Artificial Intelligence and the Future of Humanity

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Overview

Artificial Intelligence

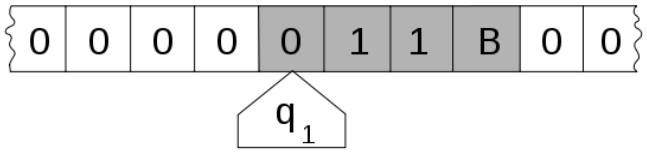
- Helps us in many fields
  - Automated manufacturing, driverless cars
- What drives this progress?
- Better than humans on many tasks
  - Takes away many jobs
- Exciting future
  - Brain-machine interface
  - Human enhancement

What is Artificial Intelligence

- Many goals and subfields:
  - Knowledge representation
    - Medical diagnosis
  - Planning and scheduling
    - Autonomous robots
  - Machine learning
    - Spam/non-spam detection
  - Natural language processing (communication)
    - Siri, Google Now
  - Perception: computer vision and speech recognition
    - Face recognition, retina scanning
  - Motion and manipulation
    - Robots
  - Logical reasoning: deduction, problem solving

Beginning of AI

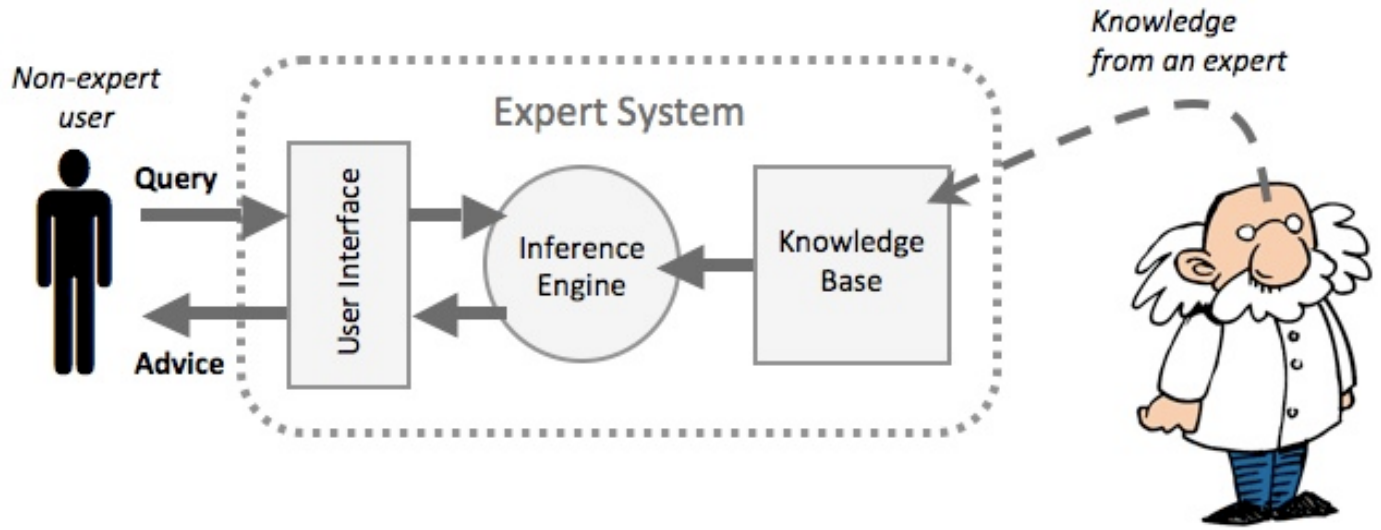
- Alan Turing
  - Turing machine (1936)
    - Abstract machine
    - Any computer is a Turing machine
  - Turing test (1950)
    - Test to judge intelligence indistinguishable from a human



- First computers
  - Code breaking machines in WWII: Z3, ENIAC and Colossus
    - Last two based on the Turing machine
- John von Neumann
  - Laid the foundations of modern computer (1945)

Expert Systems

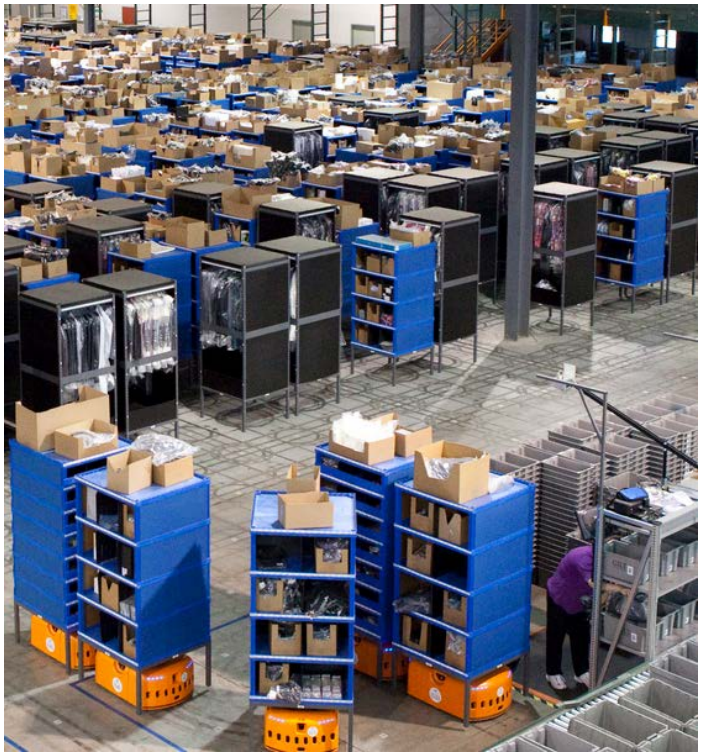
- First successful AI applications (1970s-1980s)



- Examples
  - Diagnosing infectious diseases from symptoms
  - Identifying unknown organic molecules
  - Evaluating mortgage loans
  - Space Shuttle Mission Control

Planning and Logistics Automation

- DART: Dynamic Analysis and Replanning Tool (1991)
  - Optimize and schedule transport of supplies and personnel
  - Solve other military logistical problems
  - Millions of dollars in savings
  - By 1995 saved the military all money DARPA invested in research during the previous 30 years
- Logistics Automation:
  - Mail sorting
  - Warehouse management
  - Inventory management
  - Supply chain management



Automated Manufacturing

- BMW plant (Munich)
  - 98% automated
  - Robots do most jobs: pressing, welding, painting, assembling
  - Humans for: inspection and assembling sensitive parts

Autonomous Walking

- Boston Dynamics
  - Big Dog (2008)
  - Atlas (2013)
  - Videos

Autonomous Driving

- Early work
  - Semi-autonomous highway driving
- DARPA Grand Challenges:
  - 2004, 2005 – 150 miles in the Mojave desert
  - 2007 – Urban environment
- Google autonomous cars (since 2009):
  - Millions of miles driven
  - 14 accidents, never their fault
- Tesla (2015)
  - Autopilot software update
  - Automatic parking and summon

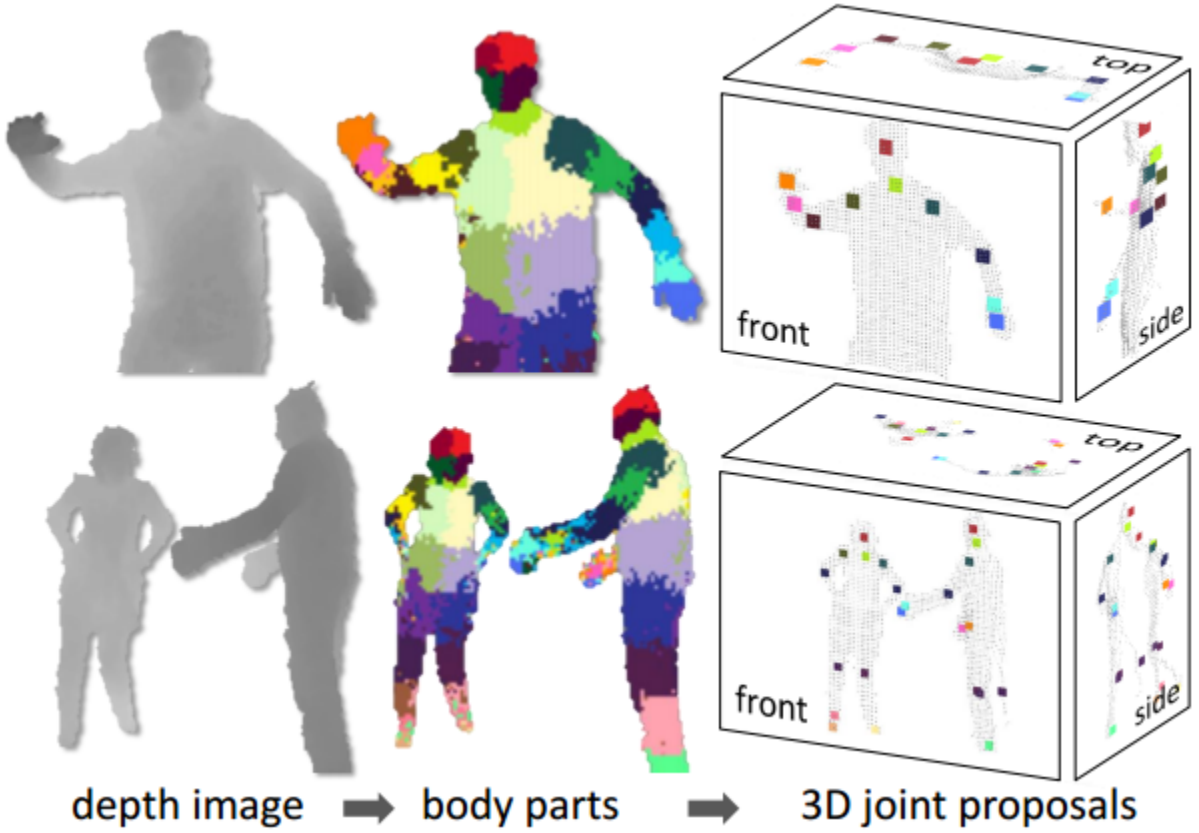
Recommender Systems

- Predicts the ratings a user would give to certain items
  - E.g. “Customers also bought …” in Amazon
  - Movies in Netflix
  - Book, music, online dating
- Fuses information
  - Age, gender, location
  - Ratings given to other items
  - Items purchased
- Netflix Prize (2006-2009)
  - Predict 100 million movie ratings
  - 1 million dollars to team that beats the Netflix system by 10%
  - Won by BellKor's Pragmatic Chaos team in September 2009

Kinect (2010)

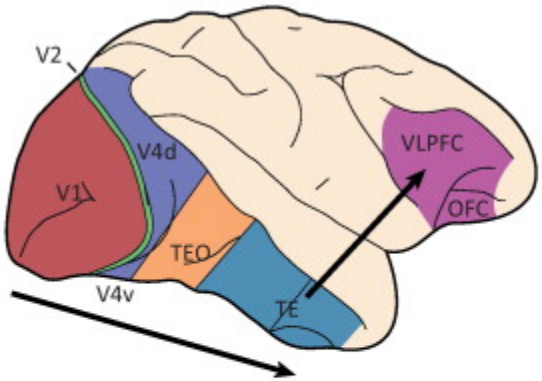
Smart sensor

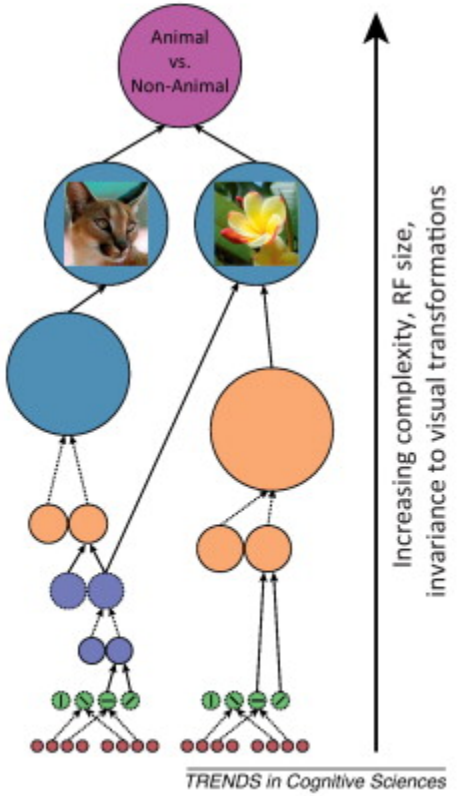
- Depth images
- Detects 3D joint locations



The Human Brain

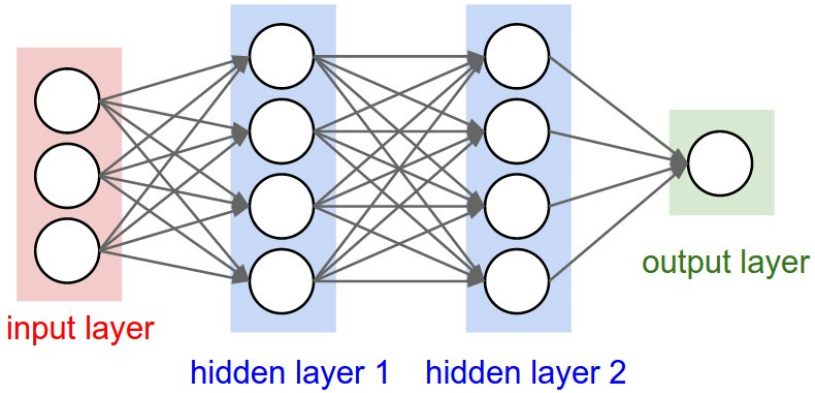
- 86 billion neurons
  - Has many layers, maybe hundreds
- Layers
  - Levels of abstraction
  - Increasing complexity
  - Invariance to deformations
- 100 trillion connections
  - Each neuron connected with ~1000 others





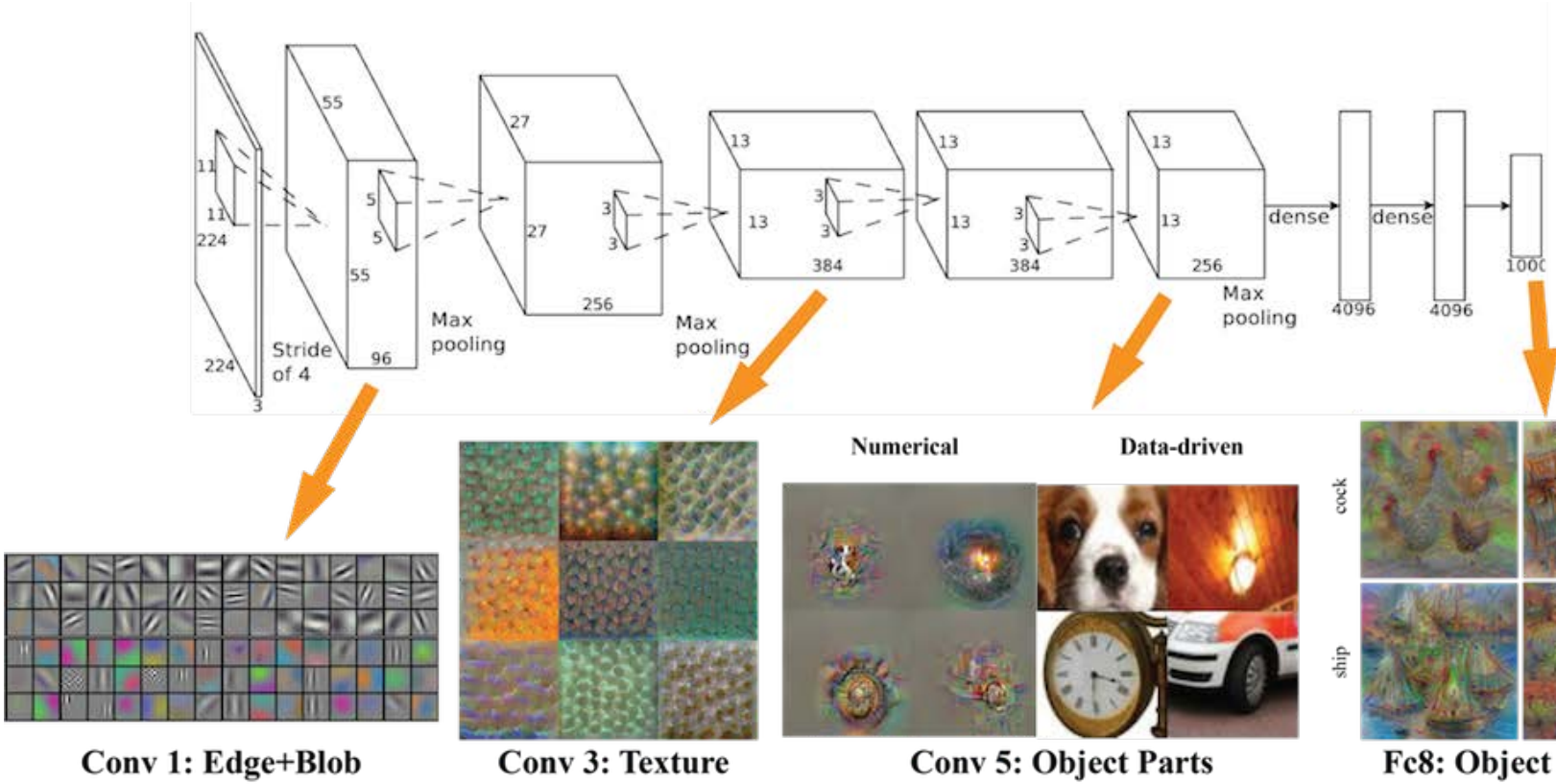
Neural Networks

- Neural networks (1943)
  - Try to mimic the brain
  - Many computational units=neurons
- Simplified neurons
  - Many inputs and one output
  - Organized in layers
  - Parameters = input weights
- Supervised learning
  - Trained to minimize a measure of error
  - Until recently, limited to max 3-4 layers



Deep Learning

- Deep neural networks
  - As many as 30 layers or more
  - Recent advances make training possible
  - 100X faster on GPUs

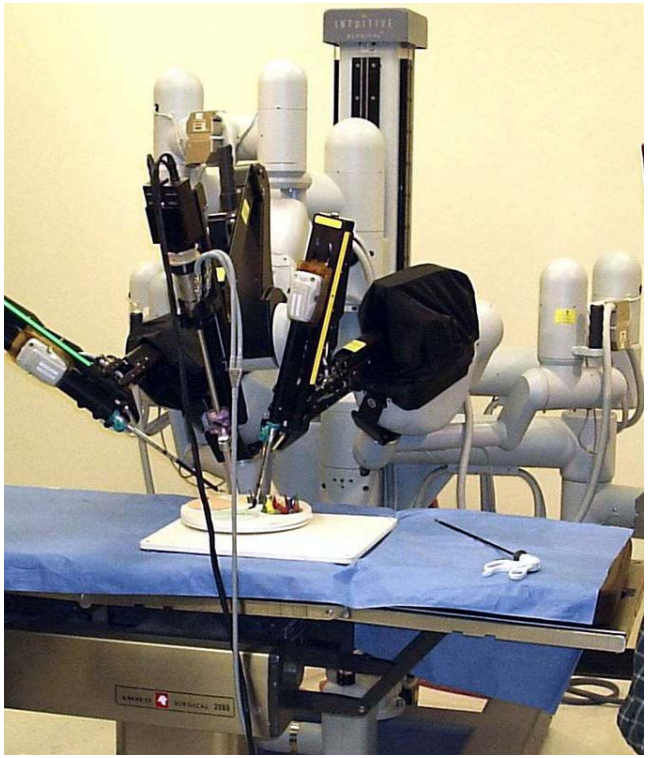


Deep Learning Applications

- Speech Recognition: Siri, Google Now, Automotive
- Translation: Google Translate
- Natural Language Processing: Siri, Google Now
- Customer relationship management
  - Sentiment Analysis: Amazon
- Recommendation systems: Online commerce
- Handwriting Recognition: Android, IPhone
- Object recognition
- Face recognition: surveillance
- High Energy Physics
  - Higgs boson classification

Medical Applications

- Computer Aided Diagnostics:
  - Detect lymph nodes, tumors, polyps, etc
  - Delineate and measure organs
- Robot assisted surgery
  - More precision
  - Remote operation
  - Automation for some procedures
- Drug discovery
  - Predict molecule-protein interactions
  - Predicted novel molecule candidates for Ebola and multiple sclerosis (2015)



Future in Medical Applications

- Automatic diagnosis from images
  - Emergency room
  - Suggest treatment
- Robotic surgery
  - Full automation
  - Gain speed and precision
- Nano-robots
  - Fight cancer or other diseases
  - Perform surgery in hard to reach places (brain, spinal cord, etc)
    - Stem cell insertion
  - Read hormone levels, neurons, etc

Brain-Machine Interface

Present

- Mind controlled robotic arm (2013)
- Human-human brain interface
  - Control somebody else's arm (2013)
  - Answer questions (2015)

Future

- Store your memories on a hard-drive
- Access information using your thoughts
- Increase your brain power

Implications

- Read somebody else's memories
- Download knowledge into brain

Human Enhancement

Present:

- Screen for some genetic defects:
  - Down syndrome, Cystic fibrosis, etc.

Future:

- Thorough understanding of gene modifications
  - Which ones correspond to serious diseases
- Genetic engineering
  - Correct only genes with bad modifications
  - Make smart and beautiful babies

Outperforming Humans

Computers start outperforming humans at many tasks:

- Games:
  - Backgammon (1979), Checkers (1994)
  - Deep Blue defeats world chess champion Gary Kasparov (1997)
  - Jeopardy (2011)
    - Complex natural language
  - Rock-paper-scissors (2012)
  - Go (2016)
    - Much more complex than chess
- Face recognition (2014)
- Object recognition
  - Almost there

What Drives This Progress?

IBM's Deep Blue

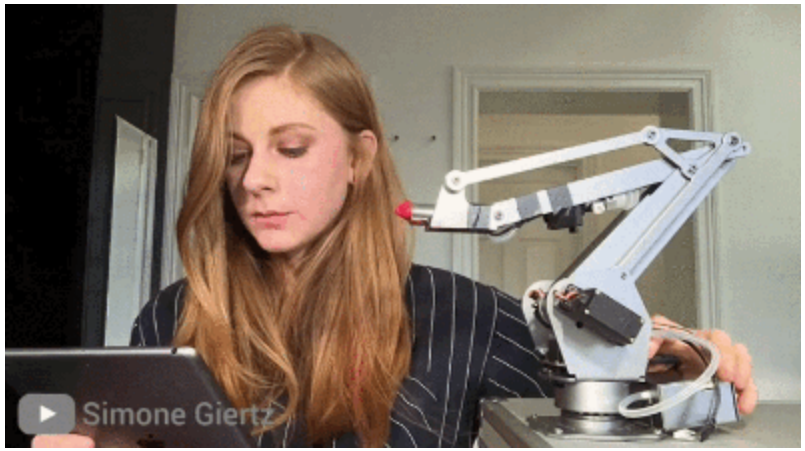
- Scientific advances
  - Better methods and algorithms
- Exponential growth of technology:
  - Computer power doubles every two years
  - Increases 1000 fold in 20 years!
  - Today's smartphone is faster than the Deep Blue supercomputer of 1997
  - Similar laws for memory size, data transfer speed, etc.
- We process **more data** with **faster computers** and **better algorithms**

What Are the Strengths of the Machines?

- Great at logical thinking
- Unbiased, reliable, no personality or ego
- Huge memory
  - Store pictures, videos with great amount of detail
  - Never forget
- Good at estimating probabilities of events
  - Use data to estimate probabilities
  - Use thousands of variables to make decisions
- Huge computational power
  - Evaluate millions of scenarios/cases
  - Make almost instant decisions

What Are their Weaknesses?

- Natural language
  - Abstract concepts
  - Nuances, irony, euphemisms
- Adaptability
  - Unable to handle ambiguity and formulate multiple solutions
  - Unable to create new scenarios that explain new data
- Fine manipulation, eye-hand coordination



Displaced by Machines

Blue collar jobs

- Farming, agriculture
- Postal worker, warehouse worker
- Manufacturing: pressing, welding painting, assembly, sewing
- Fast food cook, barista, bartender
- Sales: cashier, street vendor

White collar jobs

- Librarian
- Insurance underwriter, loan officer, travel agent
- Data entry, file clerk, word processor/typist, telemarketer
- Food service manager, advertising/promotion manager

What Jobs Will Be Displaced?

Forecast: within 20 years, technology will eliminate almost half of all jobs.

Blue collar

- Mining
- Cab, bus, and truck drivers (due to autonomous cars)

White collar

- Teacher, accountant
- Pilot, air traffic controller
- Interpreter/translator, reporter
- Health sector: radiologist, surgeon, personal aid

Part-time/gig employment: CFO, handyman

The Singularity

Kurzweil's predictions:

- 2020 – computers will be capable of simulating the human brain
- 2029 – reverse-engineering of the human brain
  - Machines with human-level intelligence
    - Fast access to the global knowledge pool
  - Faster technological advances
- 2030 – connect our brain to the cloud
  - Back-up our memory
  - Access the global knowledge pool
  - Expand brain power on-demand (IQ 1000)
  - Accelerated Innovation

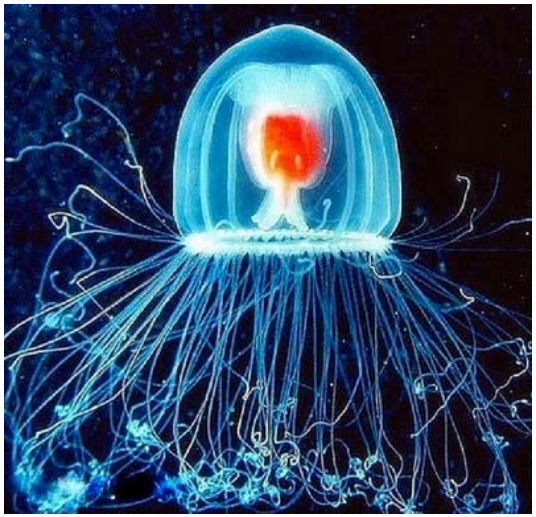
- 2045: Singularity – machines a billion times faster than human intelligence

Can We Live Forever?

Two scenarios

- Brain-machine interface
  - Electronic brain
  - Download ourselves to an electronic brain
  - Live forever in electronic form

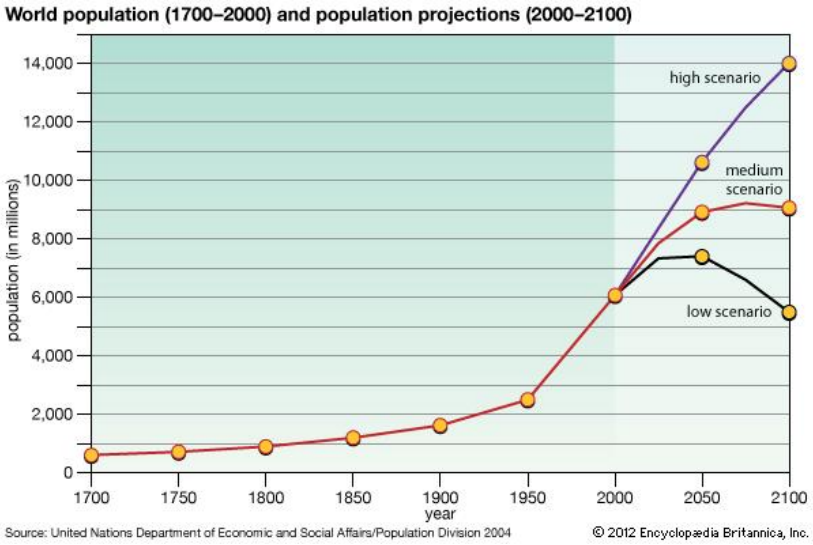
- No brain-machine interface
  - Better health care
  - Conquer aging
    - There exist immortal jellyfish
  - Live long lives in human form



Population Problem

Potential future

- Machines do most jobs
  - Who owns the machines and gets the profits?
- Billions of people without jobs
  - Long miserable lives
  - Decreased buying power
  - Social unrest
- Inequality
  - Stratified society
  - Superhumans – connected to the cloud
  - The rest, many without means of survival



Planning Ahead

Possible options

- Population control?
- Social programs?
- New forms of government?
- Unplug?
- Forego technology?

Future of Life Institute

- Research to keep AI beneficial for humanity
- Elon Musk invested 10 Million

Conclusion

Artificial Intelligence

- Very helpful nowadays
  - Smartphones, manufacturing
- Starts outperforming humans at many tasks
  - Takes away many jobs
- Future will be very exciting
  - Higher inequality
  - Better health
  - Need to plan ahead

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