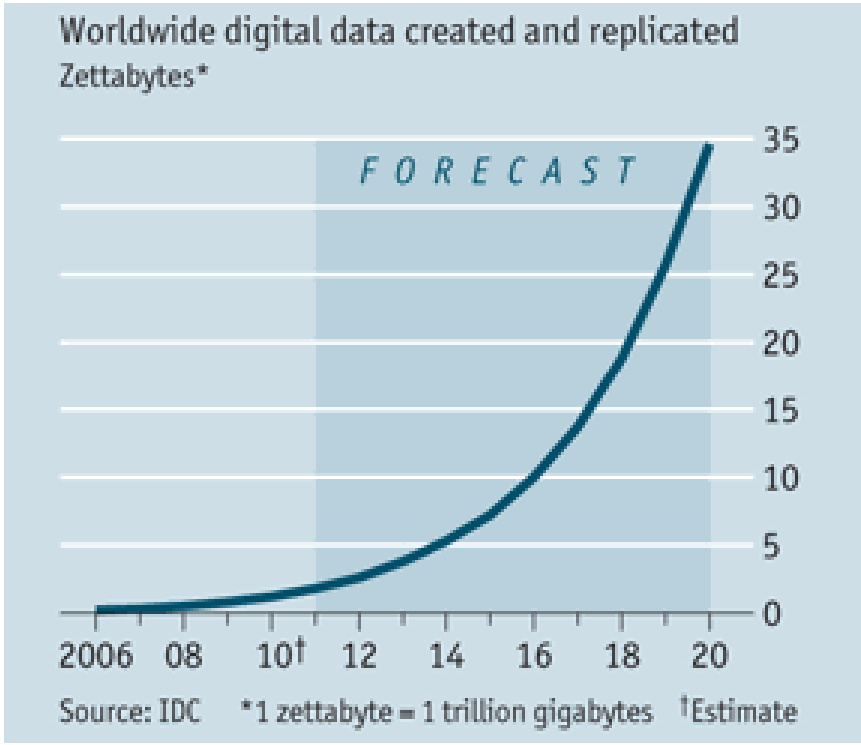

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Jeanne Calment

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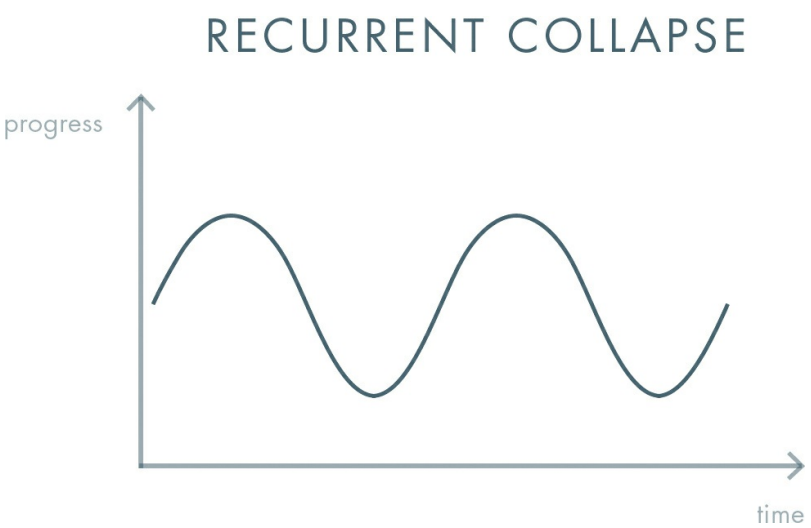
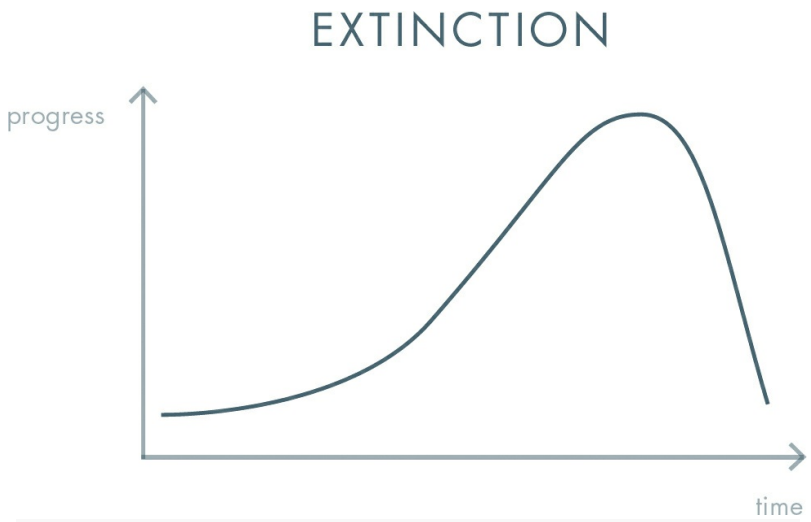
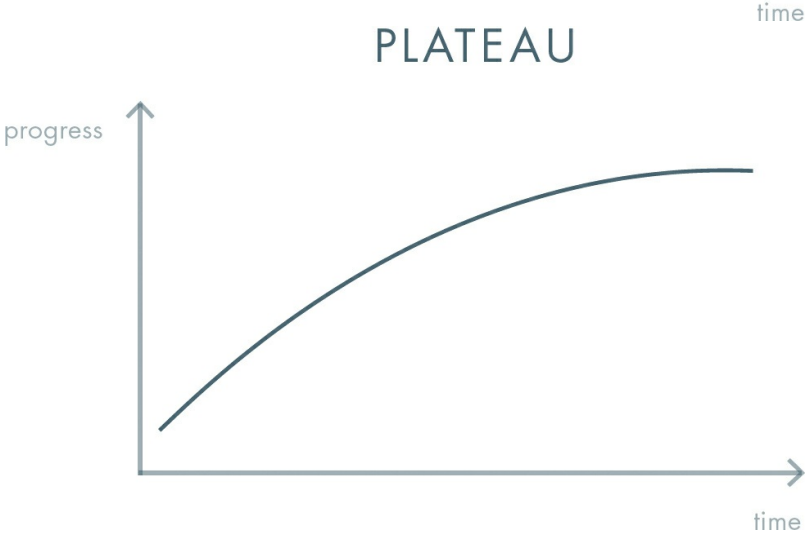
Thiel & Masters (2014)







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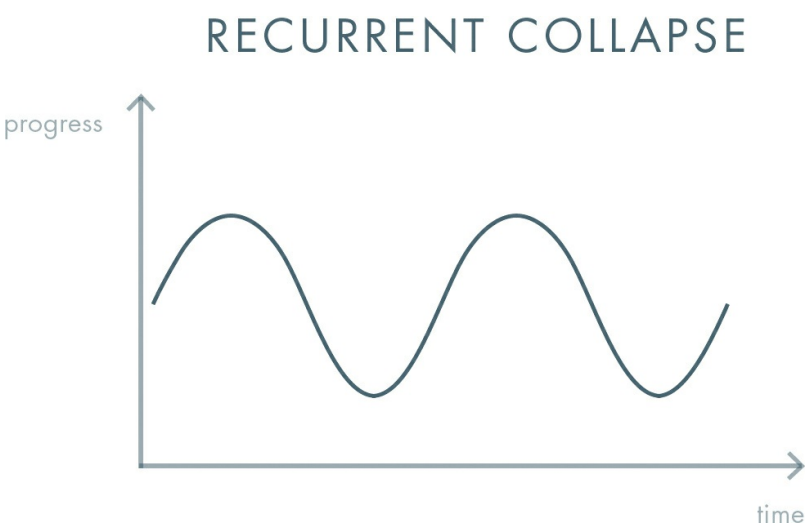

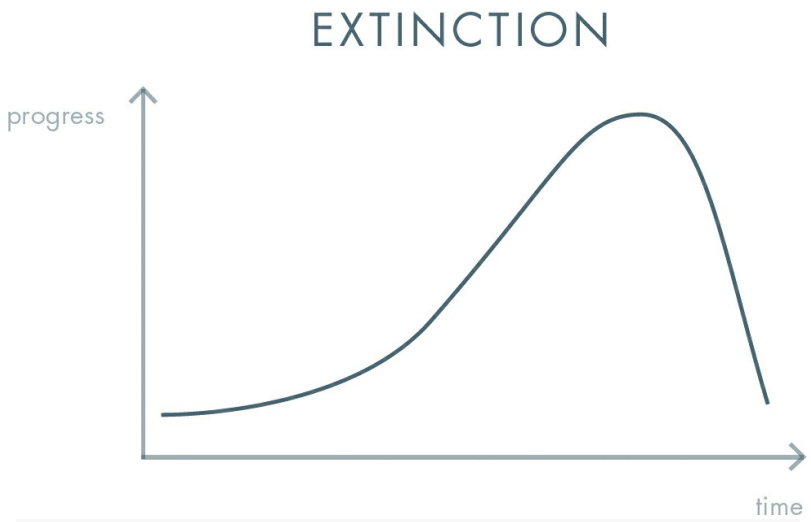

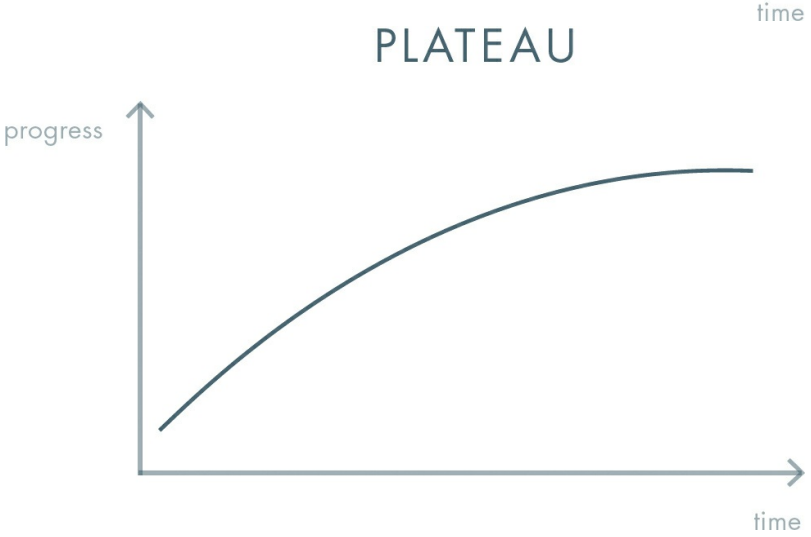

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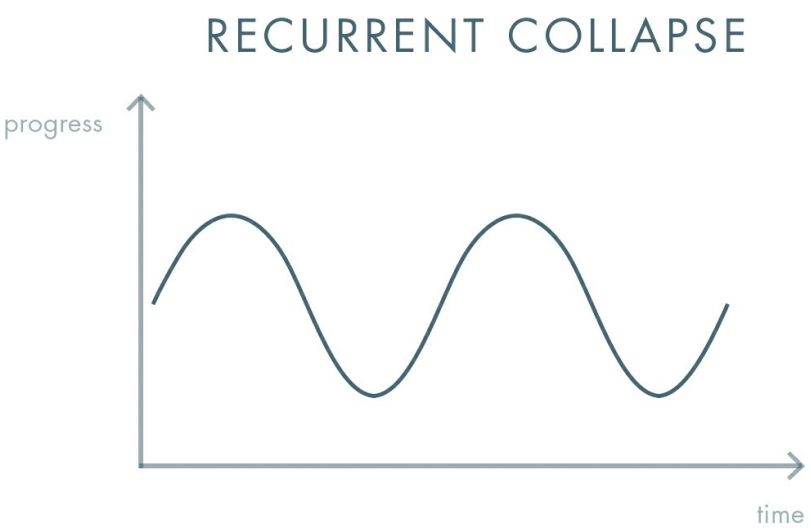

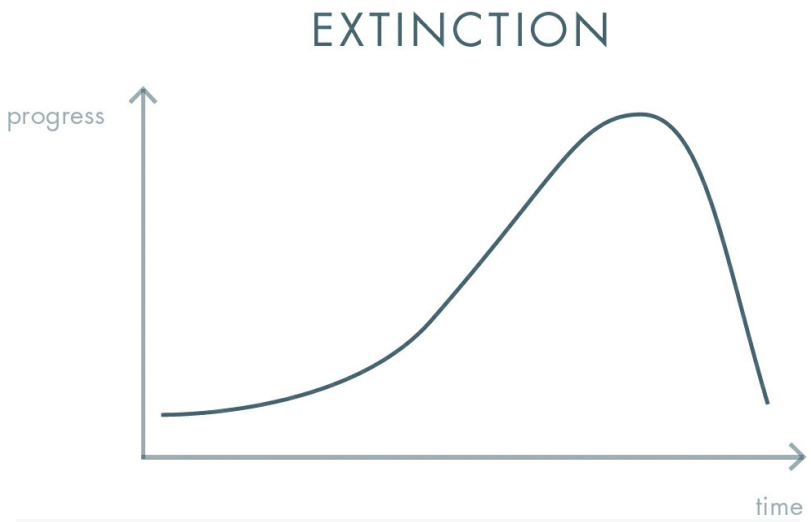

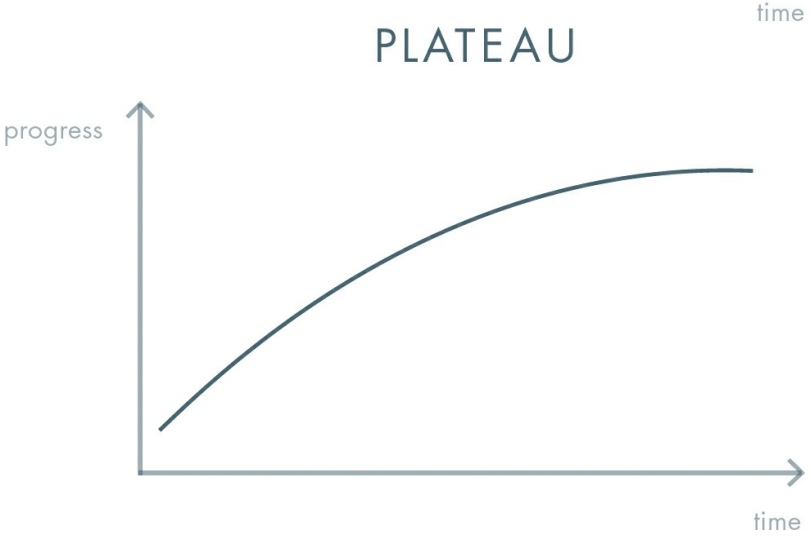

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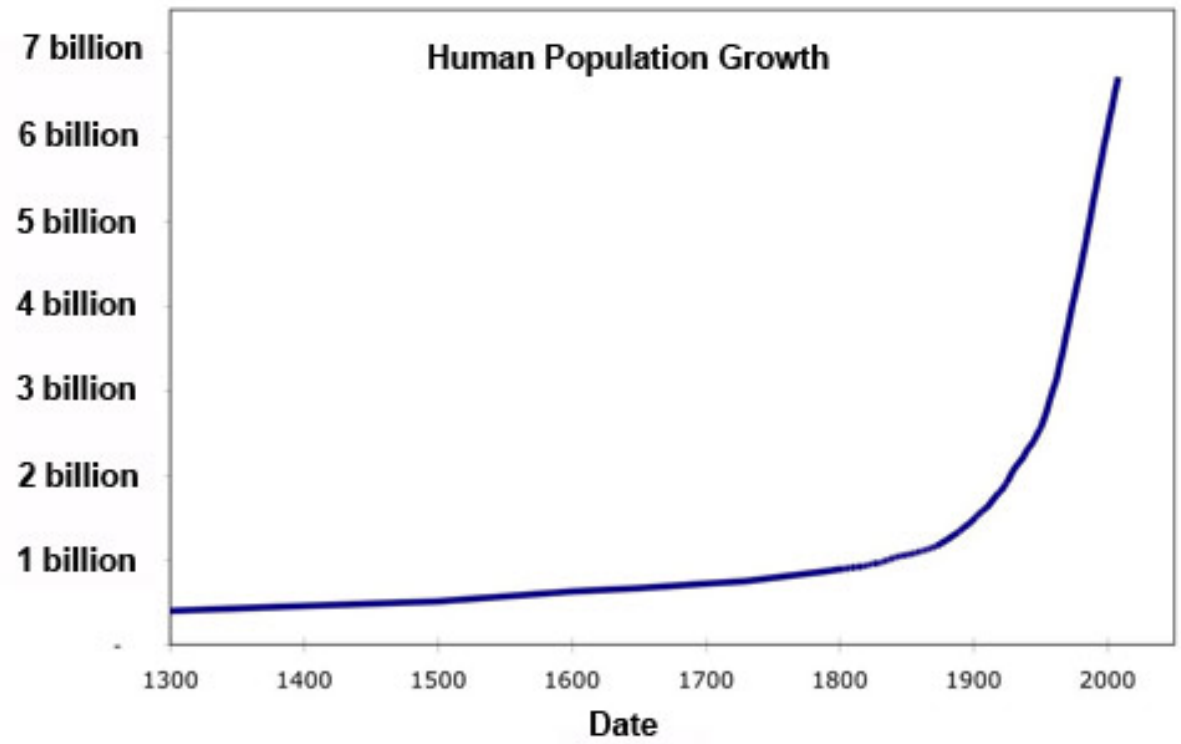
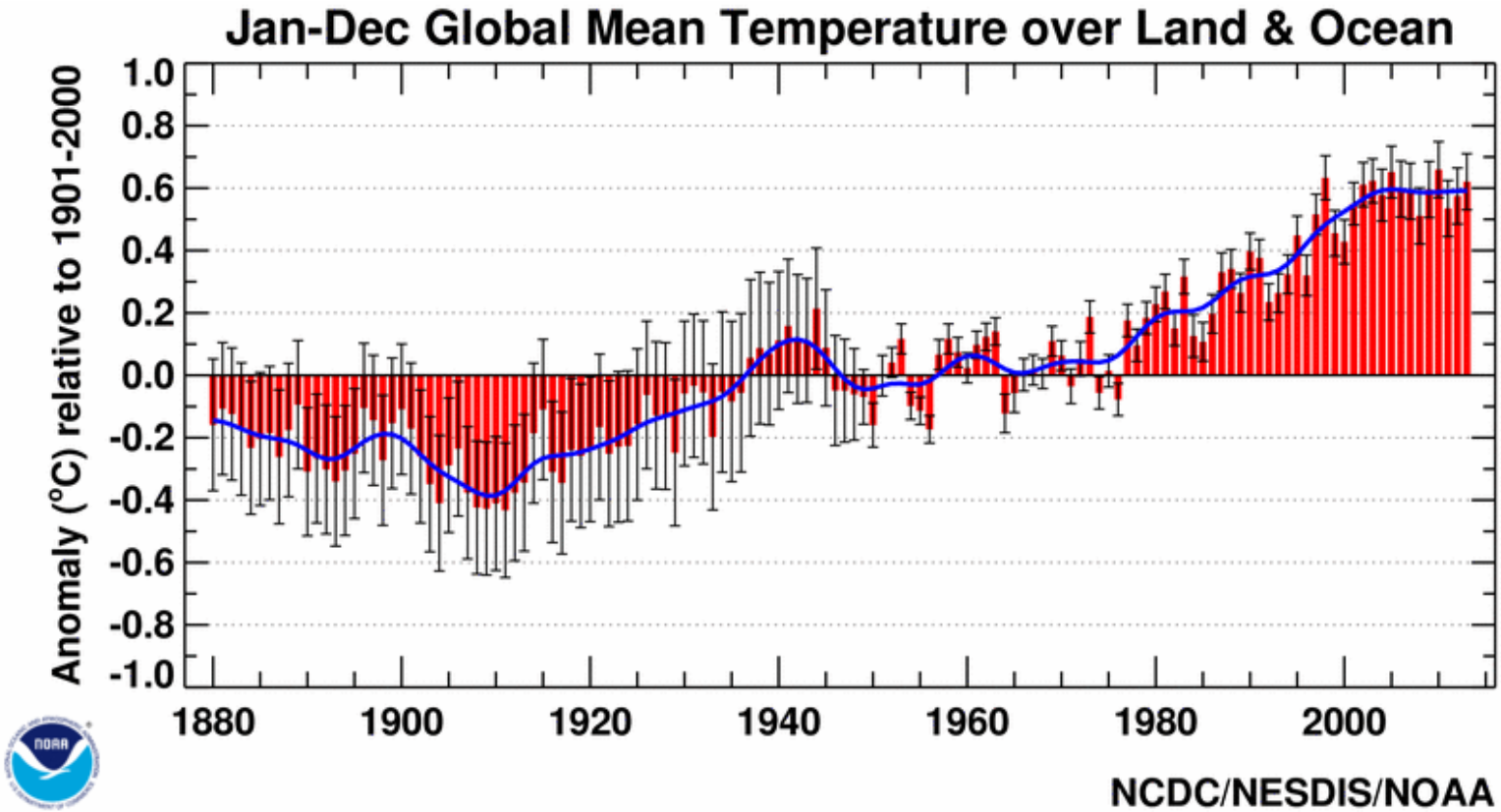
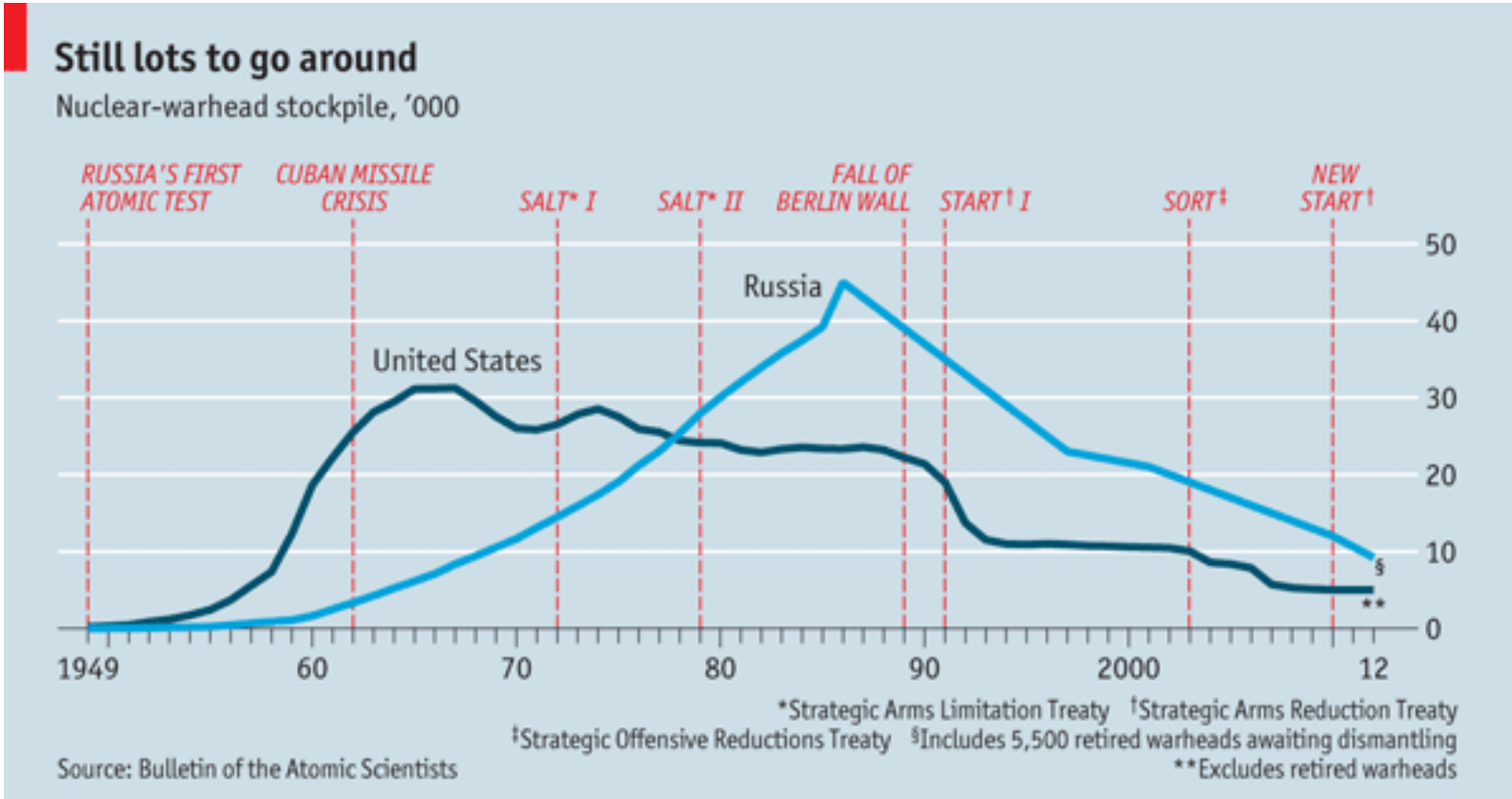

Human Population Growth
7 billion
6 billion
5 billion
4 billion
3 billion
2 billion
1 billion
1300
1400
1500
1600
1700
1800
1900
2000
Date


Jan-Dec Global Mean Temperature over Land & Ocean
Anomaly (°C) relative to 1901-2000
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
1880
1900
1920
1940
1960
1980
2000
NCDC/NESDIS/NOAA



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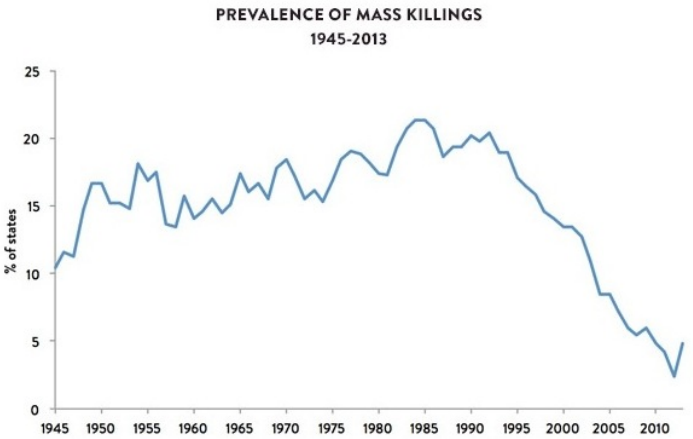
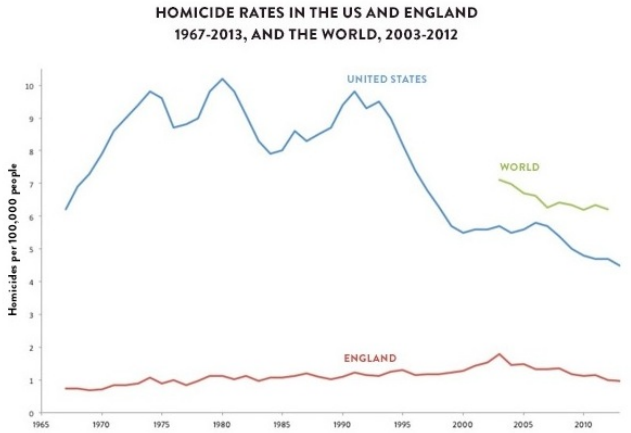
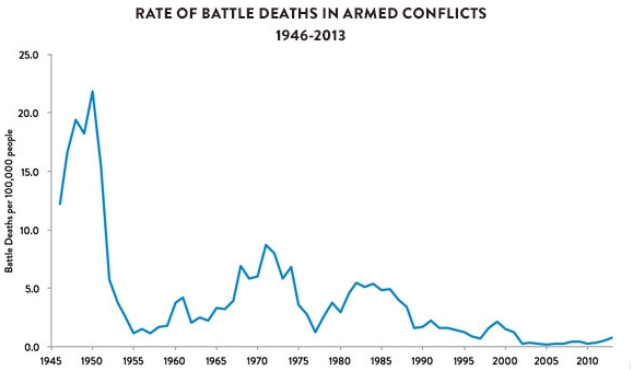
Pinker & Mack (2014)



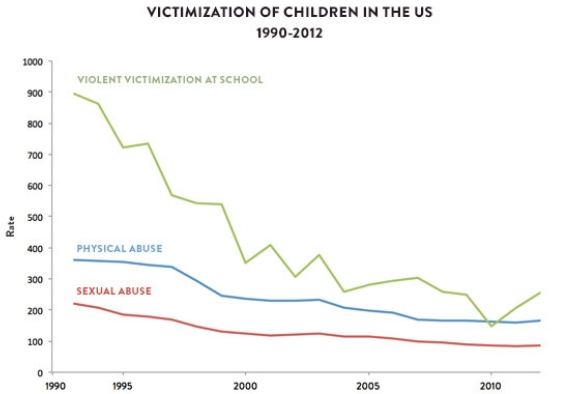
Source: Early Warning Project, https://cpgearlywarning.wordpress.com/; Ulfelder, Jay and Valentino, Benjamin, "Assessing Risks of State-Sponsored Mass Killing" (Feb. 1, 2008). Available at SSRN: http://ssrn.com/abstract=1703426 or http://dx.doi.org/10.2139/ssrn.1703426



Sources: U.S., FBI Uniform Crime Reports. England (including Wales): U.K. Office for National Statistics. World: U.N. Office on Drugs and Crime, reported in U.N. Economic and Social Council's "World crime trends and emerging issues and responses in the field of crime prevention and social justice," Feb. 12, 2014, Figure 1. The percentages were converted to homicide rates by setting the 2012 rate at 6.2, the figure reported in the UNODC Global Study on Homicide 2013, Page 12.



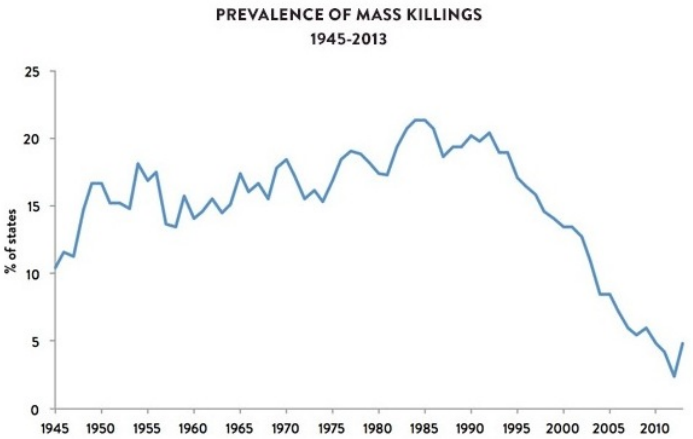
Source: Uppsala Conflict Data Program Battle-Related Deaths Dataset v.5-2014, 1989-2013, "Best Estimates." Missing estimate for 2013 for the Syrian civil war calculated from a revised UCDP "Low Estimate" and a "High Estimate" from the Peace Research Institute Oslo (both obtained in consultation with Erik Melander of UCDP). The "High Estimate" is for May 2013–April 2014, rather than calendar year 2013, and comes from Page 9 of M. Price, A. Gohdes, & P. Ball, "Updated Statistical Analysis of Documentation of Killings in the Syrian Arab Republic," Human Rights Data Analysis Group, http://www.ohchr.org/Documents/Countries/SY/HRDAGUpdatedReportAug2014.pdf. World population figures from U.S. Census Bureau, http://www.census.gov/population/international/data/worldpop/table_population.php



Rates for physical and sexual abuse are per 100,000 children younger than 18. Rates for violent victimization at school are per 10,000 children age 12–17.

Sources: Physical and sexual abuse, National Child Abuse and Neglect Data System, analyzed by David Finkelhor, 2014, in "Trends in Child Welfare," Presentation at the Carsey Institute Policy Series, March 31, 2014. Victimization at school, Bureau of Justice Statistics (bjs.gov), using the National Crime Victimization Survey Victimization Analysis Tool.

Pinker & Mack (2014)



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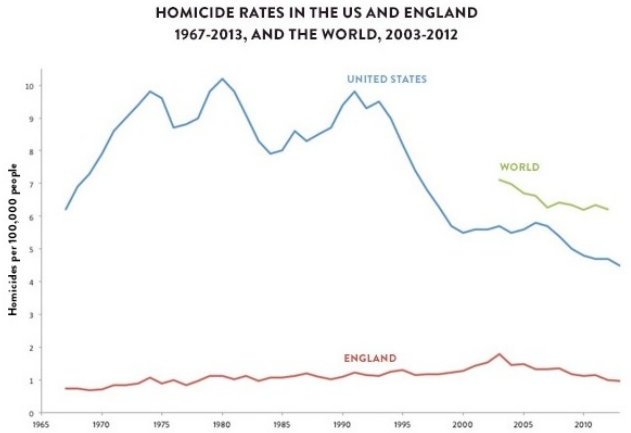

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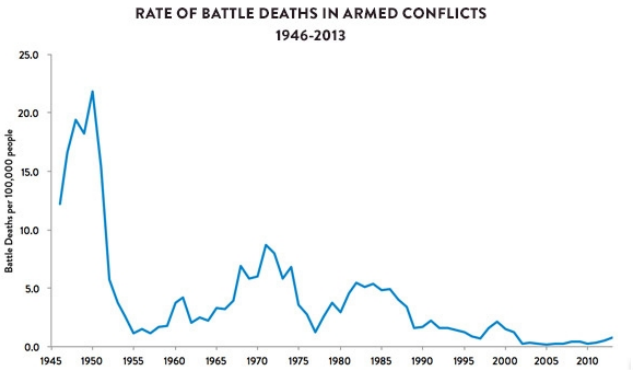
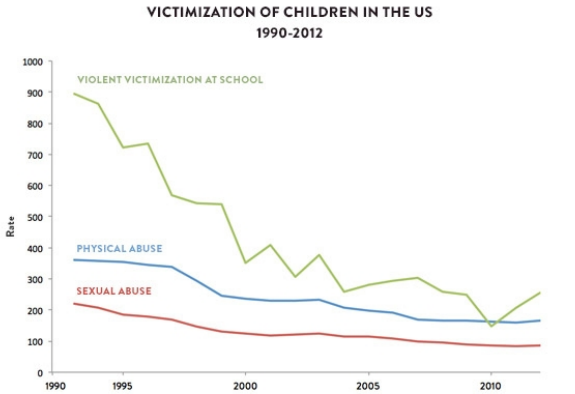


Source: Uppsala Conflict Data Program Battle-Related Deaths Dataset v.5-2014, 1989-2013, "Best Estimates." Missing estimate for 2013 for the Syrian civil war calculated from a revised UCDP "Low Estimate" and a "High Estimate" from the Peace Research Institute Oslo (both obtained in consultation with Erik Melander of UCDP). The "High Estimate" is for May 2013–April 2014, rather than calendar year 2013, and comes from Page 9 of M. Price, A. Gohdes, & P. Ball, "Updated Statistical Analysis of Documentation of Killings in the Syrian Arab Republic," Human Rights Data Analysis Group, http://www.ohchr.org/Documents/Countries/SY/HRDAGUpdatedReportAug2014.pdf. World population figures from U.S. Census Bureau, http://www.census.gov/population/international/data/worldpop/table_population.php



Rates for physical and sexual abuse are per 100,000 children younger than 18. Rates for violent victimization at school are per 10,000 children age 12–17.

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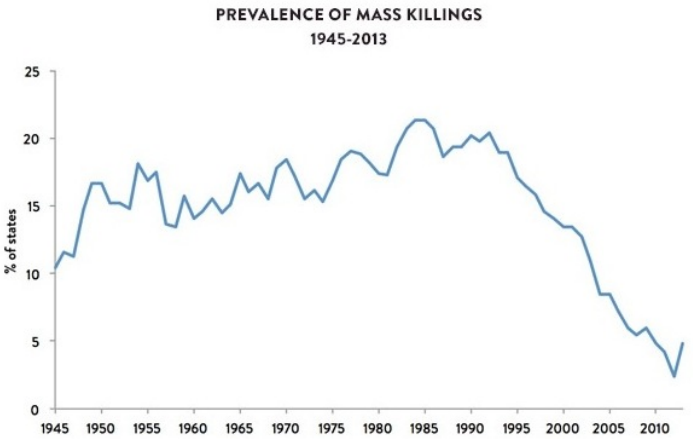
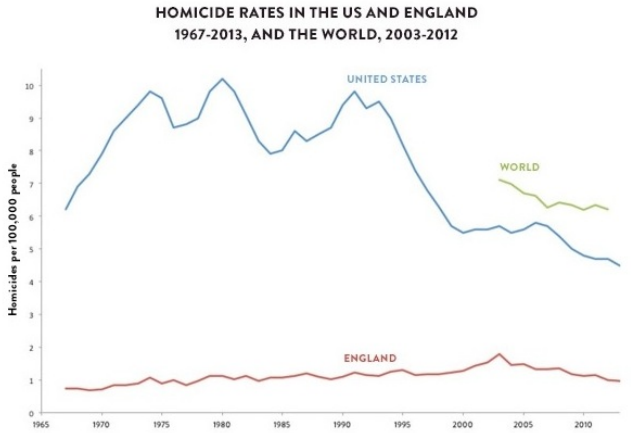
Pinker & Mack (2014)



Source: Early Warning Project, https://cpgearlywarning.wordpress.com/; Ulfelder, Jay and Valentino, Benjamin, "Assessing Risks of State-Sponsored Mass Killing" (Feb. 1, 2008). Available at SSRN: http://ssrn.com/abstract=1703426 or http://dx.doi.org/10.2139/ssrn.1703426



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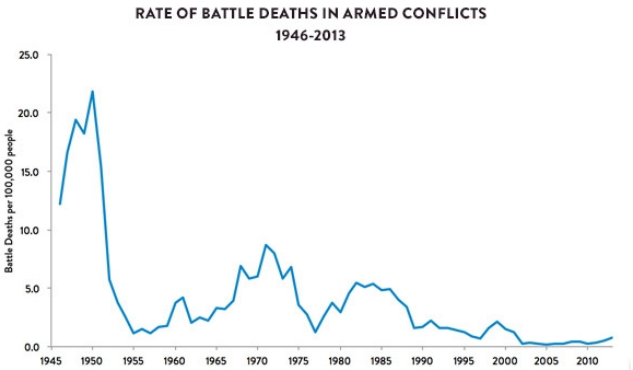

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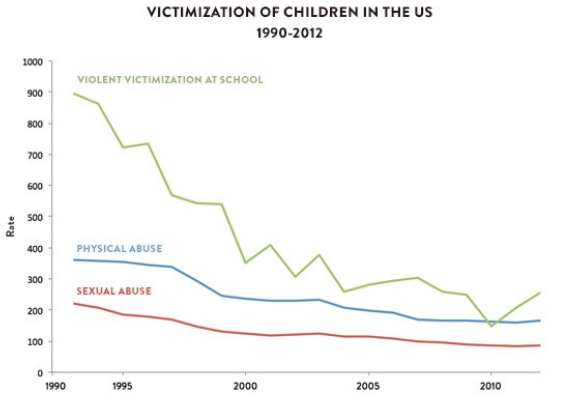

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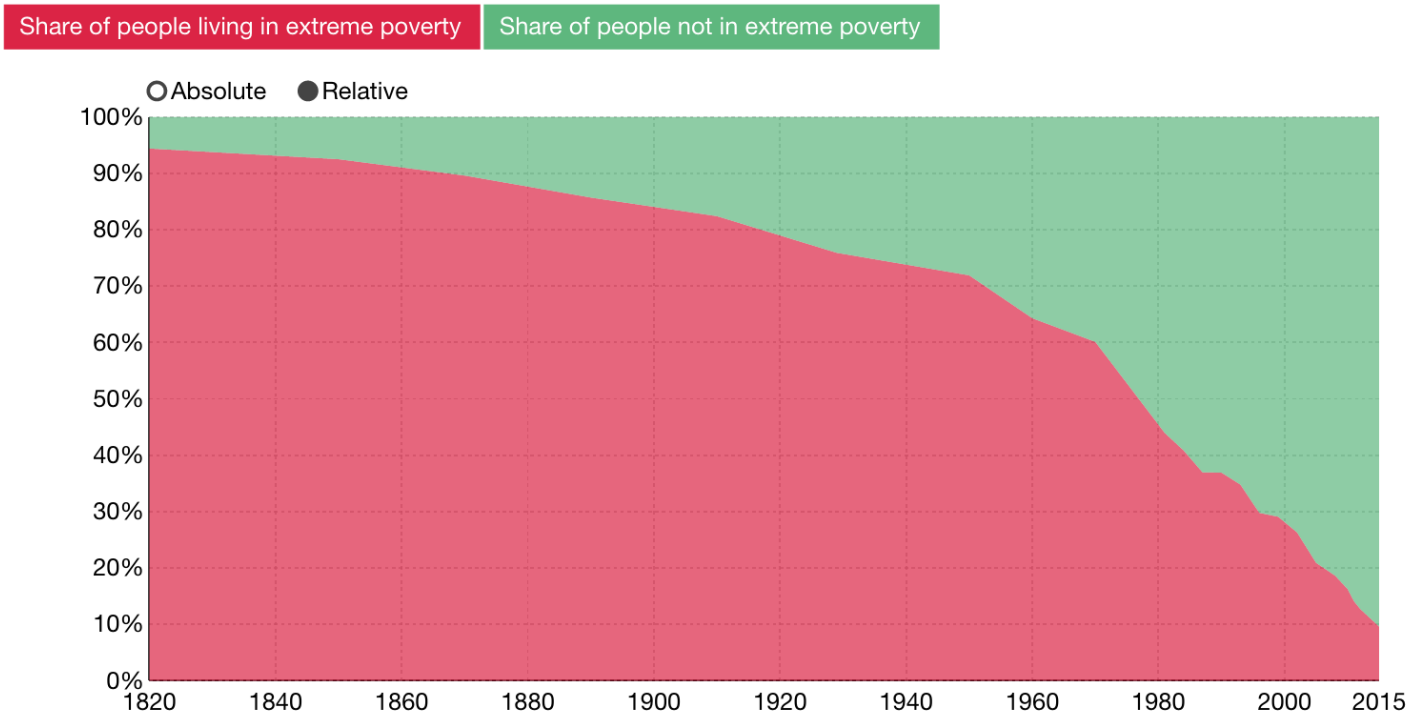
World population living in extreme poverty, 1820 to 2015

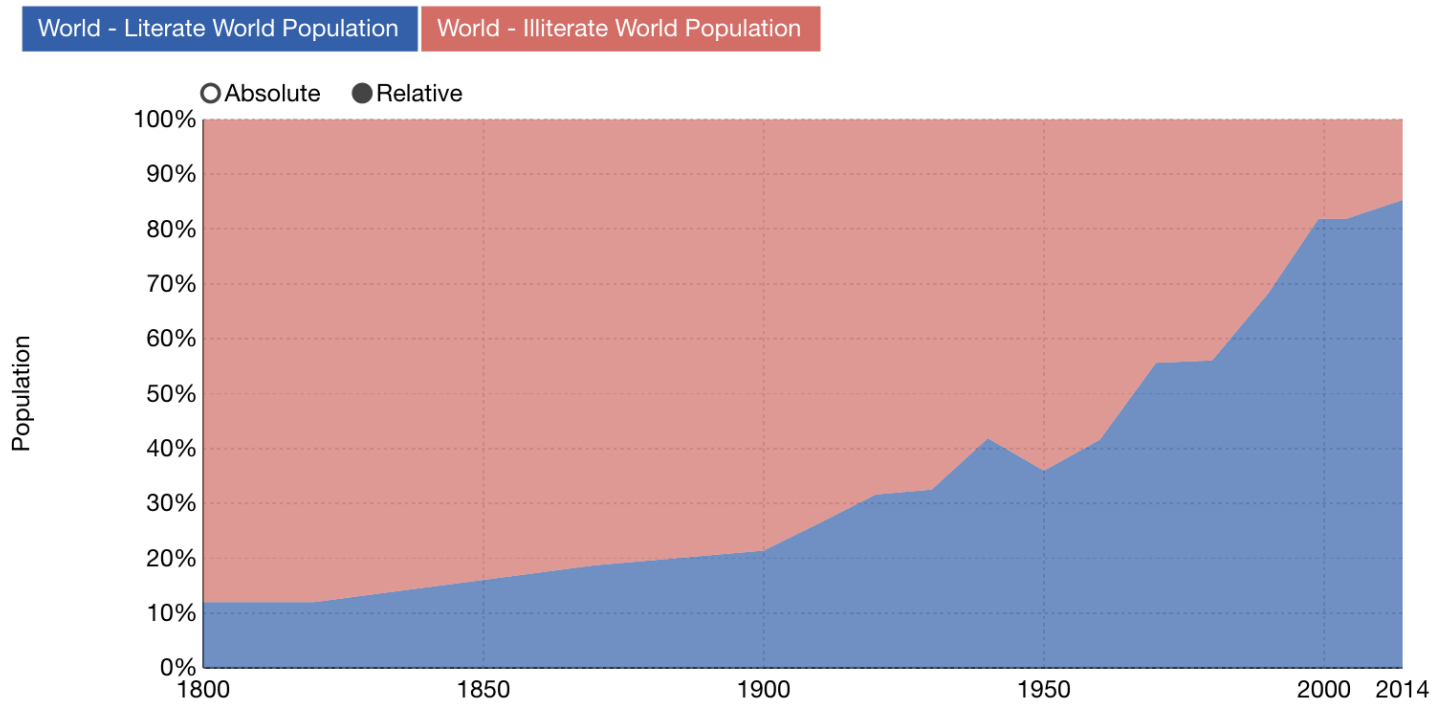
Our World in Data



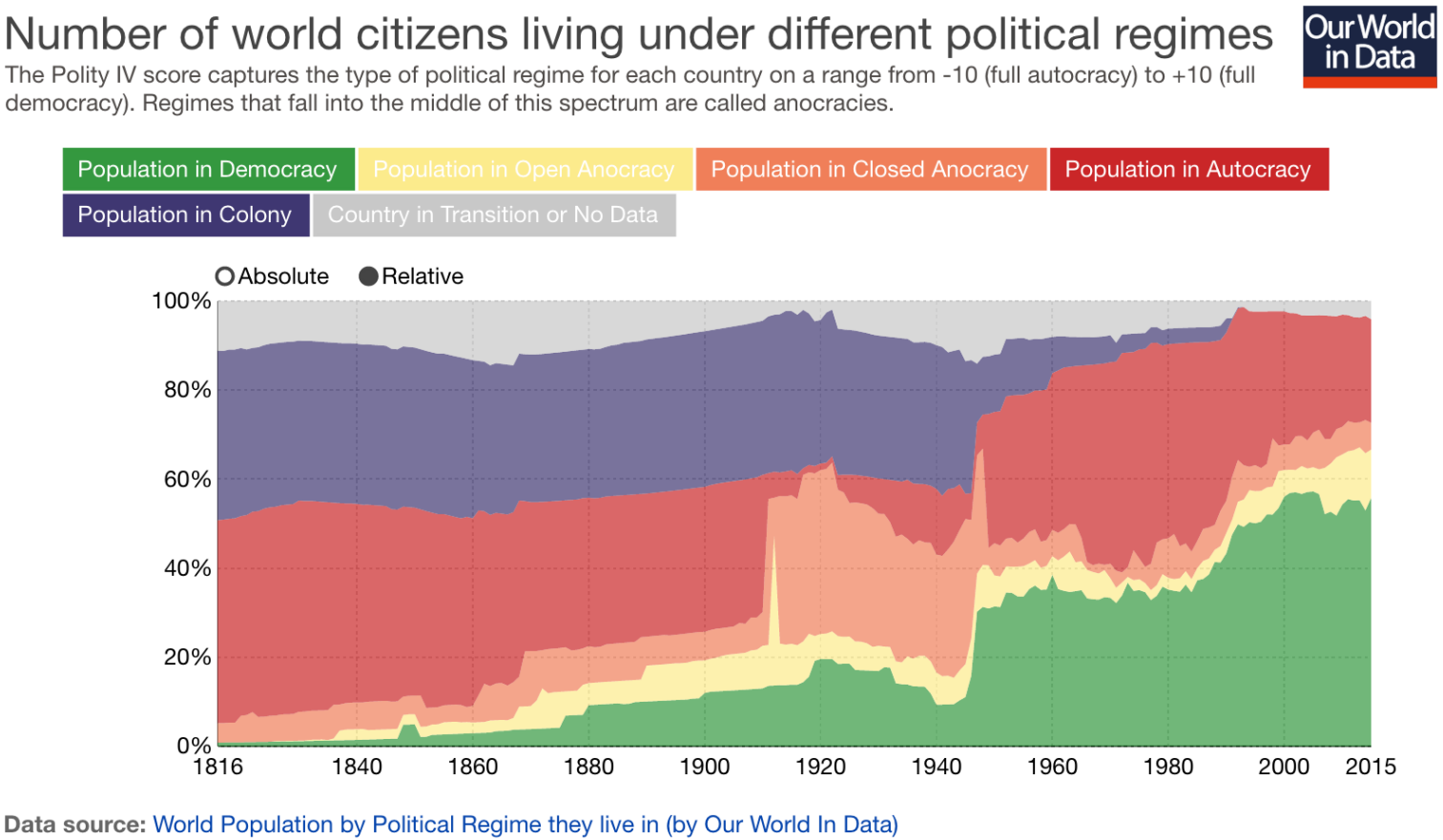
Data source: World Poverty in absolute numbers (Max Roser based on World Bank and Bourguignon and Morrisson (2002))

Literate and illiterate world population, 1800 to 2014

Our World in Data



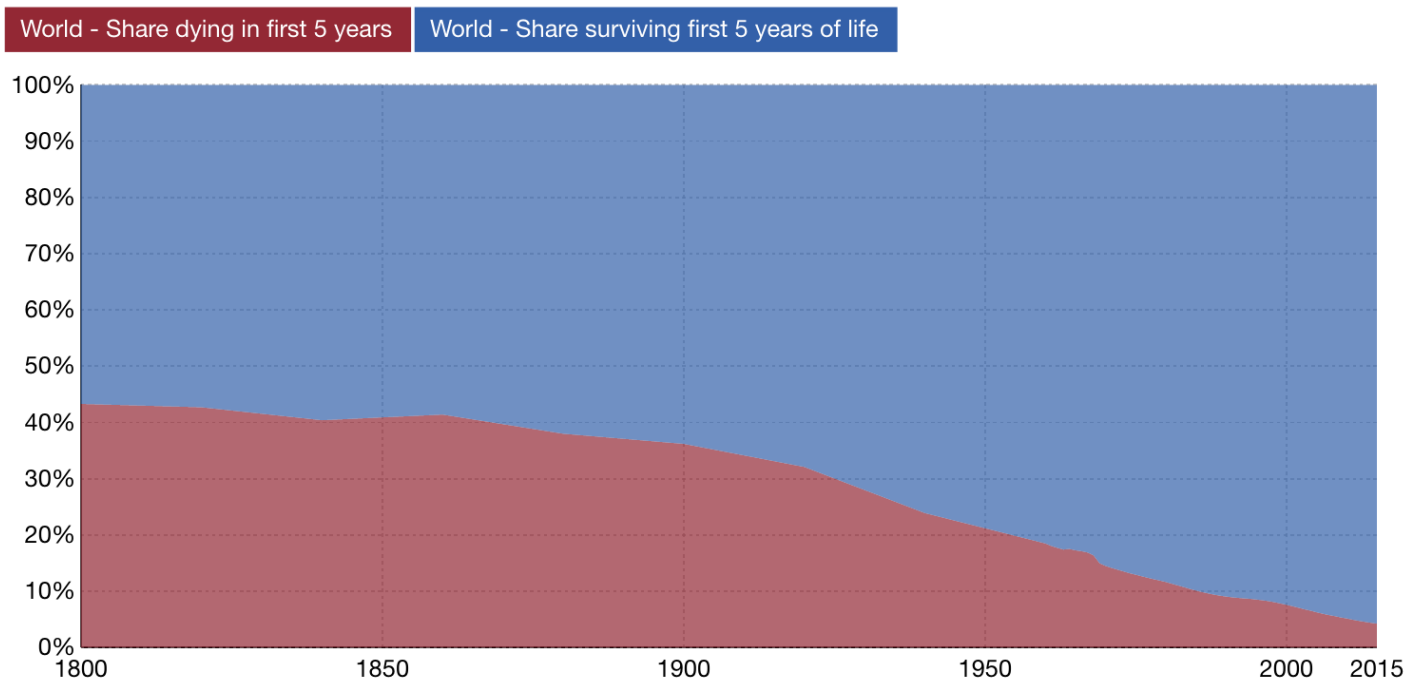
Data source: Literate World Population (Our World In Data based on OECD and UNESCO)


Number of world citizens living under different political regimes
The Polity IV score captures the type of political regime for each country on a range from -10 (full autocracy) to +10 (full democracy). Regimes that fall into the middle of this spectrum are called anocracies.
Our World in Data
Population in Democracy
Population in Open Anocracy
Population in Closed Anocracy
Population in Autocracy
Population in Colony
Country in Transition or No Data
Absolute
Relative
100%
80%
60%
40%
20%
0%
1816
1840
1860
1880
1900
1920
1940
1960
1980
2000
2015
Data source: World Population by Political Regime they live in (by Our World In Data)

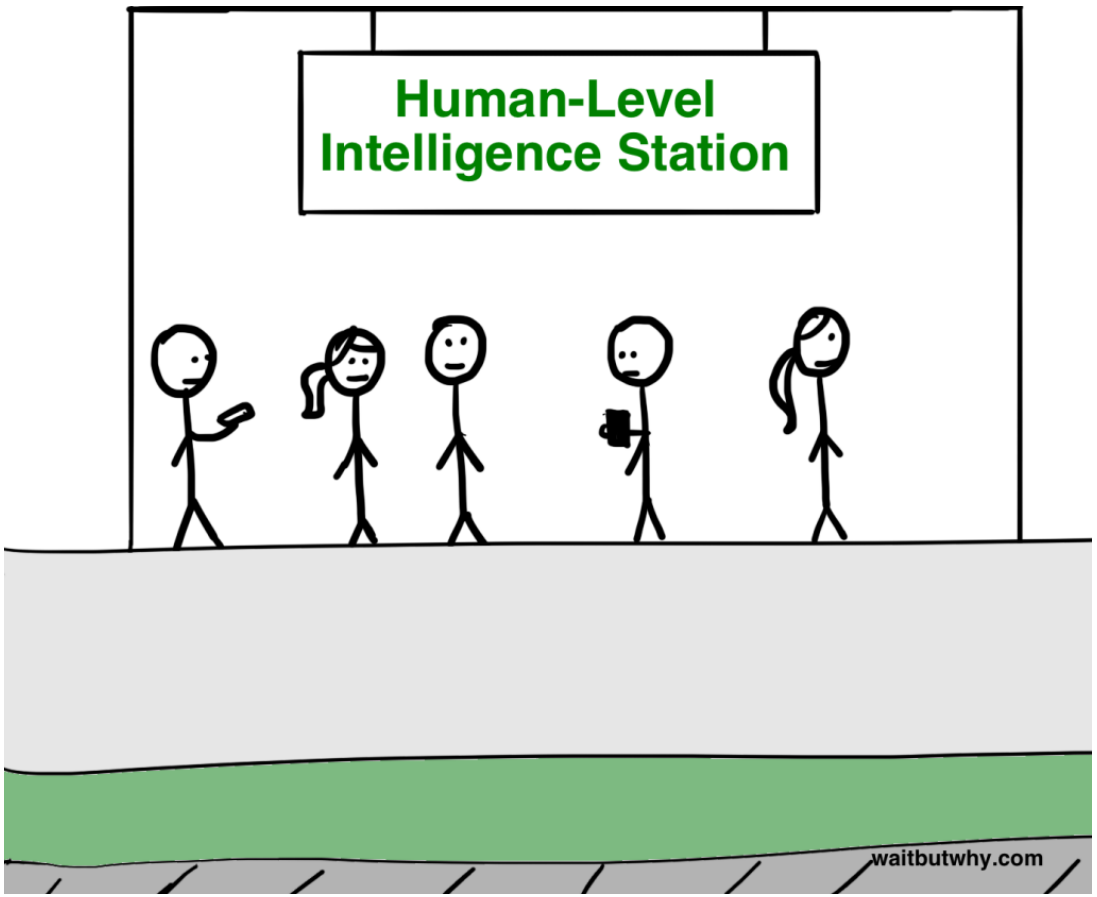
Global child mortality, 1800 to 2015

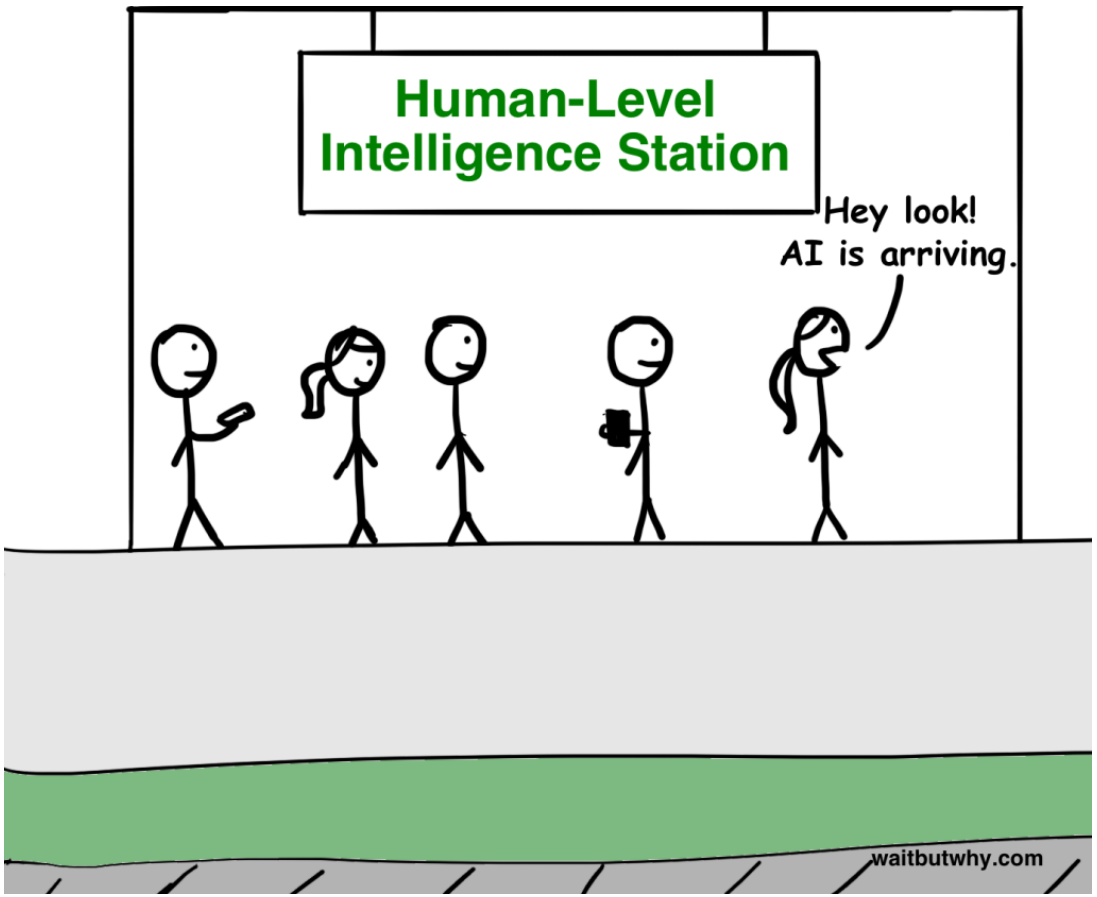
Share of the world population dying and surviving the first 5 years of life.

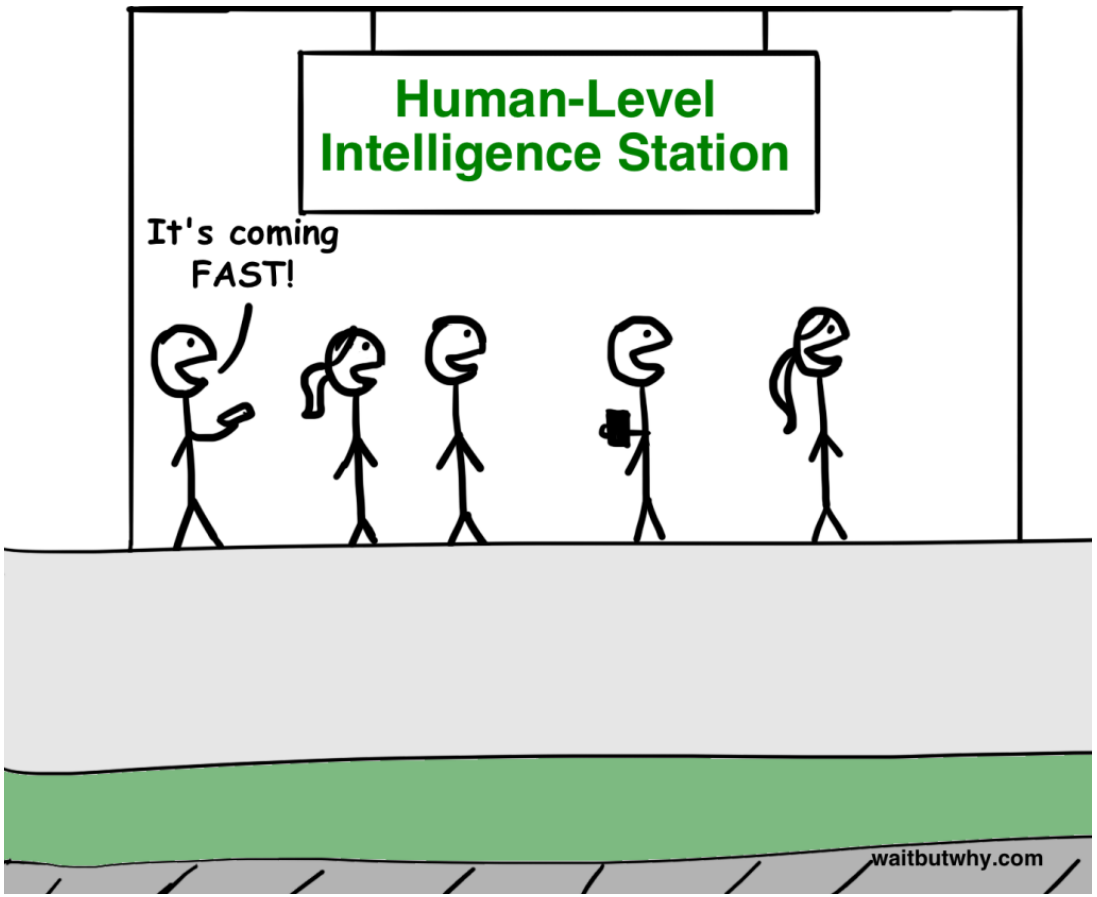
Our World in Data

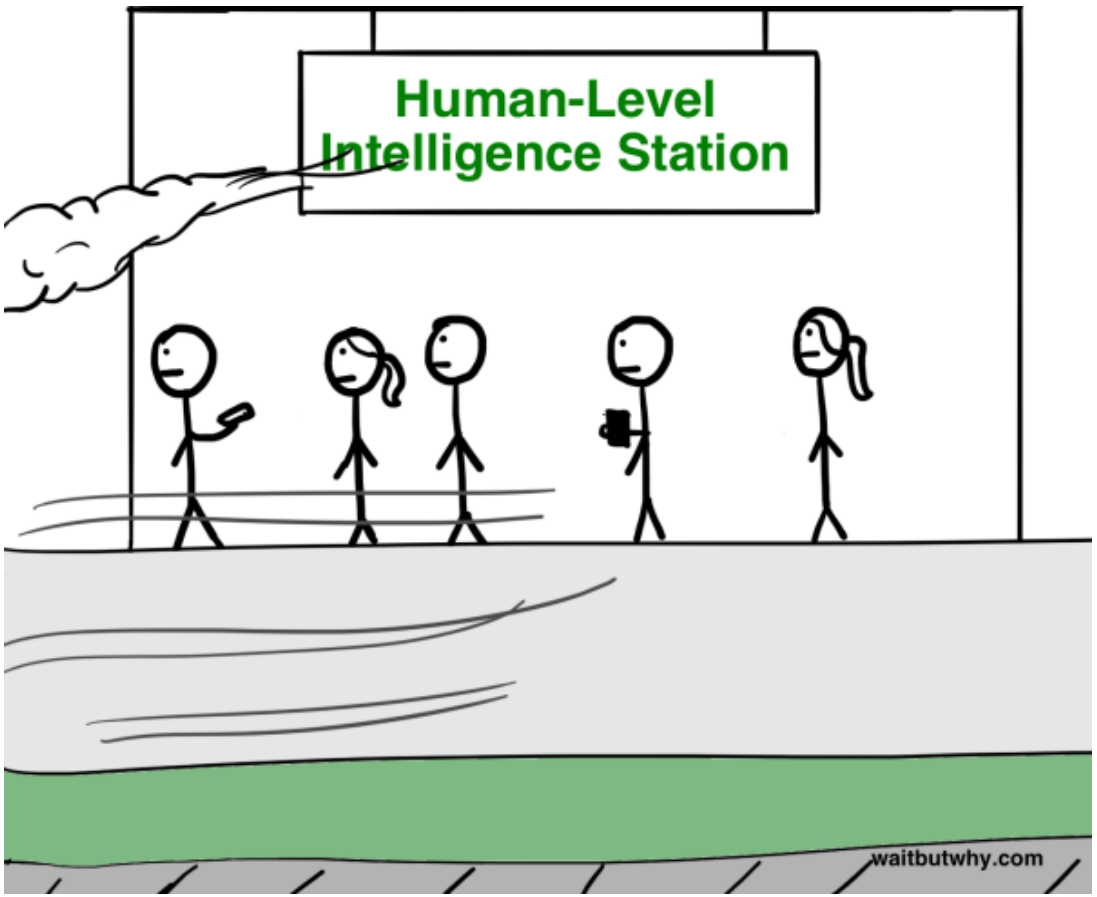


Data source: Global child mortality (since 1800) based on Gapminder and World Bank

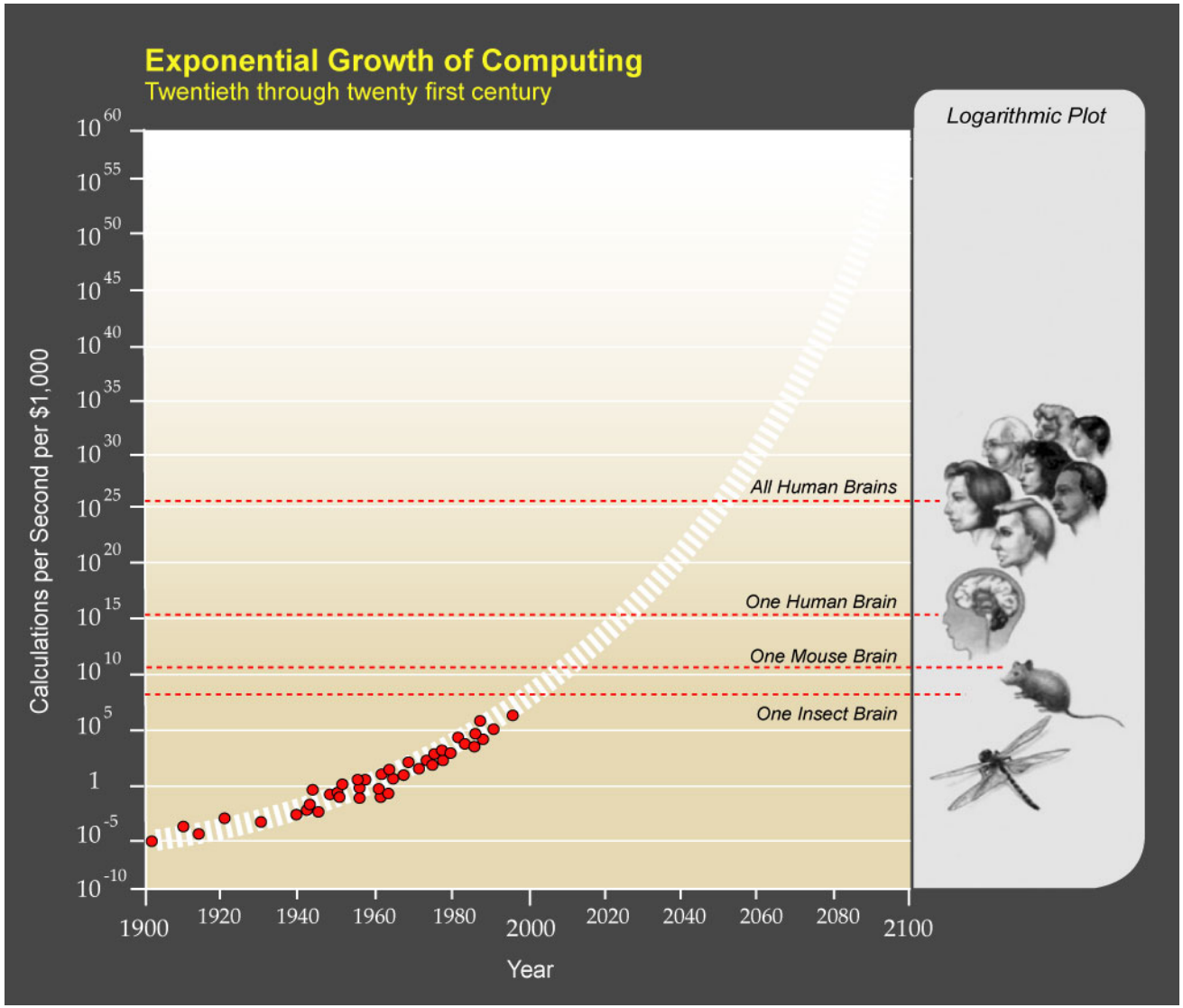

Human-Level
Intelligence Station
waitbutwhy.com


Human-Level Intelligence Station
Hey look! AI is arriving.
waitbutwhy.com

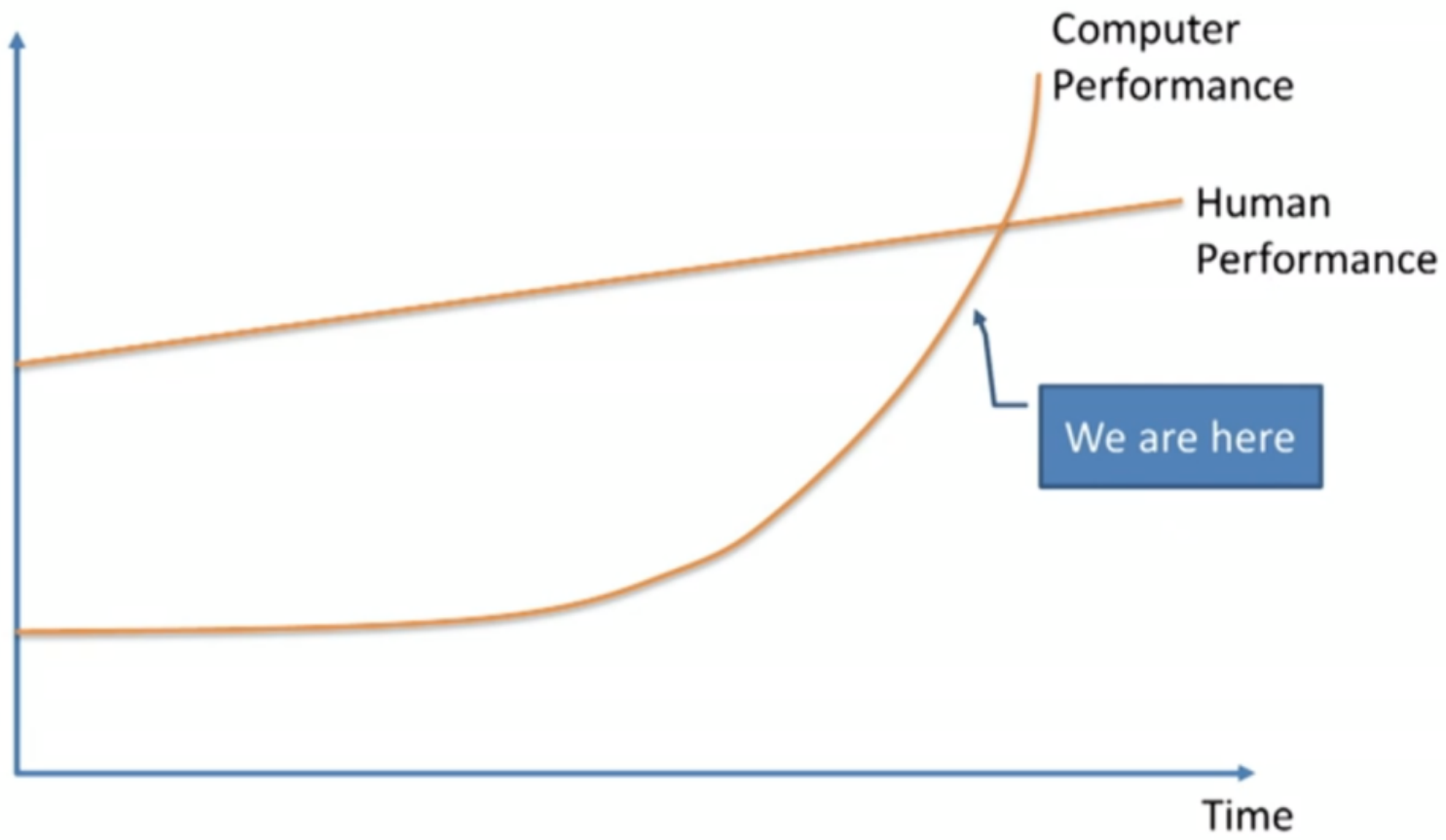

Human-Level Intelligence Station
It's coming FAST!
waitbutwhy.com

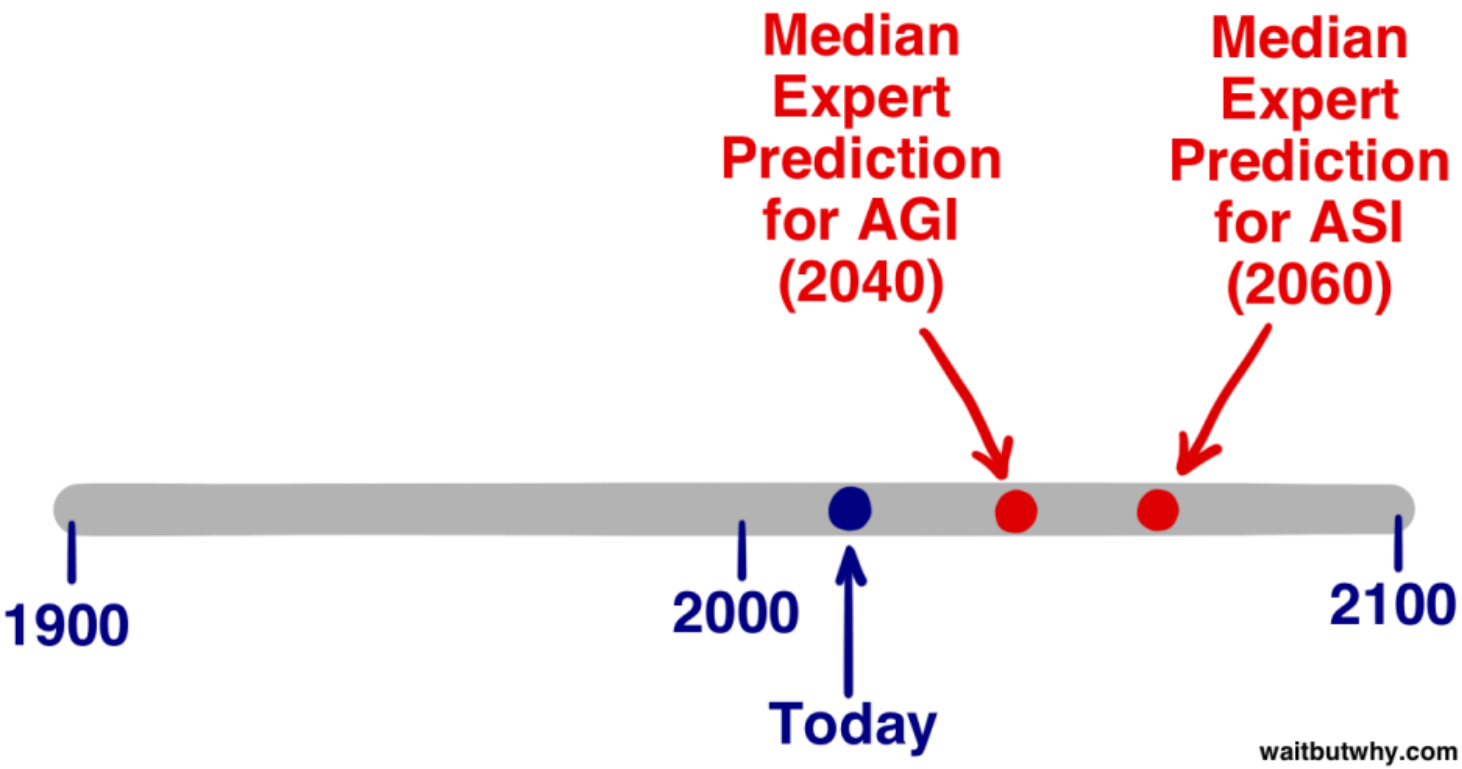

Human-Level Intelligence Station
waitbutwhy.com

Intro
Theory
In Practice
Applications
AI Revolution



NYC DATA SCIENCE ACADEMY


Computer Performance
Human Performance
We are here
Time



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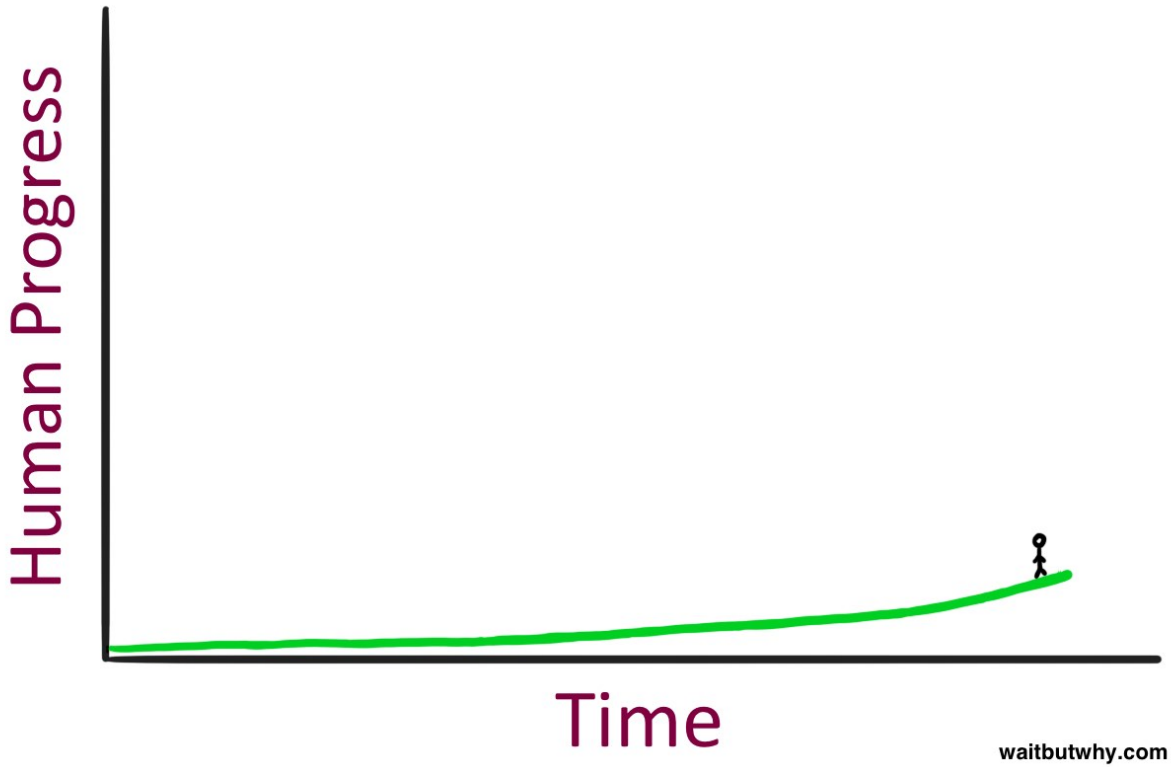
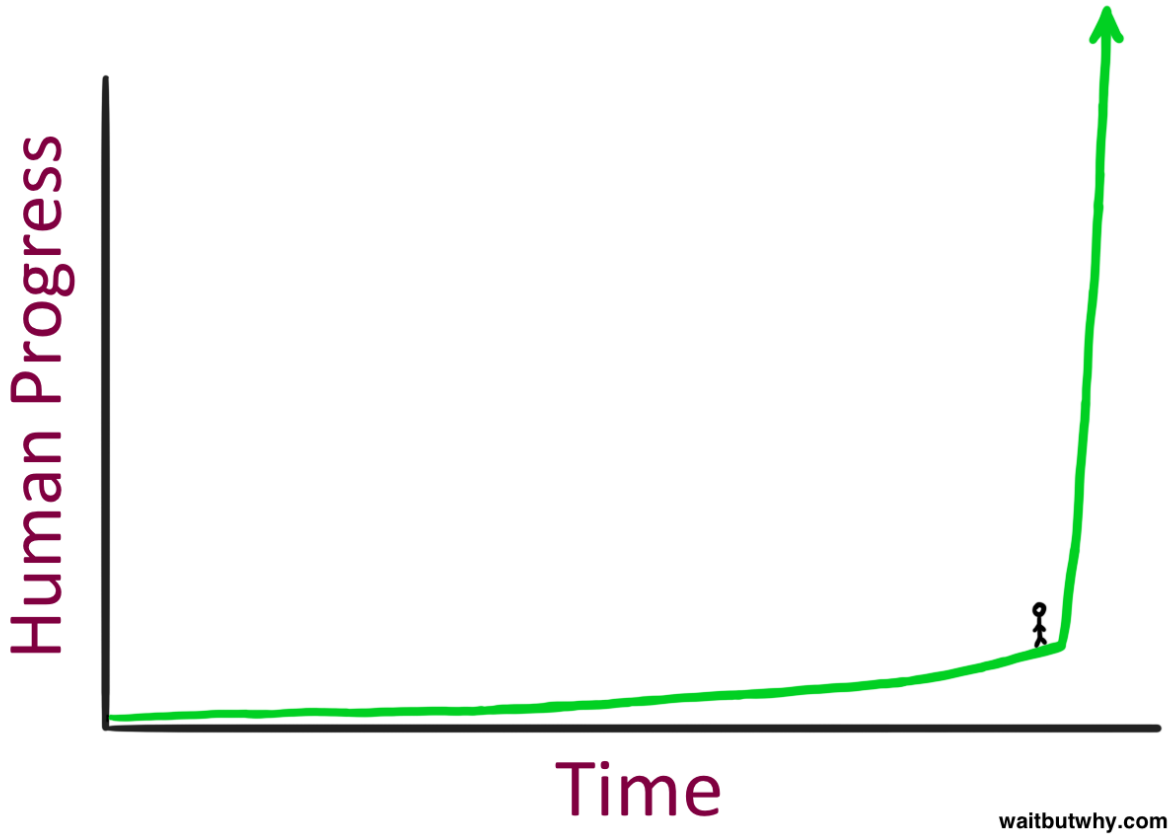

Human Progress
Time
waitbutwhy.com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