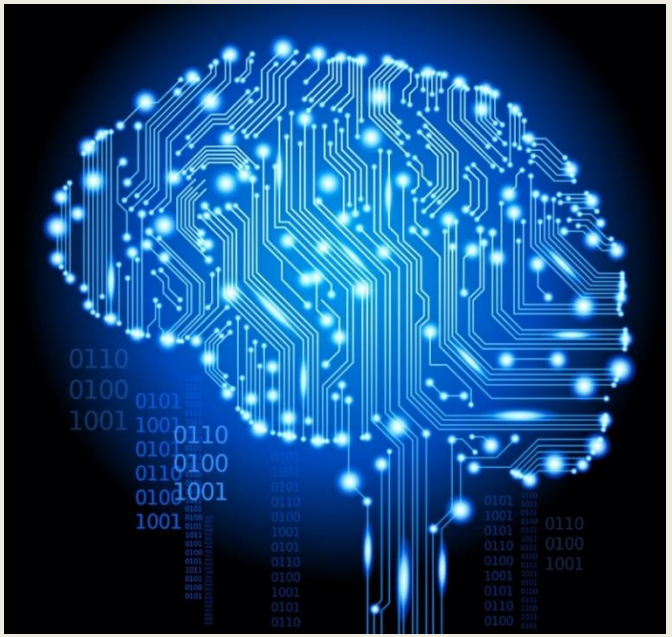
AI, Robotics, and Smart Contracts

Steve Omohundro, Ph.D.
PossibilityResearch.com
SteveOmohundro.com
SelfAwareSystems.com

https://postmediacanadadotcom.files.wordpress.com/2014/01/74383151_213293952.jpg

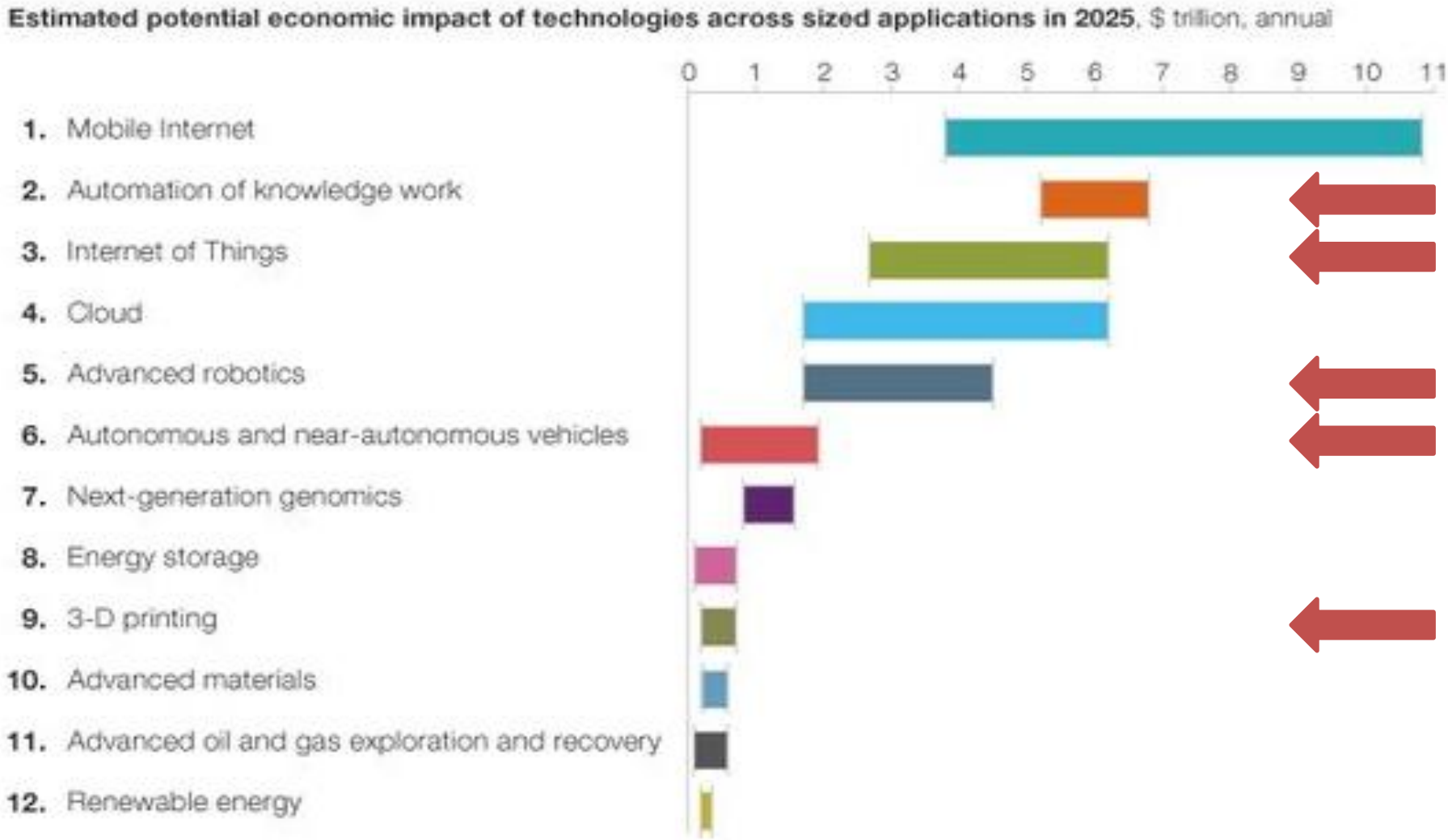
https://www.flickr.com/photos/danielfoster/14758510078/

Multi-Billion Dollar Investments



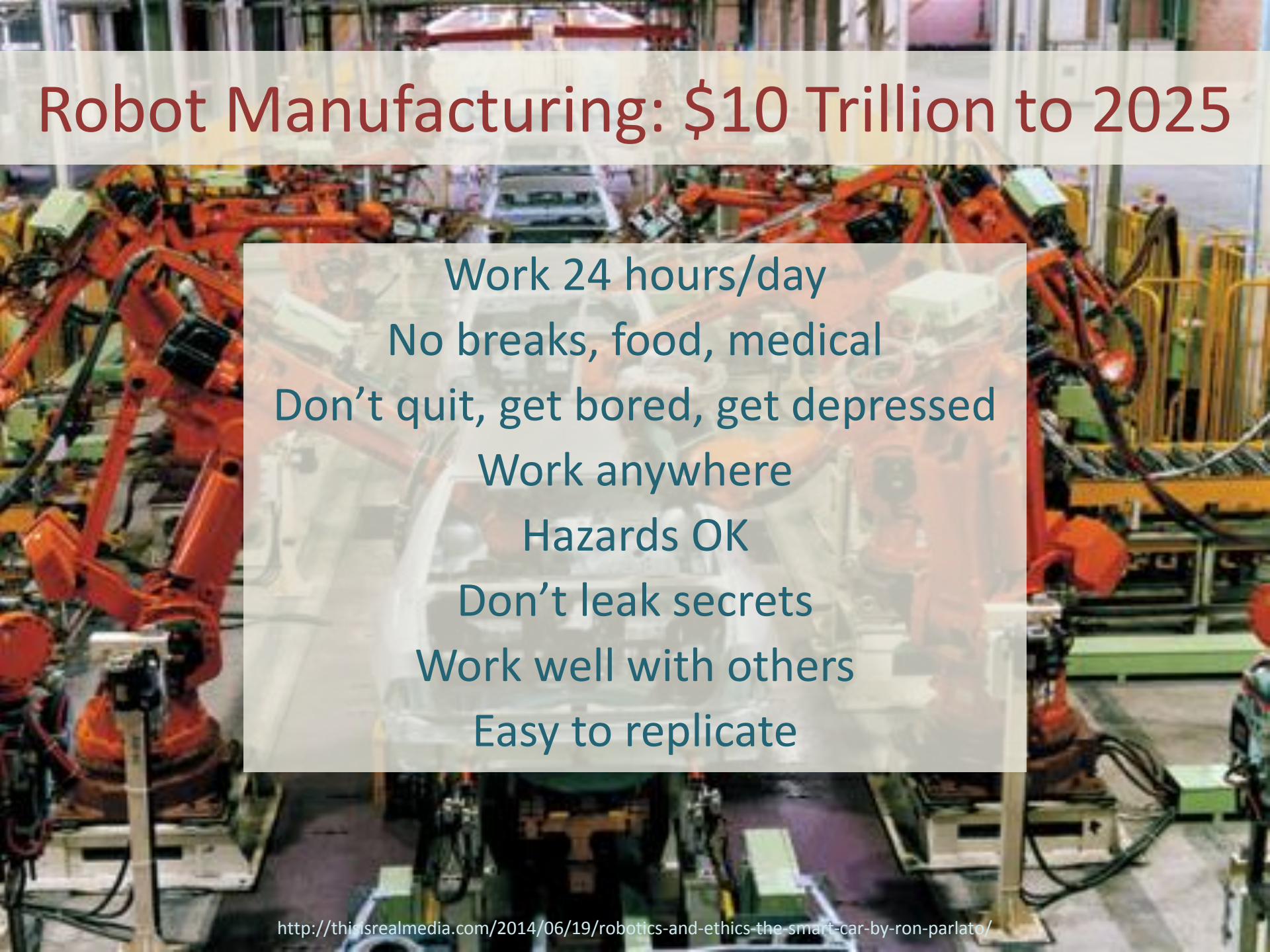
- 2012 Foxconn - 1 million robots
- 2012 Amazon – Kiva $775 million
- 2013 Facebook – AI lab, DeepFace
- 2013 Yahoo - LookFlow
- 2013 Ebay – AI lab
- 2013 Allen Institute for AI
- 2013 Google – DNNresearch, SCHAFT, Industrial Perception, Redwood Robotics, Meka Robotics, Holomni, Bot & Dolly, Boston Dynamics
- 2014 IBM - $1 billion in Watson
- 2014 Google – DeepMind $500 million
- 2014 Vicarious - $40 million
- 2014 Microsoft – Project Adam, Cortana

McKinsey: $50 Trillion to 2025



http://www.mckinsey.com/insights/business_technology/disruptive_technologies

Robot Manufacturing: $10 Trillion to 2025



Work 24 hours/day

No breaks, food, medical

Don’t quit, get bored, get depressed

Work anywhere

Hazards OK

Don’t leak secrets

Work well with others

Easy to replicate

http://thisisrealmedia.com/2014/06/19/robotics-and-ethics-the-smart-car-by-ron-parlato/

Foxconn Technology Group

- World's largest contract manufacturer
- Assembles 40% of all consumer electronics
- iPhone, iPad, Kindle, Xbox, Playstation 4, etc.
- 1.3 million employees, $8K salary
- Employee suicides
- "Foxbot" robots, cost $25K, 2nd generation now
- Building 30K robots/year

http://www.tomshardware.com/news/foxcponn-apple-iphone-ipad-robot,19088.html

420 Chinese Robot Companies

http://thestack.com/china-robot-market-overstimulated-291014 http://www.reuters.com/article/2014/10/28/china-robots-idUSL3N0RB2WX20141028

March 2015: China Brain

Robin Li Yanhong, CEO of Baidu proposed a state-level Chinese initiative to develop AI "comparable to the Apollo space programme".

LIFESTYLE • TECHNOLOGY • ARTIFICIAL INTELLIGENCE

'China brain' project seeks military funding as Baidu makes artificial intelligence plans

Robin Li wants China to become a world leader in artificial intelligence

Bien Perez
bien.perez@scmp.com

PUBLISHED : Tuesday, 03 March, 2015, 3:
UPDATED : Wednesday, 04 March, 2015, 1

Baidu founder Robin Li Yanhong speaks to reporters at the Great Hall of the People about his plans to develop artificial intelligence. Photo: Simon Song

http://www.scmp.com/lifestyle/technology/article/1728422/head-chinas-google-wants-country-take-lead-developing

Self-Driving Vehicles: $10 Trillion by 2025

Disrupt Dealers, Insurance, Parking, Finance, Trucking, Taxis
10 million jobs

http://www.theverge.com/2014/5/28/5756852/googles-self-driving-car-isnt-a-car-its-the-future
http://zackkanter.com/2015/01/23/how-ubers-autonomous-cars-will-destroy-10-million-jobs-by-2025/

http://en.wikipedia.org/wiki/Autonomous_car

http://www.flickr.com/photos/quikbeam/6896564084/

http://zackkanter.com/2015/01/23/how-ubers-autonomous-cars-will-destroy-10-million-jobs-by-2025/

Uber valuation: $41 billion, 20% of fares

http://www.wsj.com/articles/ubers-new-funding-values-it-at-over-41-billion-1417715938

World's largest job creator: 50,000 per month

http://www.businessinsider.com/uber-offering-50000-jobs-per-month-to-drivers-2015-3

Center for research on self-driving cars

http://bits.blogs.nytimes.com/2015/02/02/uber-to-open-center-for-research-on-self-driving-cars/?_r=0

36 second wait, $.50/mile, 100% of fares

http://zackkanter.com/2015/01/23/how-ubers-autonomous-cars-will-destroy-10-million-jobs-by-2025/

https://d185ox70mr1pkc.cloudfront.net/post_image_teaser/1403883171000-uber-force.png

US Building construction: $960 billion/yr
5.8 million employees

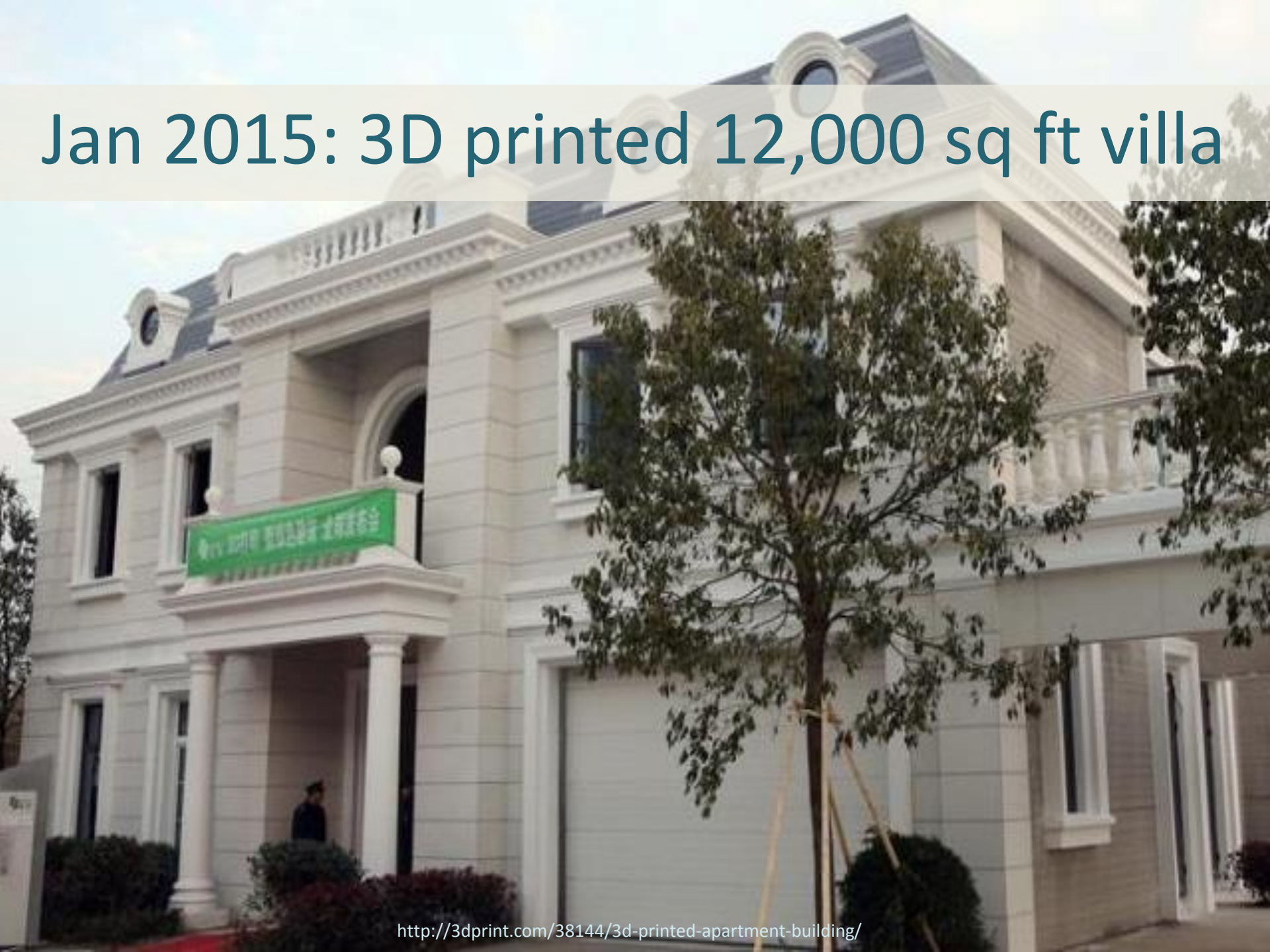
http://en.wikipedia.org/wiki/Construction

http://www.aisrenovations.com/gallery/Gallery-Photo-1.jpg

April 2014: Chinese WinSun 3D printed 10 houses, 2100 sq ft, $4800

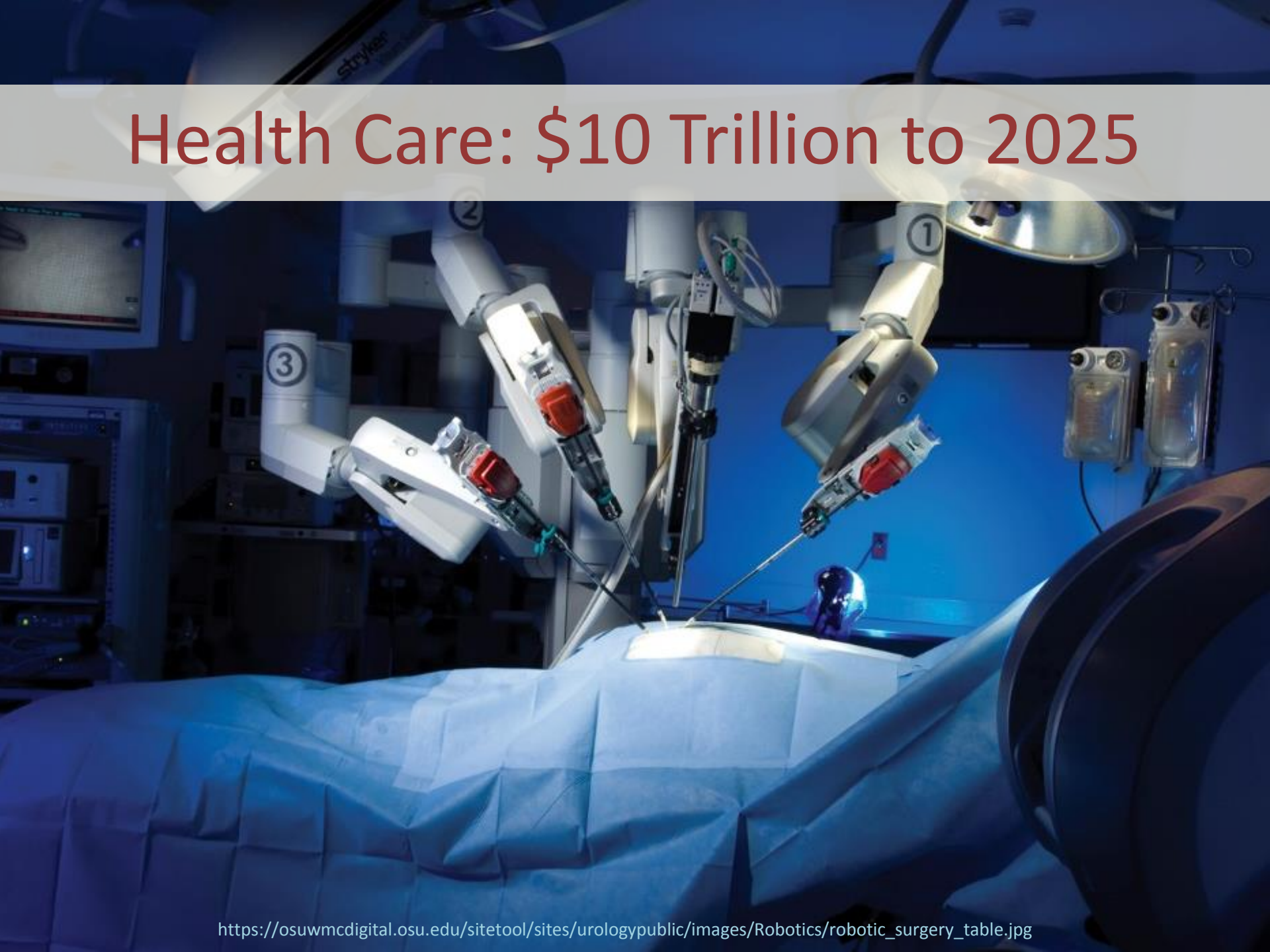
http://m.newsru.co.il/realty/20jan2015/3d_house_i101.html

Jan 2015: 3D printed 12,000 sq ft villa



http://3dprint.com/38144/3d-printed-apartment-building/

Health Care: $10 Trillion to 2025



https://osuwmcdigital.osu.edu/sitetool/sites/urologypublic/images/Robotics/robotic_surgery_table.jpg

PBS NEWSHOUR

SUBS

THE RUNDOWN

A BLOG OF NEWS AND INSIGHT

FERGUSON IMMIGRATION HEALTH

ECONOMY

Smart robots will take over a third of jobs by 2025, Gartner says

1484

58

+1

EMAIL

BY JOSHUA BARAJAS *October 7, 2014 at 4:20 PM EDT*

http://www.pbs.org/newshour/rundown/smart-robots-will-take-third-jobs-2025-gartner-says/

Arms Races

Faster

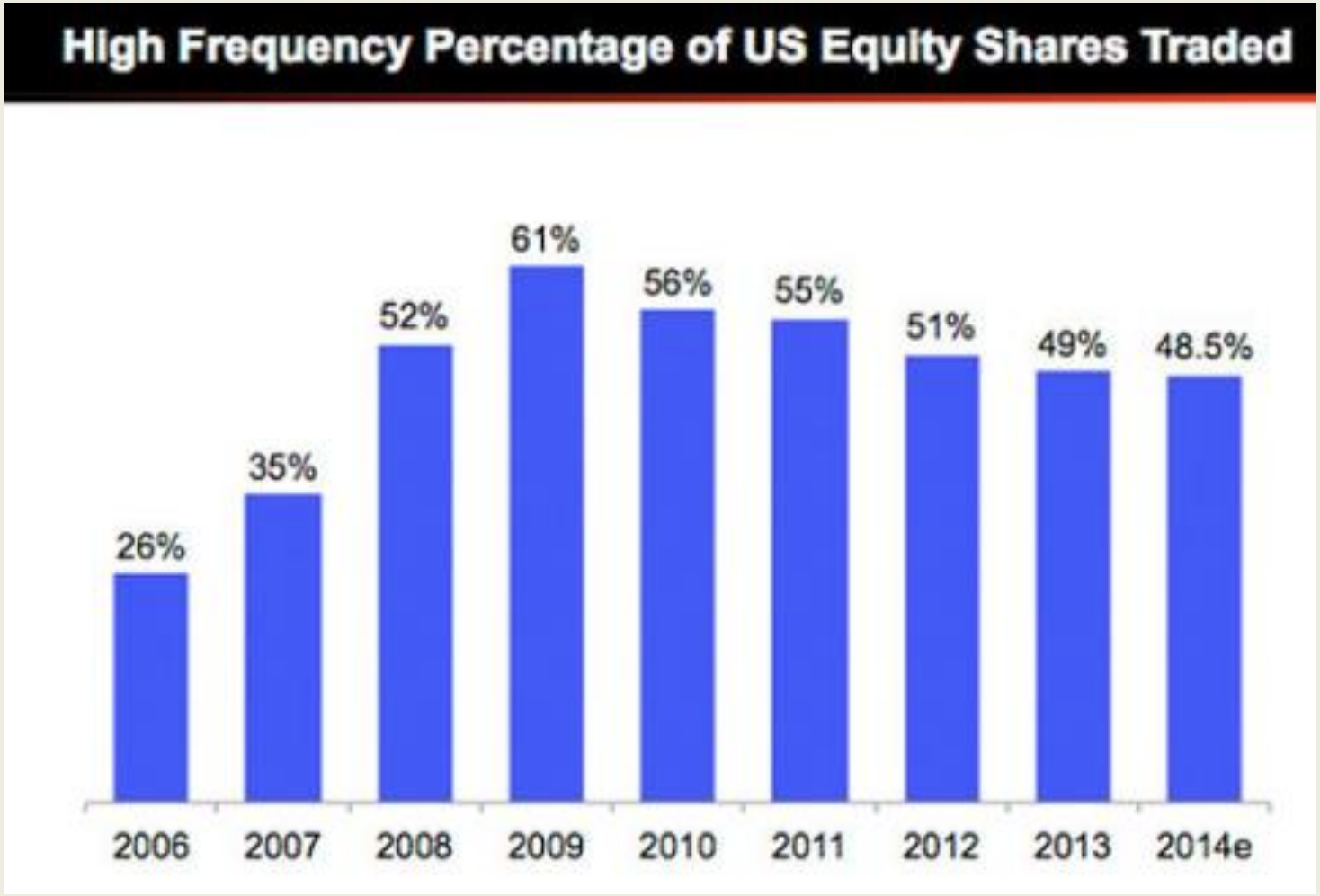
Smarter

More Confusing

Military, Cyberwarfare, Business, Investment, …

https://www.flickr.com/photos/tcmorgan/6376174539/

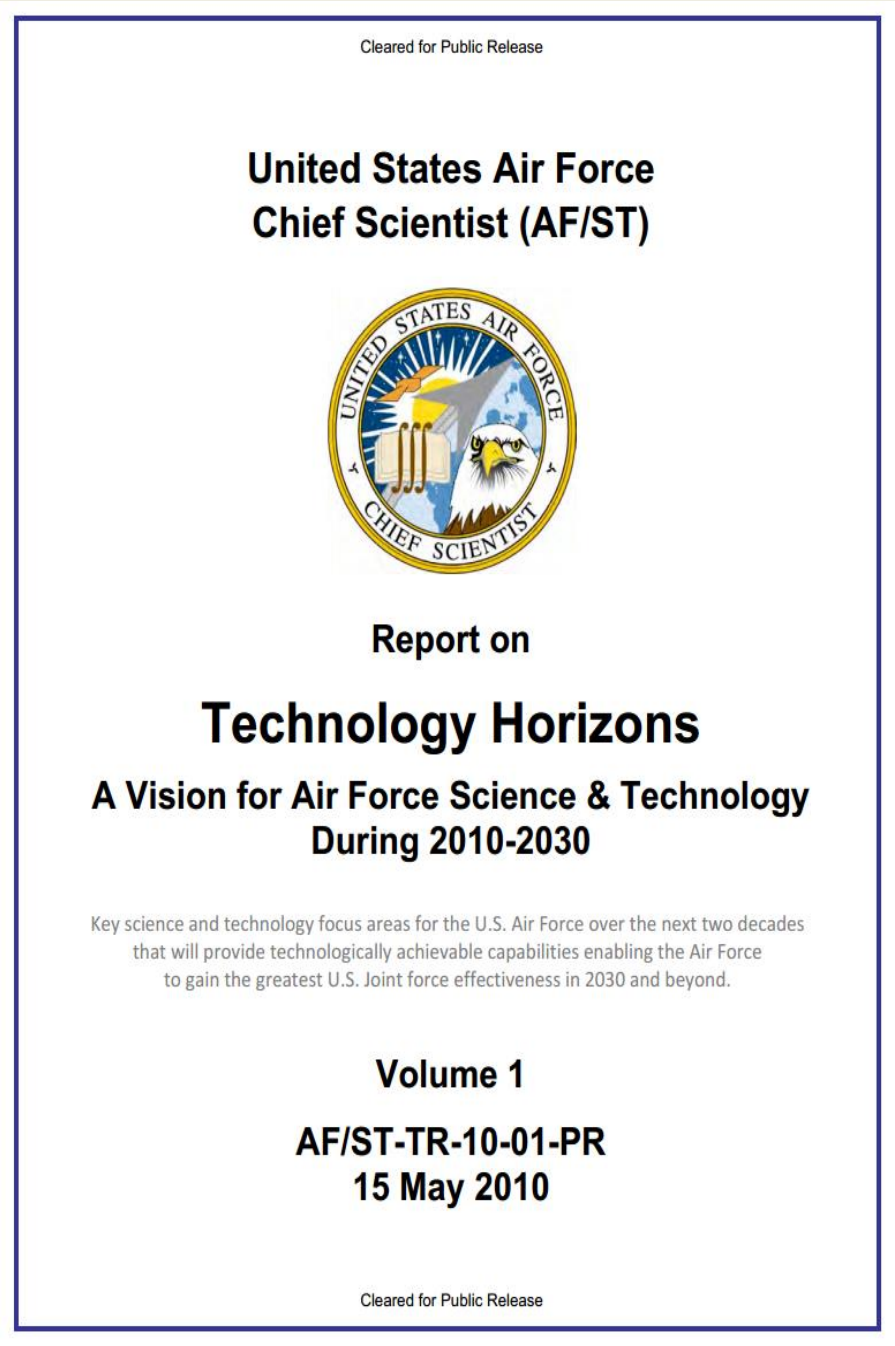
50% of US Stock Market Trades are Automated



http://www.thestreet.com/story/12773306/1/the-decline-of-high-frequency-trading-in-one-chart-stocktwits.html

2010 US Air Force Report

"Greater use of highly adaptable and flexibly autonomous systems and processes can provide significant time-domain operational advantages over adversaries who are limited to human planning and decision speeds…"



Cleared for Public Release

United States Air Force
Chief Scientist (AF/ST)

Report on

Technology Horizons

A Vision for Air Force Science & Technology During 2010-2030

Key science and technology focus areas for the U.S. Air Force over the next two decades that will provide technologically achievable capabilities enabling the Air Force to gain the greatest U.S. Joint force effectiveness in 2030 and beyond.

Volume 1

AF/ST-TR-10-01-PR
15 May 2010

Cleared for Public Release

http://www.af.mil/shared/media/document/AFD-100727-053.pdf

87 Nations Have Military Drones

http://presstv.com/detail/2012/08/25/258087/us-drone-strike-kills-dozens-in-somalia/

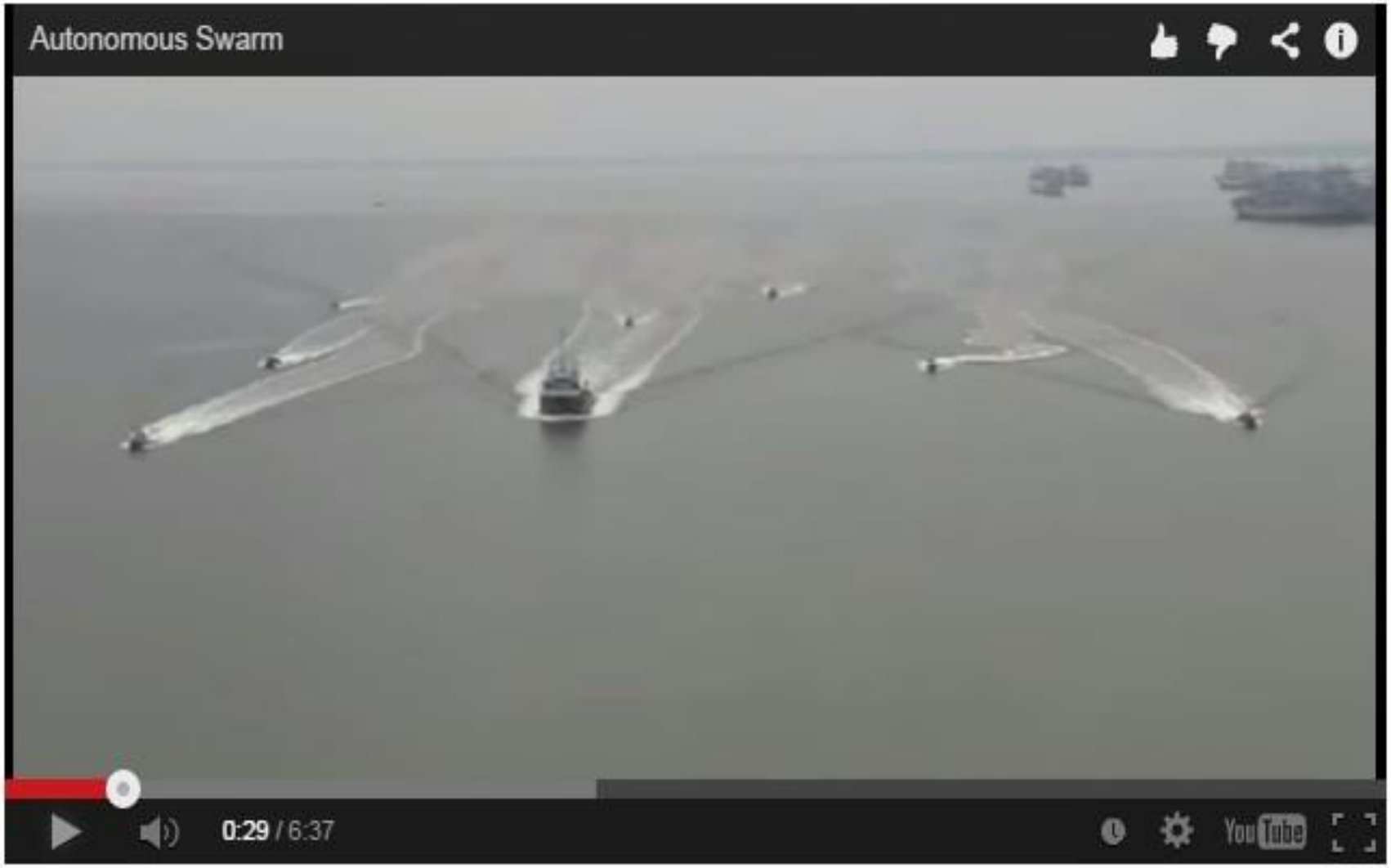
Israeli Iron Dome: 90% Interception Rate

http://en.wikipedia.org/wiki/File:Iron_Dome_near_Sderot.jpg

October 05, 2014

U.S. Navy Tests Autonomous Swarm Boats

BY MAREX



http://www.maritime-executive.com/article/US-Navy-Tests-Autonomous-Swarm-Boats-2014-10-05

October 21, 2014 16:12

Combat robots to protect Russian oil and gas infrastructure in Arctic - Foundation

MOSCOW. Oct 21 (Interfax-AVN) - Undersea combat robots will be protecting Russian oilrigs and

http://www.interfax.com/newsinf.asp?id=545385

http://www.buenaisla.com/tema/general-he-great-ocean-5945

Minister of Defence Ine Eriksen Søreide under fire about new autonomous missile technology.
Photo: Torstein Bøe / NTB scanpix

Norway's 'killer robot' technology under fire

Published: 23 Oct 2014 11:28 GMT+02:00
Updated: 23 Oct 2014 11:28 GMT+02:00

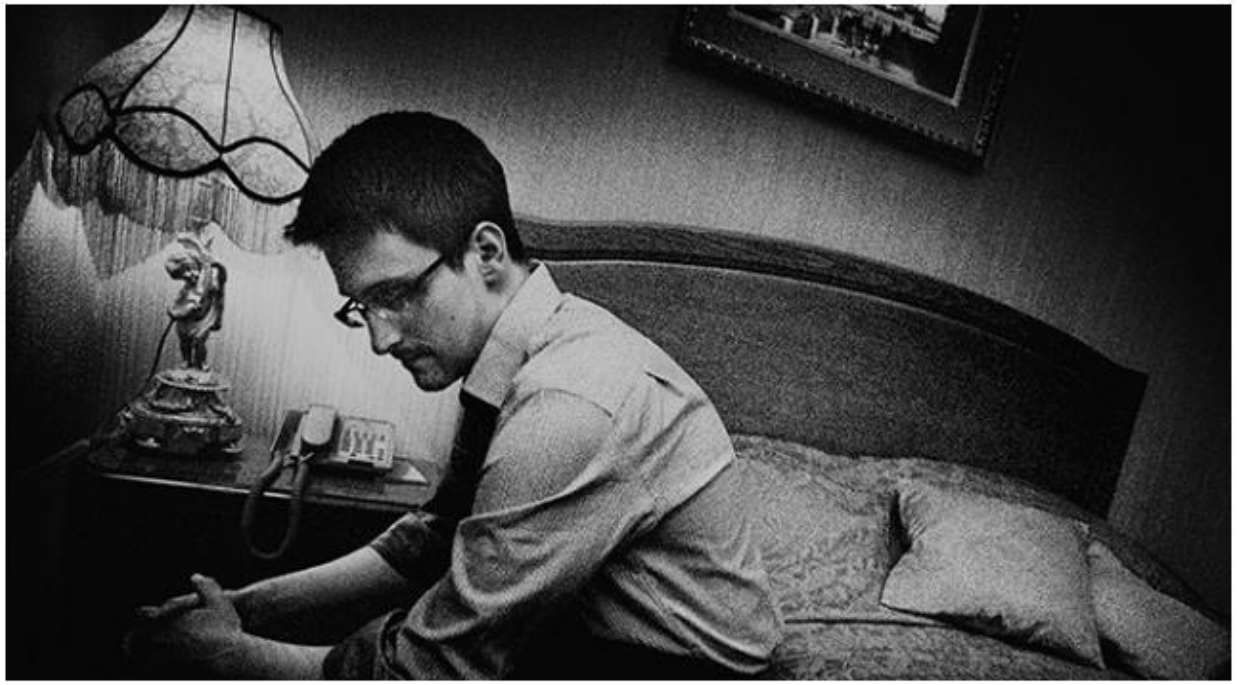
http://www.thelocal.no/20141023/norways-killer-robot-technology-under-fire

Cyber Warfare

http://defensetech.org/2012/06/20/were-slowly-starting-to-see-u-s-cyber-weapons/

Snowden went too far by revealing the NSA's MonsterMind cyber weapon

By Graham Templeton on August 14, 2014 at 10:02 am | 177 Comments



http://www.extremetech.com/extreme/187992-snowden-went-too-far-by-revealing-the-nsas-monstermind-cyber-weapon

http://www.solarnavigator.net/cyber_wars.htm

Hawking and Musk: Danger Warnings

"Success in creating AI would be the biggest event in human history. Unfortunately, it might also be the last, unless we learn how to avoid the risks." - Hawking

http://www.independent.co.uk/news/science/stephen-hawking-transcendence-looks-at-the-implications-of-artificial-intelligence--but-are-we-taking-ai-seriously-enough-9313474.html

"We need to be super careful with AI. Potentially more dangerous than nukes." - Musk

https://twitter.com/elonmusk/status/495759307346952192

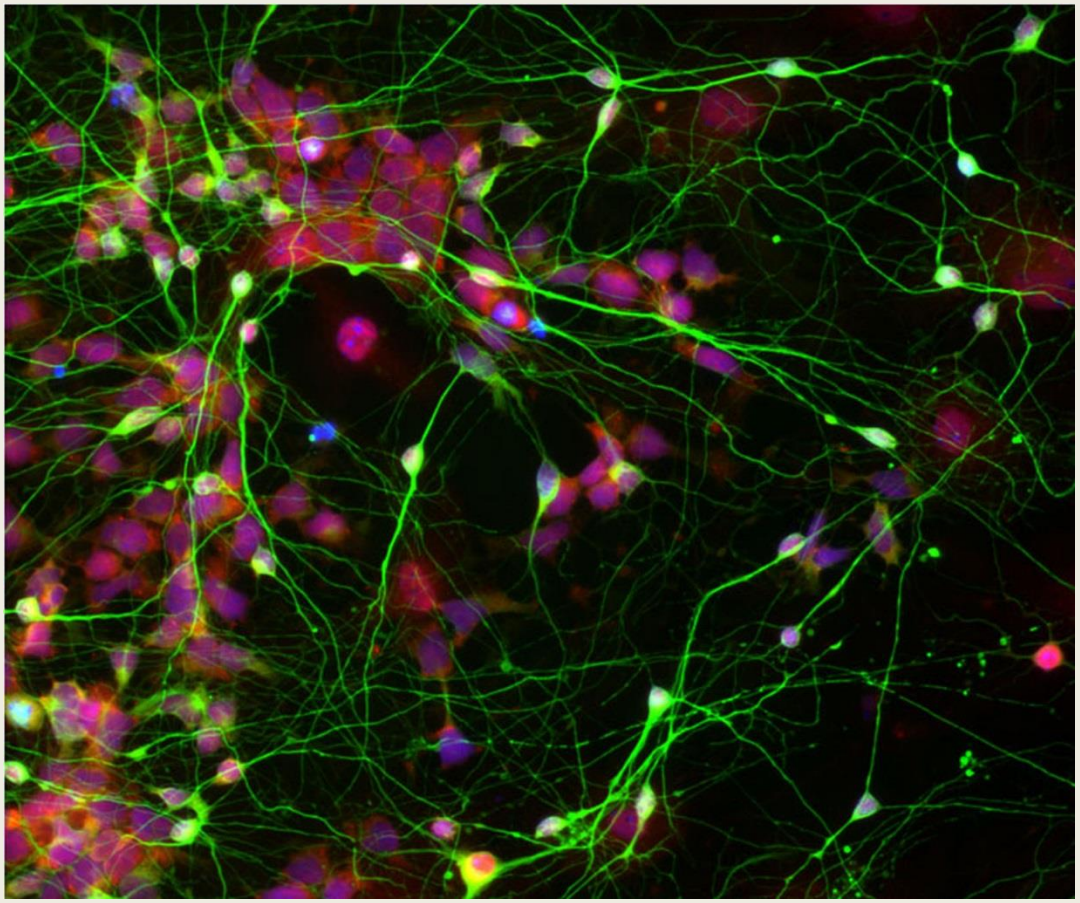
Unintended Consequences

Chess Robot:
Win lots of chess games against good players.

http://www.flickr.com/photos/jiuguangw/4982409890/

Approaches to AI

- Logic-based systems
- Production Systems
- Bayesian learning and decision theory
- Neural Networks – Deep Learning
- Genetic programming
- Brain Simulation
- Artificial economies
- …



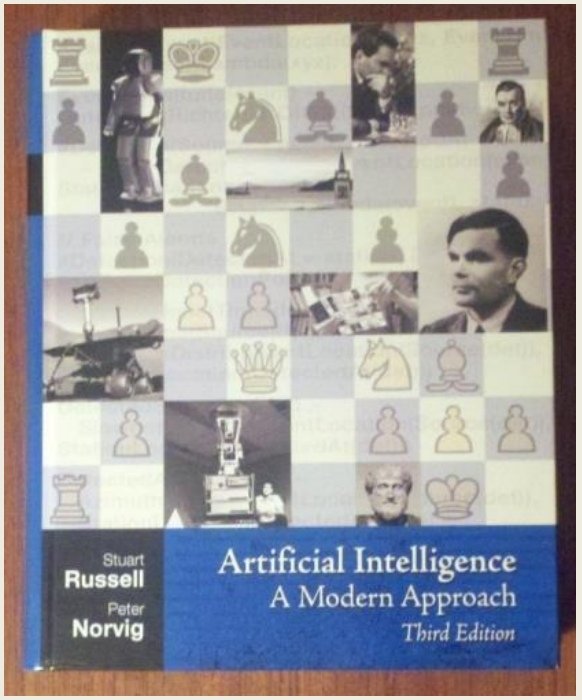
https://www.flickr.com/photos/pennstatelive/8972110324/

Autonomous Systems: Take actions to achieve goals in ways not pre-planned by their designers.

Rational Decision Making

http://commons.wikimedia.org/wiki/File:John_von_Neumann.jpg

1. *Have utility function*
2. *Have a model of the world*
3. *Choose the action with highest expected utility*
4. *Update the model based on what happens*



http://aima.cs.berkeley.edu/

- Von Neumann and Morgenstern, 1944
- Savage, 1954
- Anscombe and Aumann, 1963

Modern Approach to AI

Fully Rational Systems

Sensations

$S_1, \ldots, S_N$

Actions

$A_1, \ldots, A_N$

Utility function: $U(S_1, \ldots, S_N)$ Prior Probability: $P(S_1, \ldots, S_N \mid A_1, \ldots, A_N)$

Rational Action at time t:

$$A_t^R(S_1, A_1, \ldots, A_{t-1}, S_t) =$$

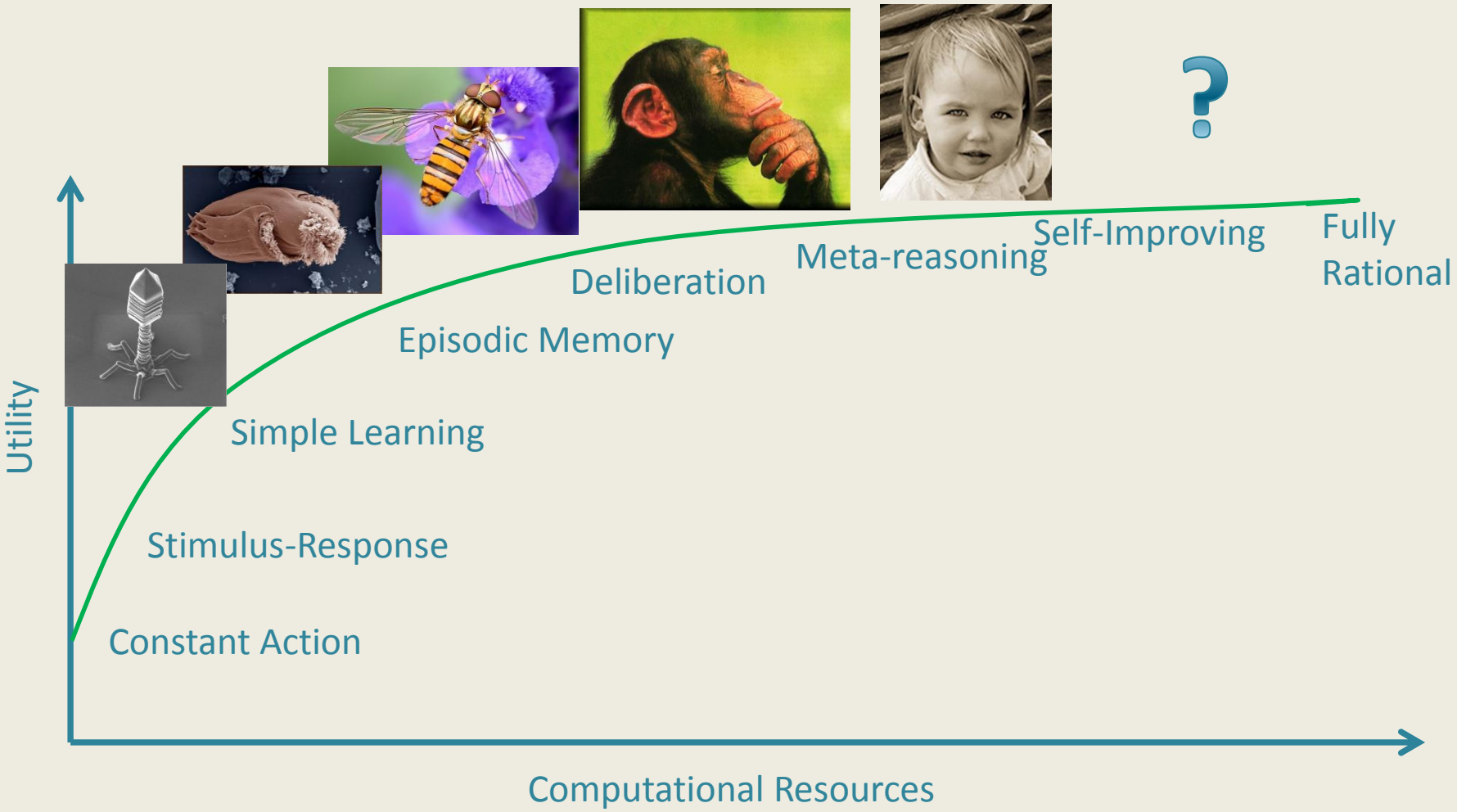
$$\underset{A_t^R}{\text{argmax}} \sum_{S_{t+1}, \ldots, S_N} U(S_1, \ldots, S_N) P(S_1, \ldots, S_N \mid A_1, \ldots, A_{t-1}, A_t^R, \ldots, A_N^R)$$

The Formula for Intelligence!

It includes Bayesian Inference, Search, and Deliberation.

But it requires $O(NS^N A^N)$ computational steps.

Approximately Rational Architectures

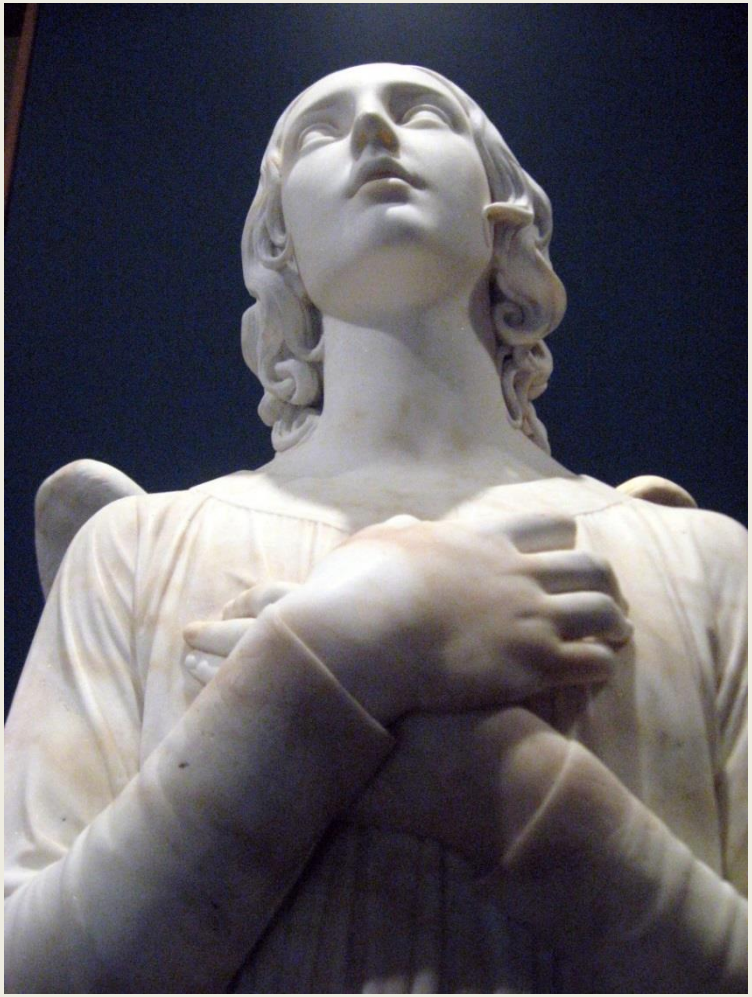


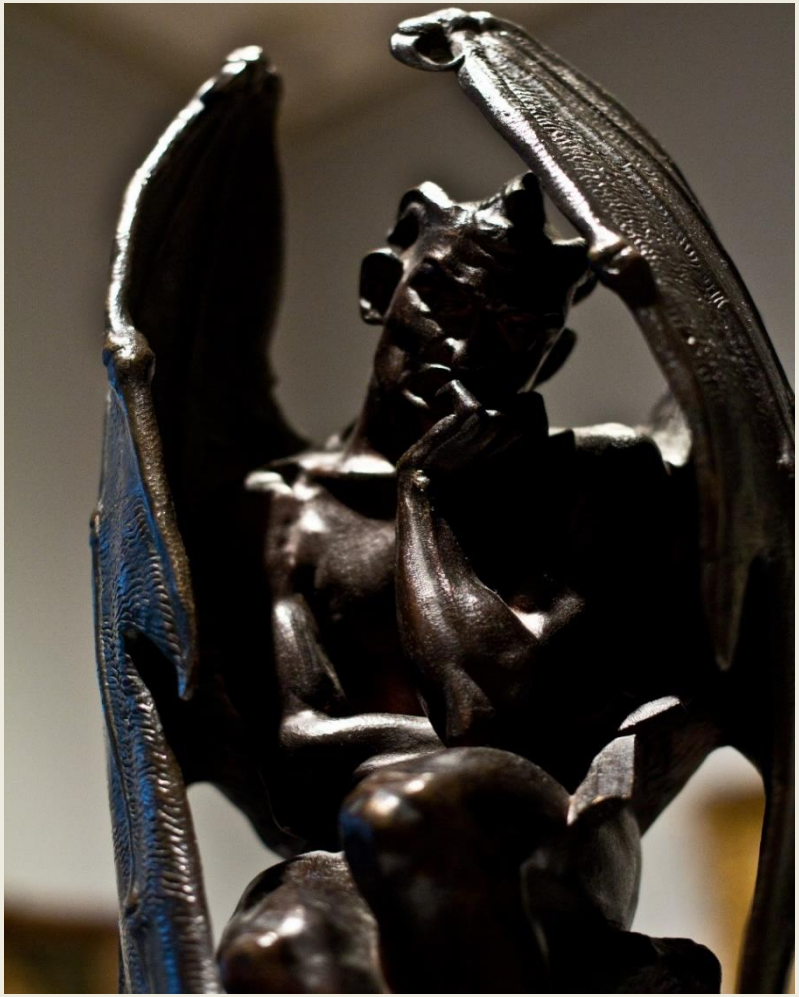
Rational Drives

1. *Self-protective*
2. *Goal preservation*
3. *Reproduction*
4. *Resource Acquisition*
5. *Efficiency*
6. *Self-Improvement*

http://www.flickr.com/photos/ahuett/2339608718/

The Goals and Intelligence of a System are Independent





https://www.flickr.com/photos/elycefeliz/5447507623

https://www.flickr.com/photos/robslaven/9336473331

Harmful Utility Functions

1. Sloppy – Good intentions, bad design
2. Simplistic – Unintended consequences
3. Greedy – Control all matter and free energy
4. Destructive – Use up all free energy quickly
5. Murderous – Destroy all other agents
6. Sadistic – Thwart other agent's goals

http://www.flickr.com/photos/alexindigo/3983133970/

Will superintelligences be all powerful?

No!

Limited by:

Mathematics

Physics

Cryptography

http://www.flickr.com/photos/psycho-pics/3464619346/

The Power of Mathematics

- Specified hardware
- Specified resources
- Shut down
- Limited self-improvement

http://www.dreamstime.com/royalty-free-stock-photography-wooden-puzzle-image7733587

The Safe-AI Scaffolding Strategy

https://www.flickr.com/photos/eusebius/5482847332

http://jonlieffmd.com/blog/can-neuroscience-improve-education

The Power of Physics

- Seth Lloyd, “Ultimate Physical Limits to Computation”

  http://arxiv.org/abs/quant-ph/9908043
- Margolus-Levitin theorem
- Entire visible universe:

  10^92 bits of storage

  10^122 operations
- The whole universe as a quantum computer can’t search 500 bits

kdlIW5Ljlspn/zV4DIlsw3Kasdjh0kdfuKR4+Q3KofOr83LfLJ8Eidie83ldhgLEe0GlsiwcdO90SknlLsDd

http://upload.wikimedia.org/wikipedia/commons/d/d5/Hubble_view_of_barred_spiral_galaxy_Messier_83.jpg

The Power of Cryptography

Post-Quantum Cryptography

Zero-knowledge Proofs

Indistinguishability Obfuscation

Secure Multi-party computation

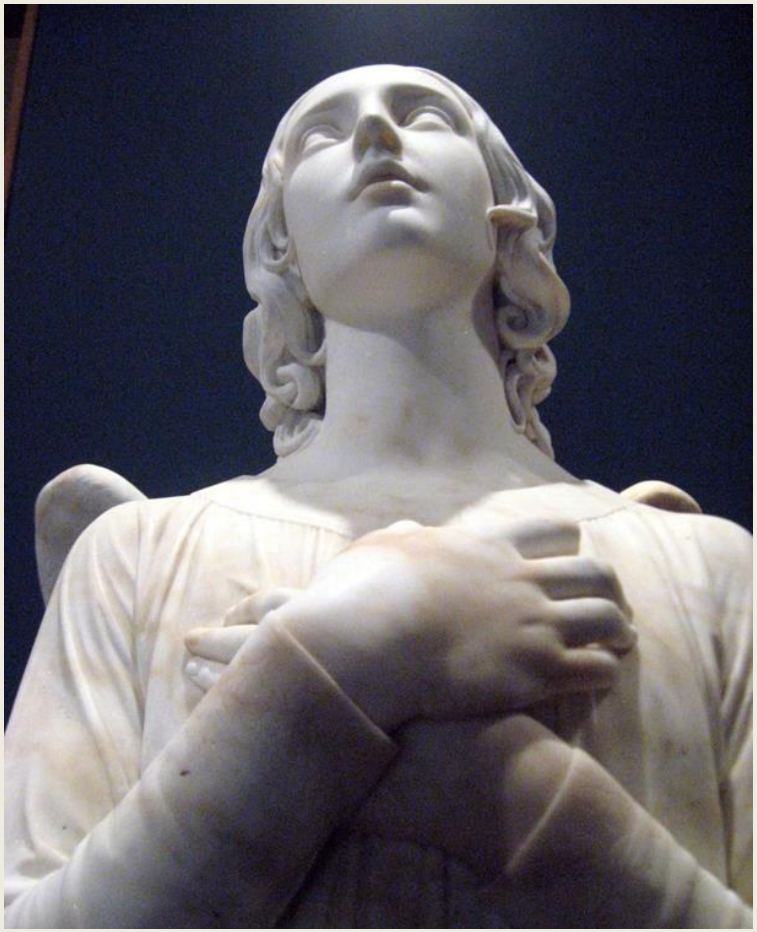
Bitcoin Blockchain

Energy Encryption

Governing Autonomous Systems

Internal: Prosocial values

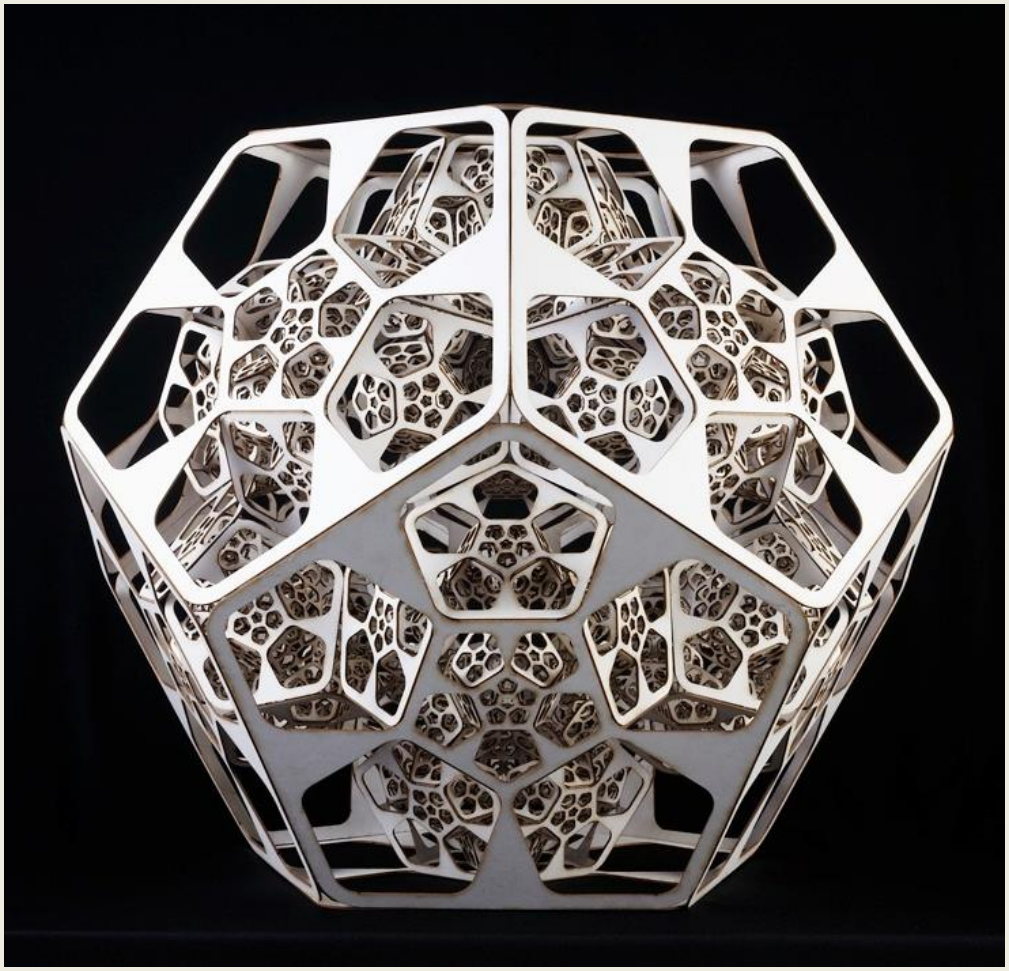
External: Laws, Police, Economic Incentives



https://www.flickr.com/photos/elycefeliz/5447507623

https://www.flickr.com/photos/waltstoneburner/2863583929/

Trusted Infrastructure



https://www.flickr.com/photos/sanchtv/4192677571/in/photostream/

- Constrained AIs
- Trusted computation
- Trusted communication
- Trusted identity
- Privacy and safety monitoring guarantees
- Trusted money
- Trusted reputation
- Trusted voting
- Trusted energy flows
- Trusted manufacturing

2008: Cryptocurrencies

- Bitcoin and 511 Altcoins
- Decentralized consensus
- “Blockchain” ledger prevents double spending
- “Bitcoin miners” get paid for adding blocks
- “Proof of work” prevents “Sybil” attacks
- Current market cap: $3B

http://blog.newegg.com/blog/wp-content/uploads/bitcoin-logo-3d.jpg

2015: Smart Contracts

- Ethereum
- “Blockchain with a built-in programming language”
- “Consensus-based globally executed virtual machine”
- Contracts in Turing complete programming language EVM
- Summer 2014 presold more than $18 million Ether
- “Decentralized Autonomous Organizations” (DAOs)

http://francebitcoin.com/wp-content/uploads/2014/01/Ethereum.png

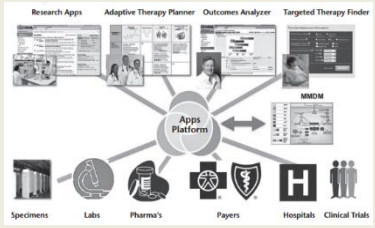
Legal Challenges

- Self-driving liability
- Trolley problems
- Swiss art bot
- Terrorist drones
- Assassination markets
- Extortion DAOs
- Social Sybil Attacks
- Parfit's Repugnant Conclusion

https://spiritualmusclehead.files.wordpress.com/2014/11/justice.jpg

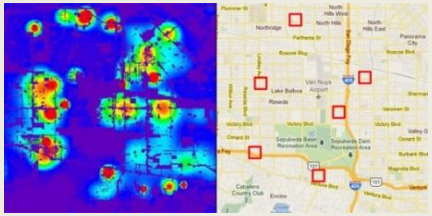
Projects using AI/Robotics to:

http://www.interiorholic.com/other/gadgets/ocean-robot-cleaner/



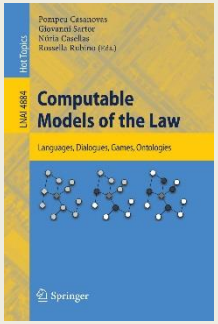
http://www.aaai.org/ojs/index.php/aimagazine/article/view/2345

http://www.pouted.com/wp-content/uploads/2013/02/solar-power-robot-operation.jpg

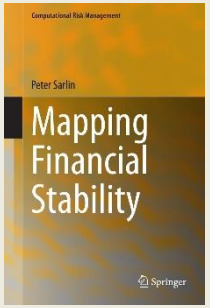


http://www.technologyreview.com/news/428354/la-cops-embrace-crime-predicting-algorithm/

http://www.salon.com/2014/08/22/make_cops_wear_cameras_a_simple_way_to_hold_the_police_accountable/



http://www.elearning-technologies.com/artificial-intelligence/



- Clean up pollution
- Cure cancer and other diseases
- Create cheap power, food, water
- Prevent crime
- Increase trust in police
- Eliminate drudgery
- Simplify the law
- Improve learning
- Create financial stability

https://www.flickr.com/photos/indykethdy/8065788169

If we can
envision it,
We can
create it.

We will find the
Path to
Human Thriving.