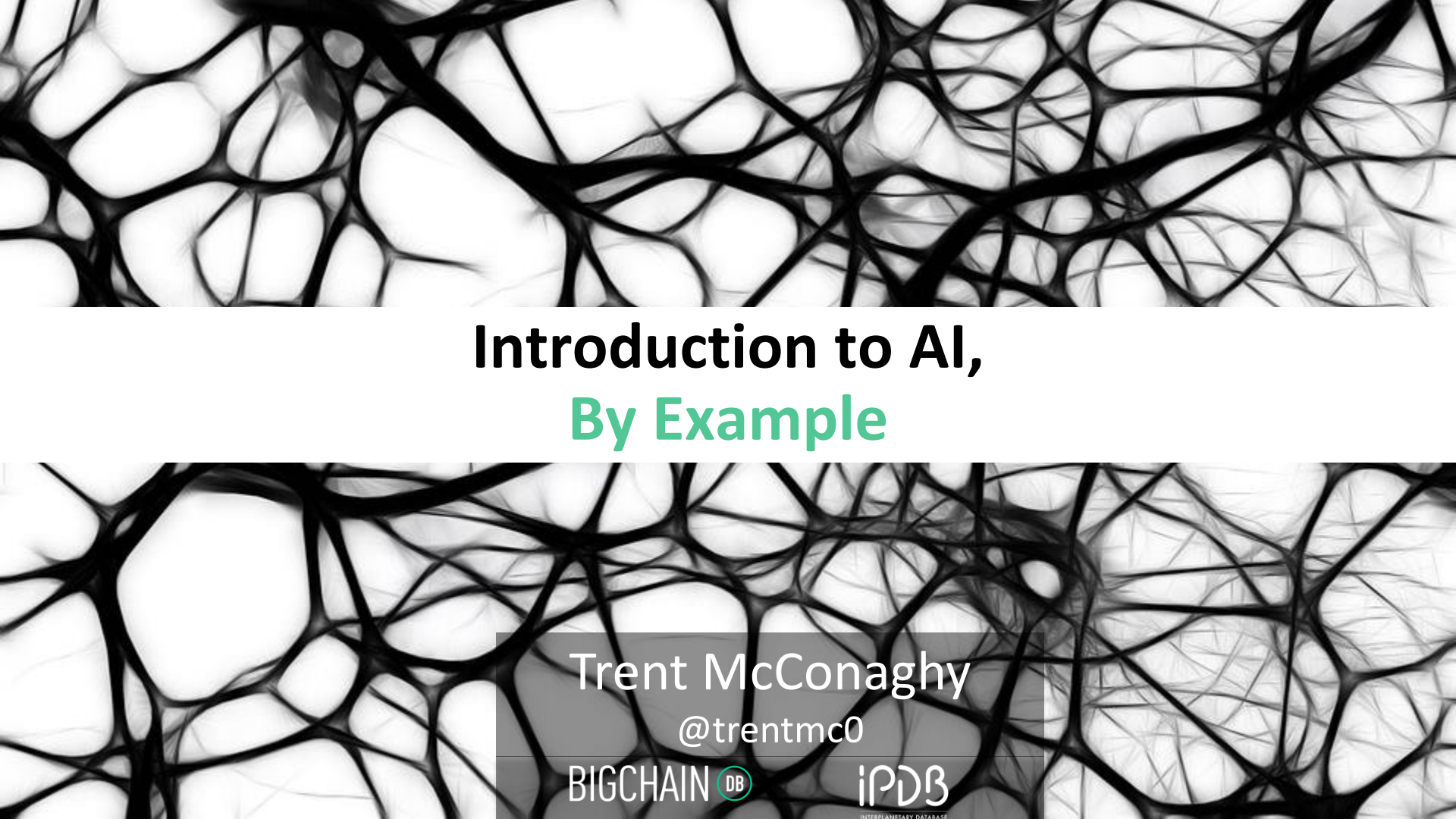


Introduction to AI,
By Example

Trent McConaghy
@trentmc0
BIGCHAIN DB
IPDB
INTERPLANETARY DATABASE

What's Artificial Intelligence (AI)?

Original:

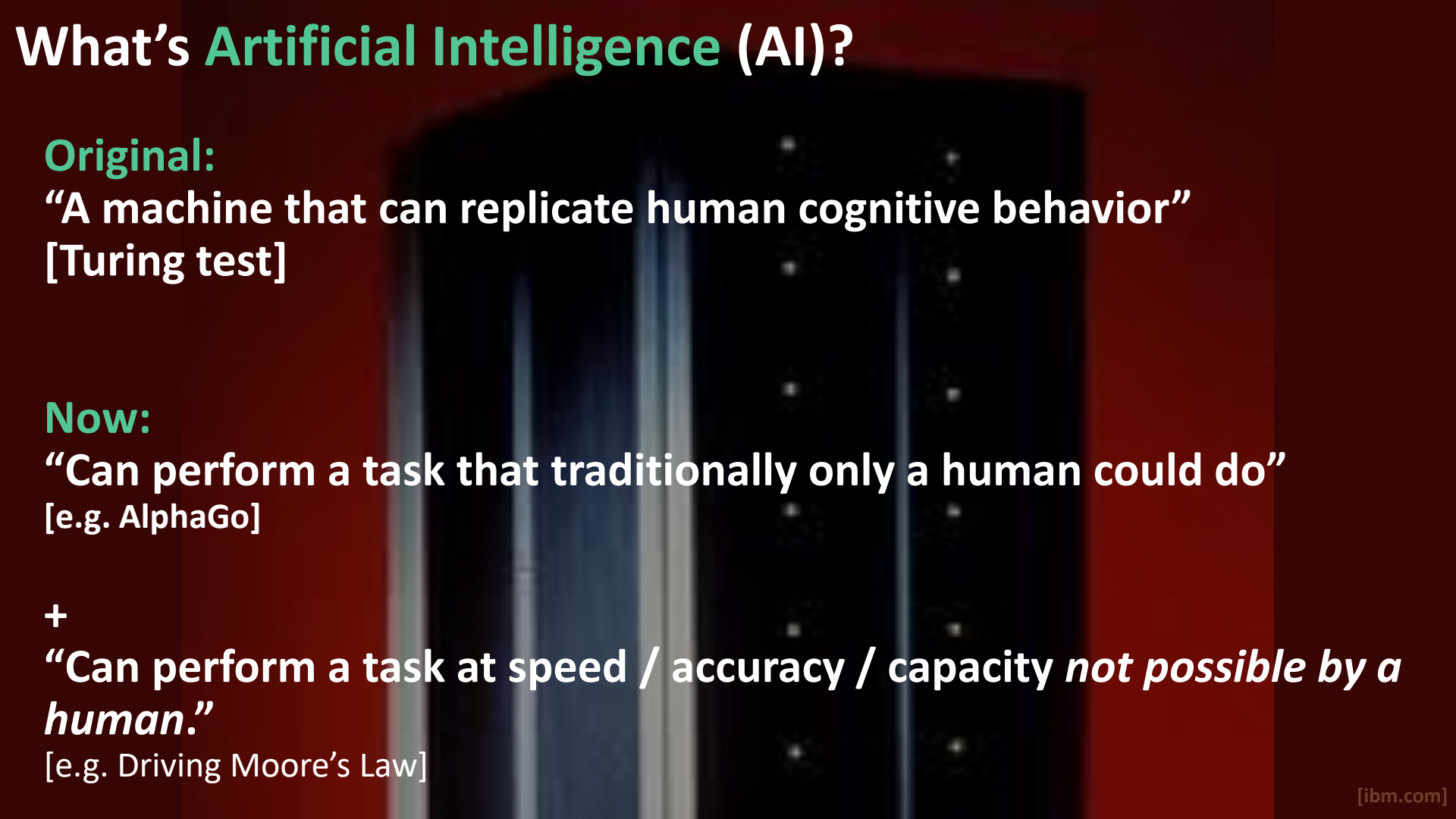
"A machine that can replicate human cognitive behavior"
[Turing test]

Now:

"Can perform a task that traditionally only a human could do"
[e.g. AlphaGo]

+

"Can perform a task at speed / accuracy / capacity *not possible by a human*."
[e.g. Driving Moore's Law]



[ibm.com]

What's Artificial Intelligence (AI)?

AI has a toolbox of ways to solve:

- Classification
- Regression
- Knowledge extraction
- Optimization
- Structural design
- …

Example biz benefits:

- Shorter time to market
- Lower cost
- Higher yield
- New products possible

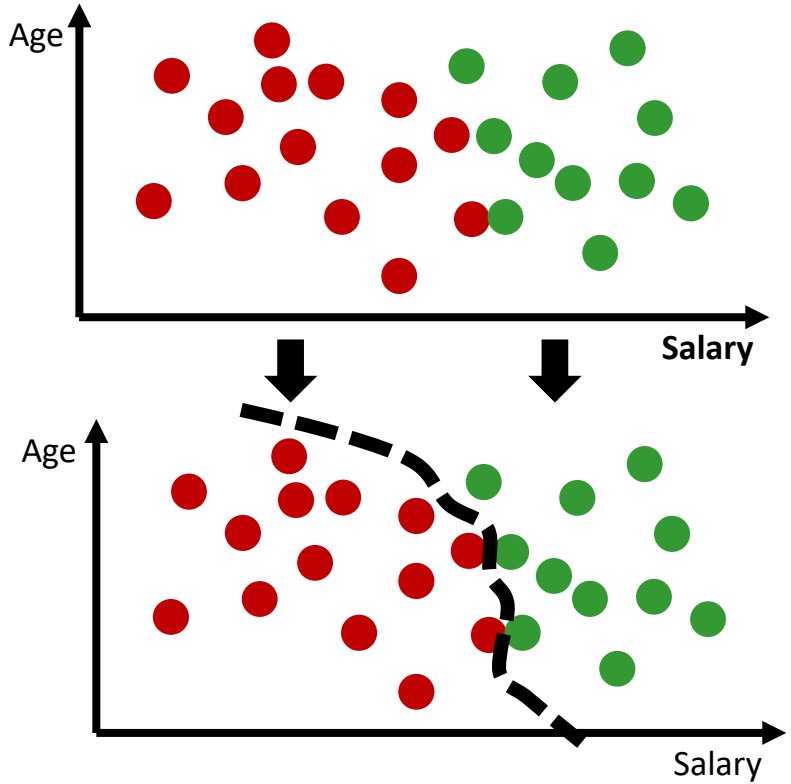
Let's explore these more…

Classification, in 2D

Use case: credit card applications

Credit profile:

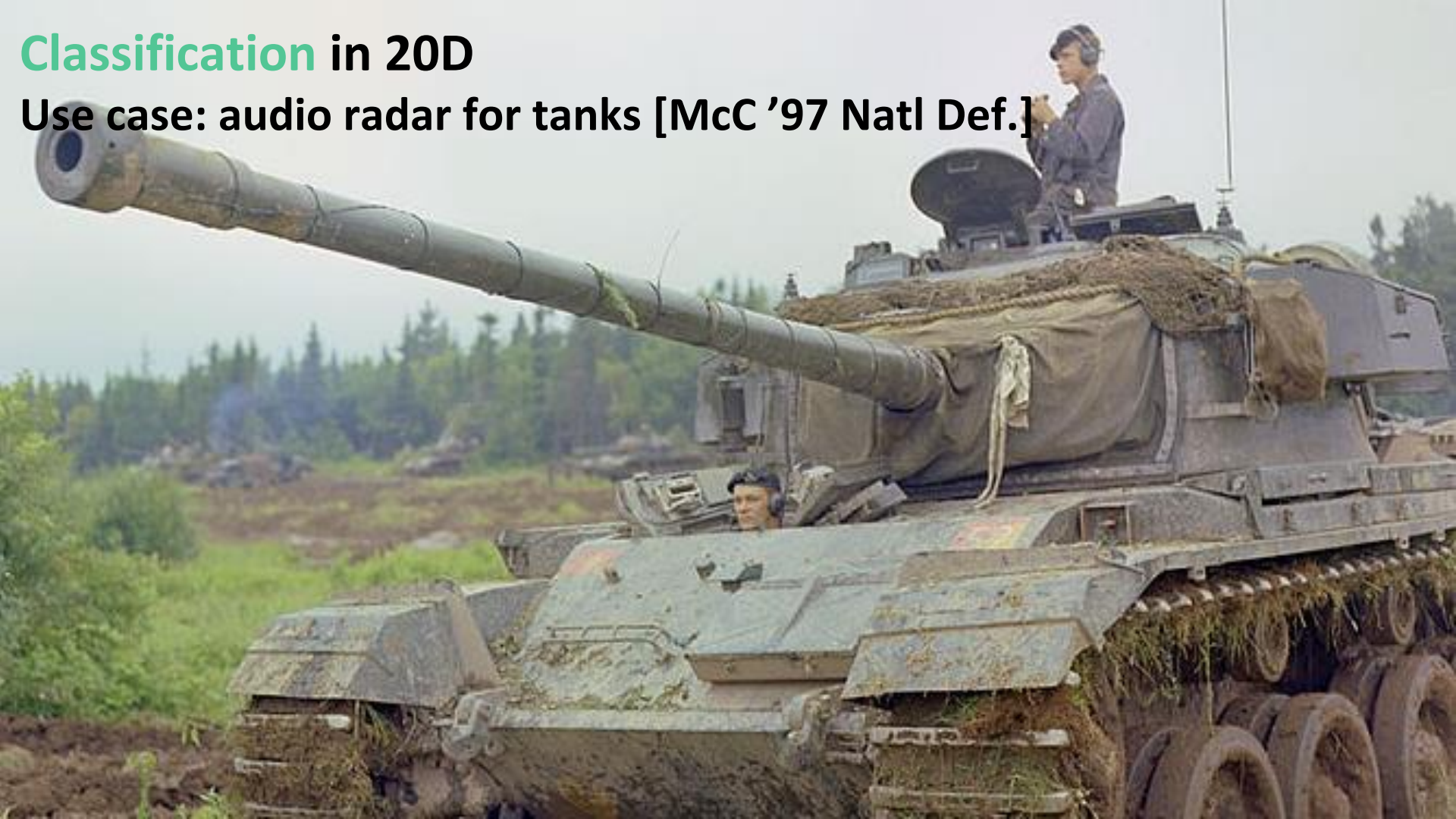
- **Paid bills**
- **Didn't pay**



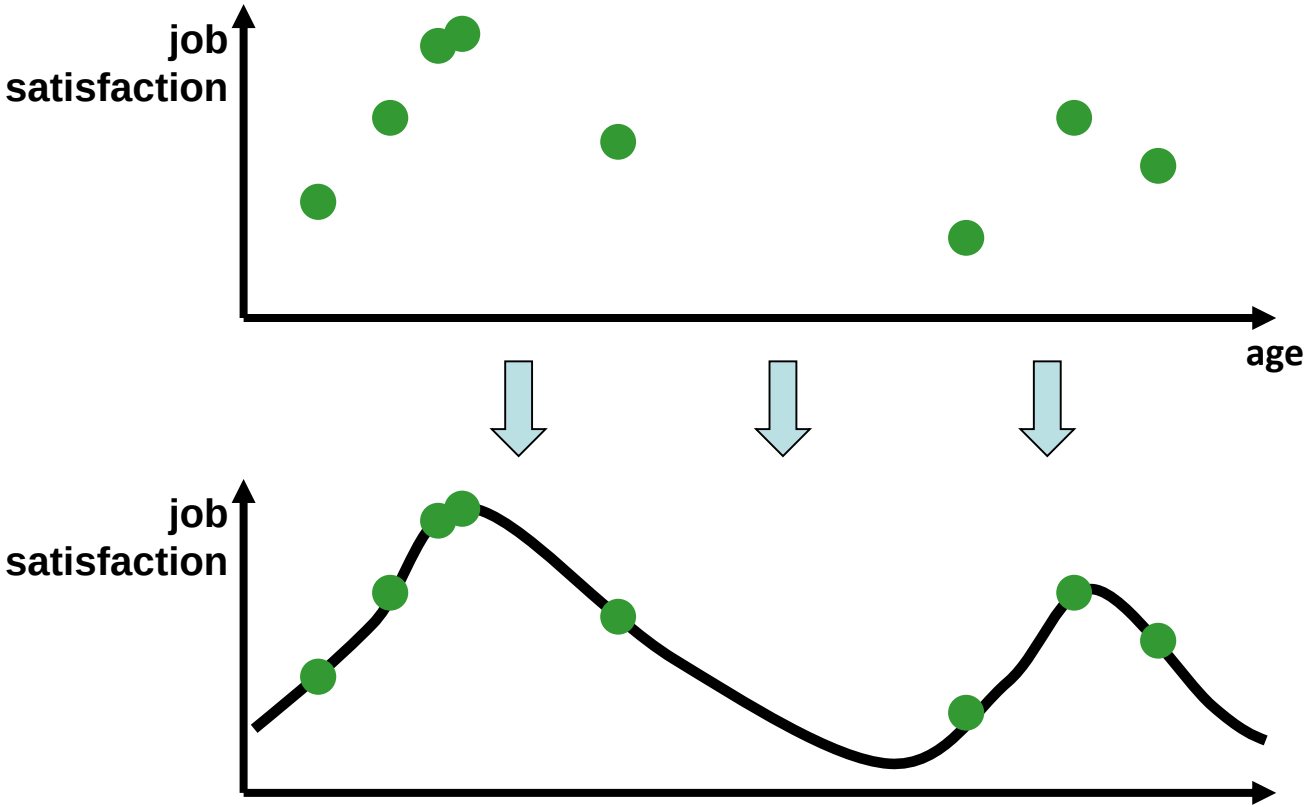
How: linear classifiers, neural networks / deep learning, support vector machines, boosted trees, random forests / bagged trees

Classification in 20D

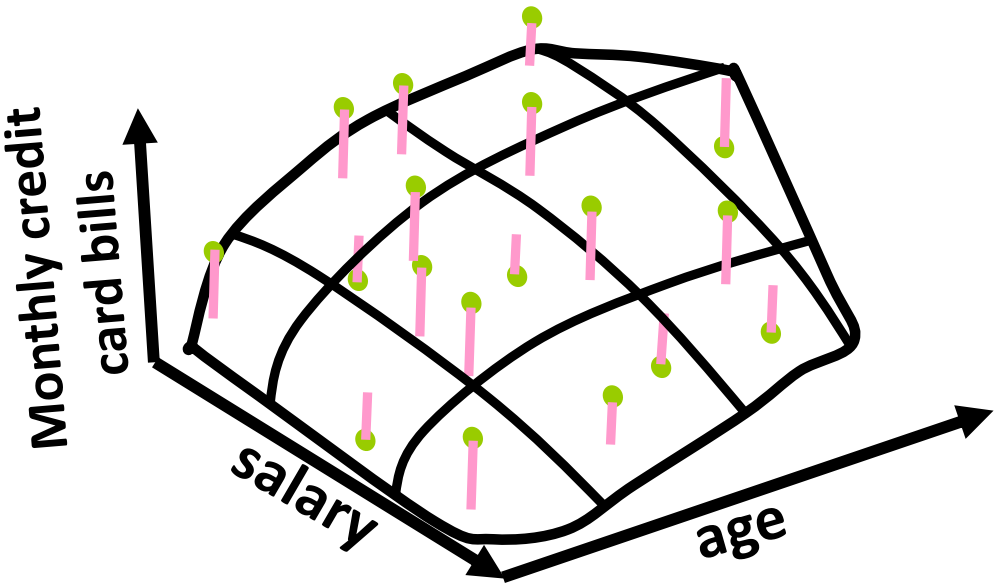
Use case: audio radar for tanks [McC ’97 Natl Def.]



Regression, in 1D

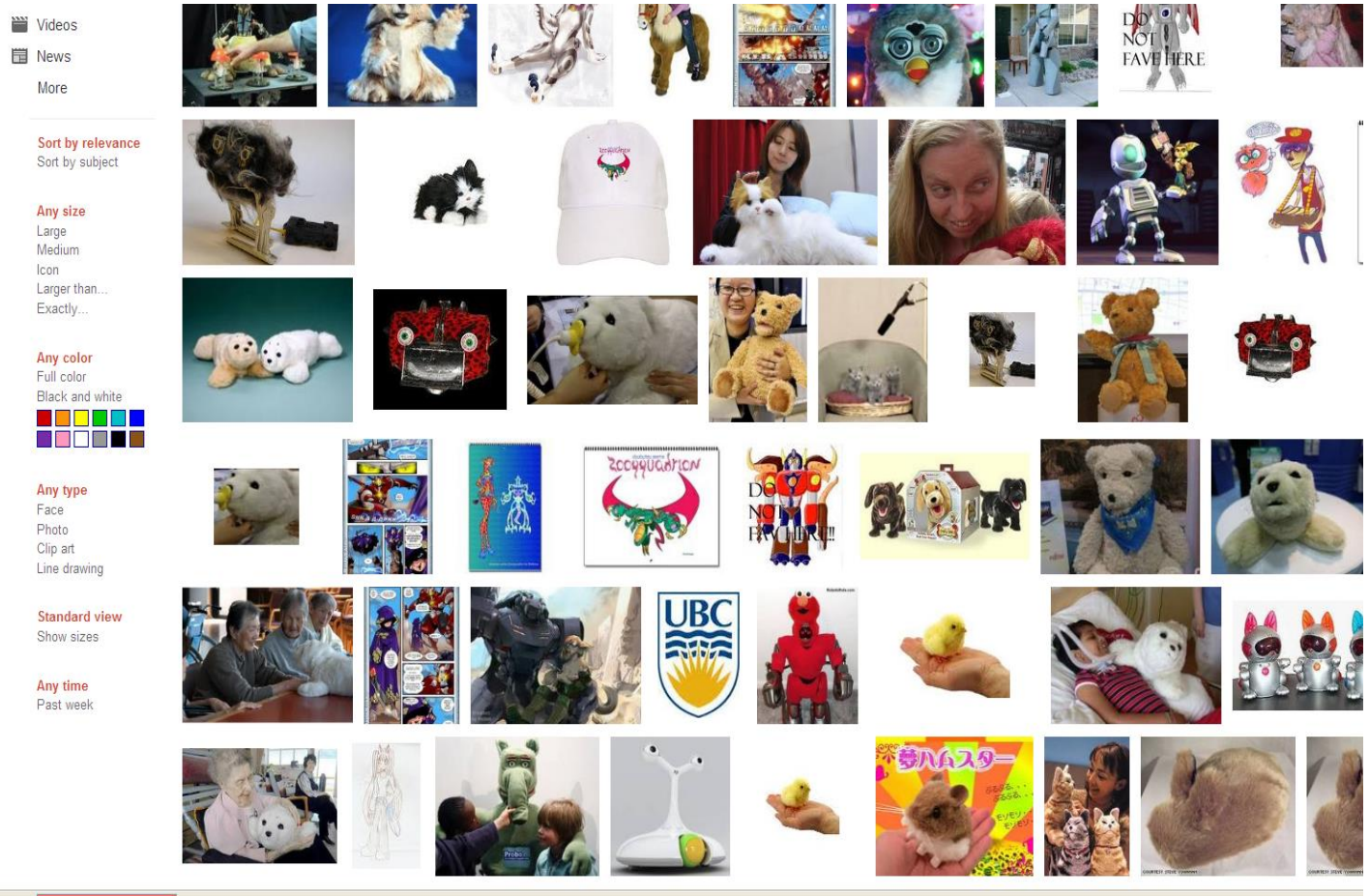


Regression, in 2D



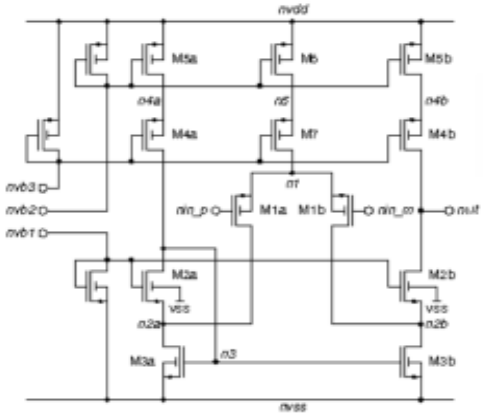
Regression in 10,000D

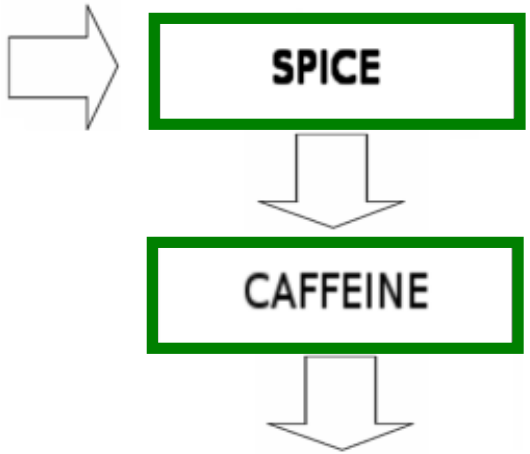
Use case: reverse image search [Google]

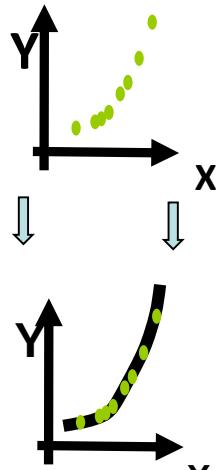


Knowledge extraction

Use case: scientific modeling of analog ccts [McC '05 KUL]



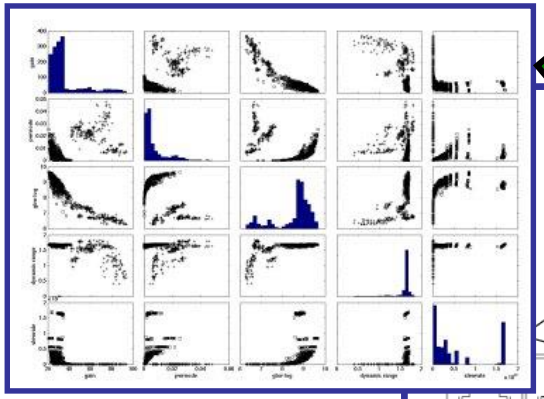


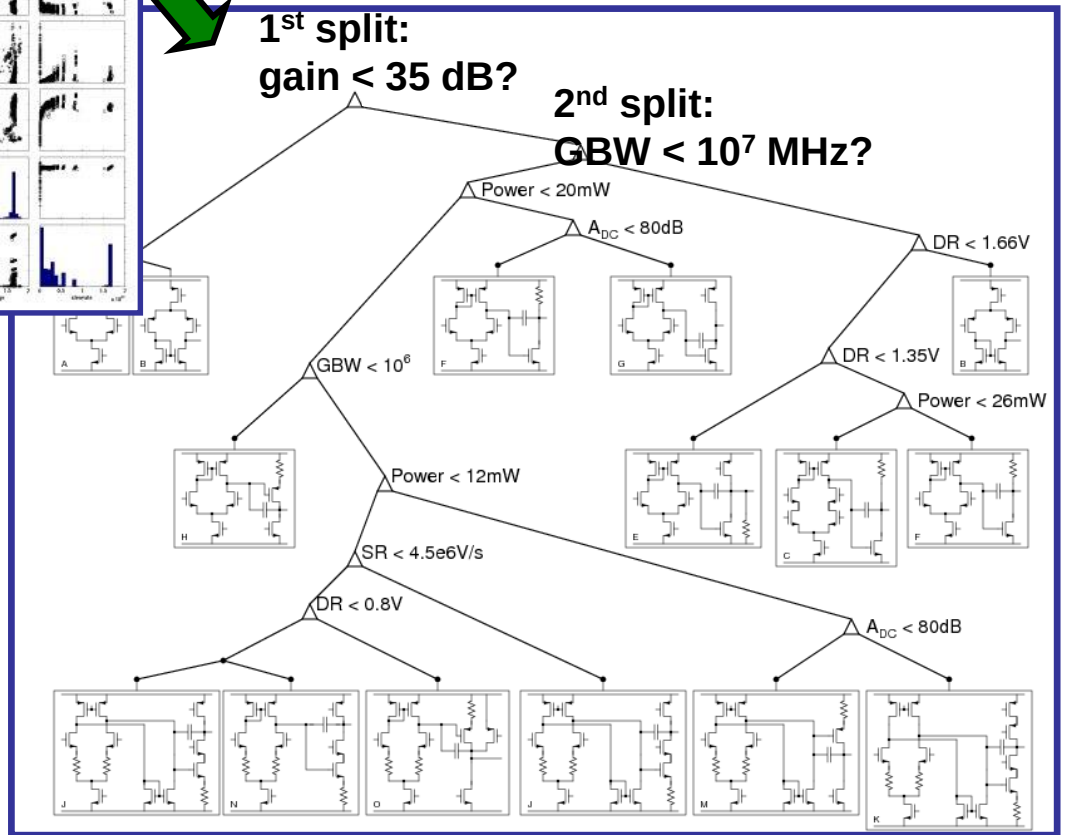


Perf.	Expression
A_{LF}	-10.3 + 7.08e-5 / id1 + 1.87 * ln(-1.95e+9 + 1.00e+10 / (vsg1*vsg3)+ 1.42e+9 *(vds2*vsd5) / (vsg1*vgs2*vsg5*id2))
f_u	10^(5.68 - 0.03 * vsg1 / vds2 - 55.43 * id1+ 5.63e-6 / id1)
PM	90.5 + 190.6 * id1 / vsg1 + 22.2 * id2 / vds2
V_{offset}	- 2.00e-3
SR_p	2.36e+7 + 1.95e+4 * id2 / id1 - 104.69 / id2 + 2.15e+9 * id2 + 4.63e+8 * id1
SR_n	- 5.72e+7 - 2.50e+11 * (id1*id2) / vgs2 + 5.53e+6 * vds2 / vgs2 + 109.72 / id1

Knowledge extraction

Use Case: Topology decision tree [McC '08 KUL]

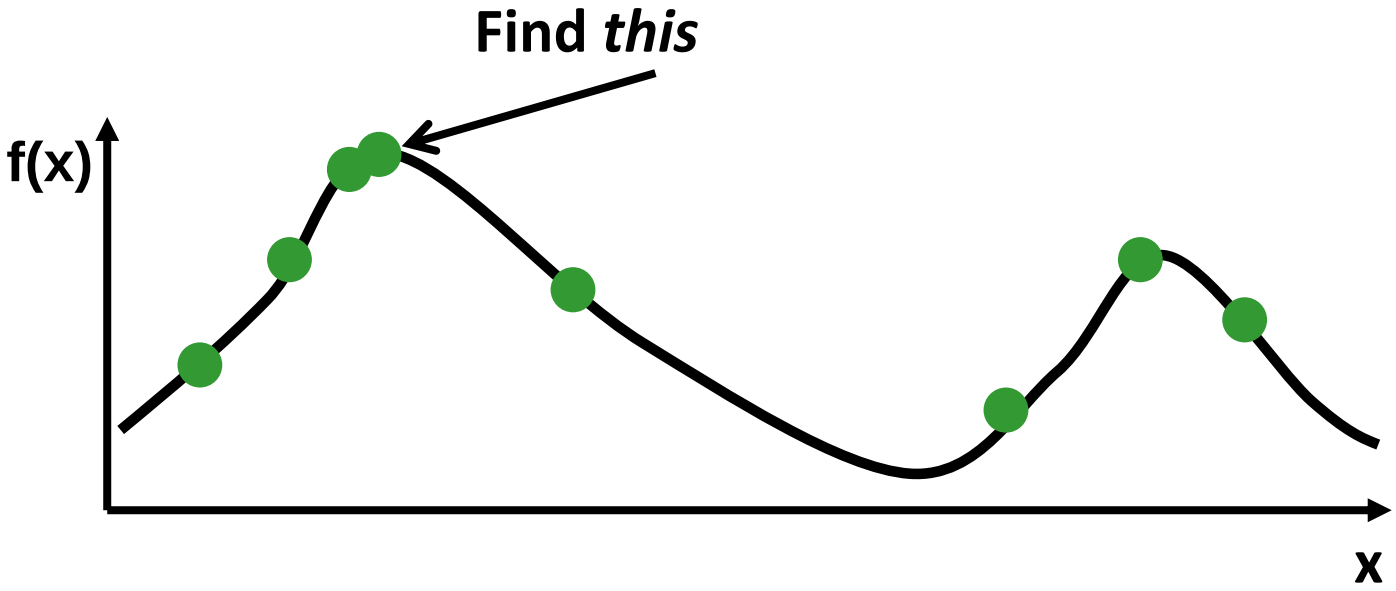




solido DESIGN AUTOMATION

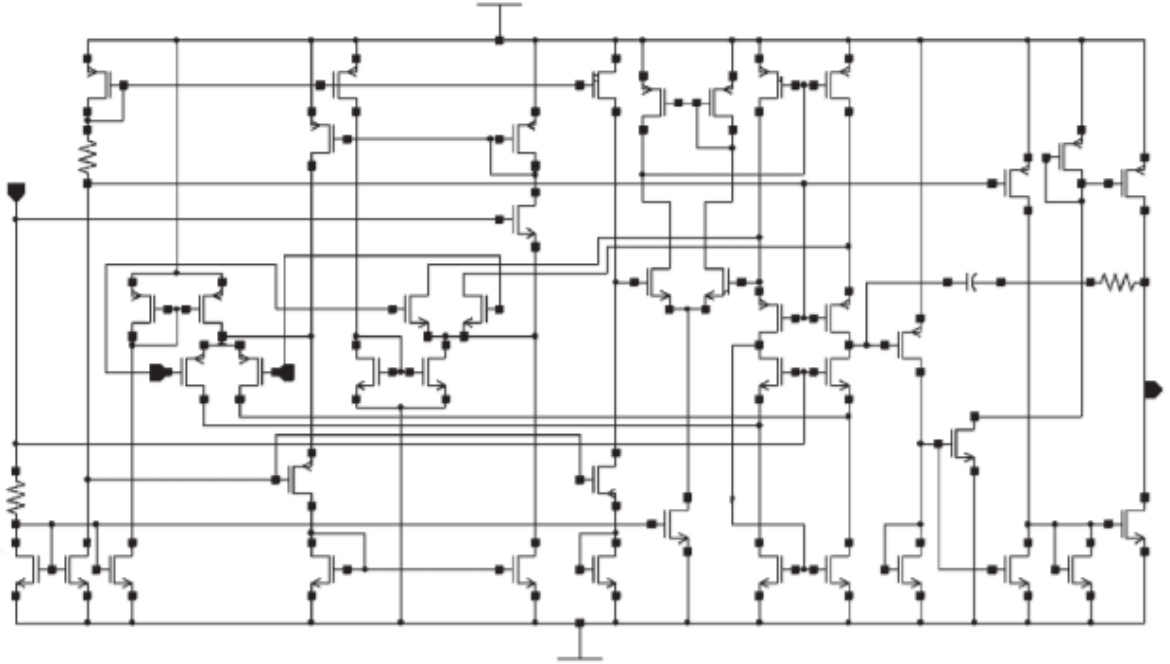
Optimization

“Find the x that maximizes f(x)”
(With as few evaluations of f(x) as possible)



Optimization

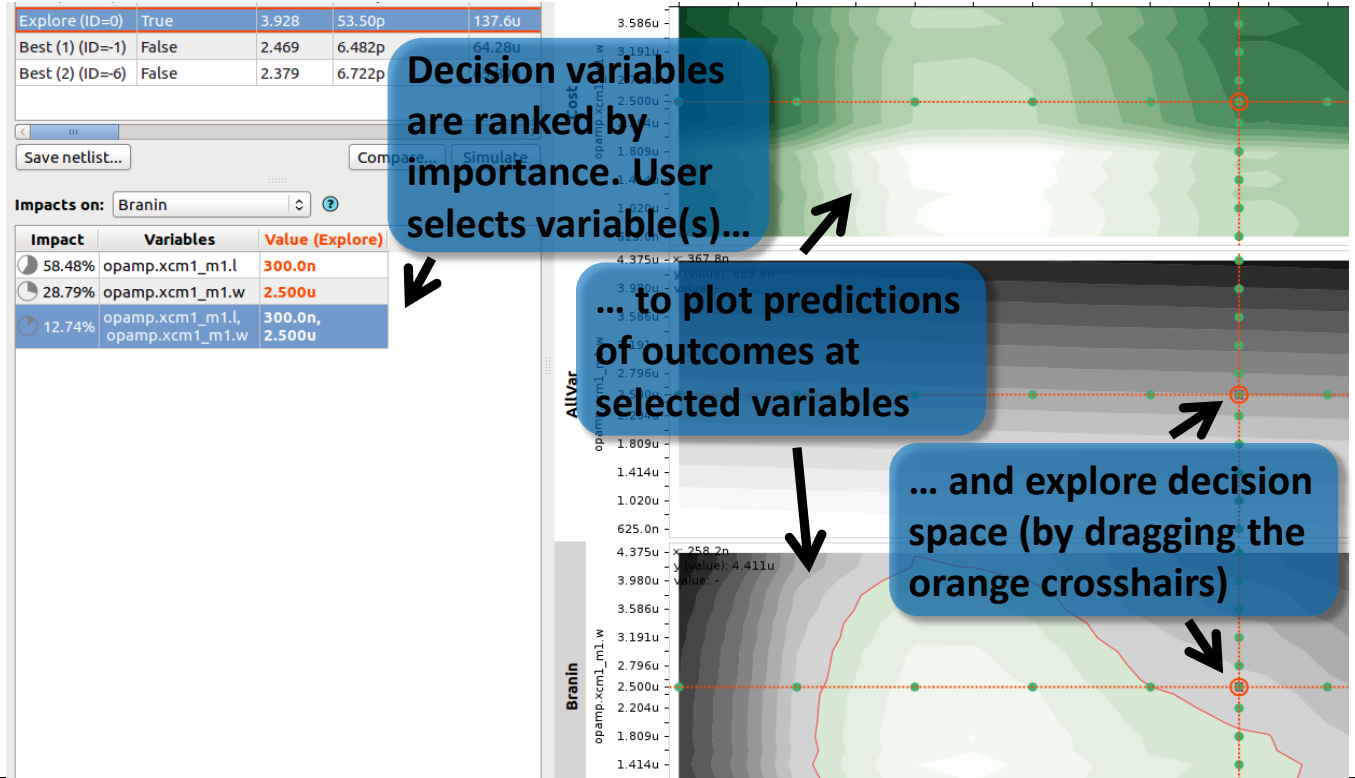
Use Case: Optimize perf. of lg. analog circuits [McC ‘01 ADA]



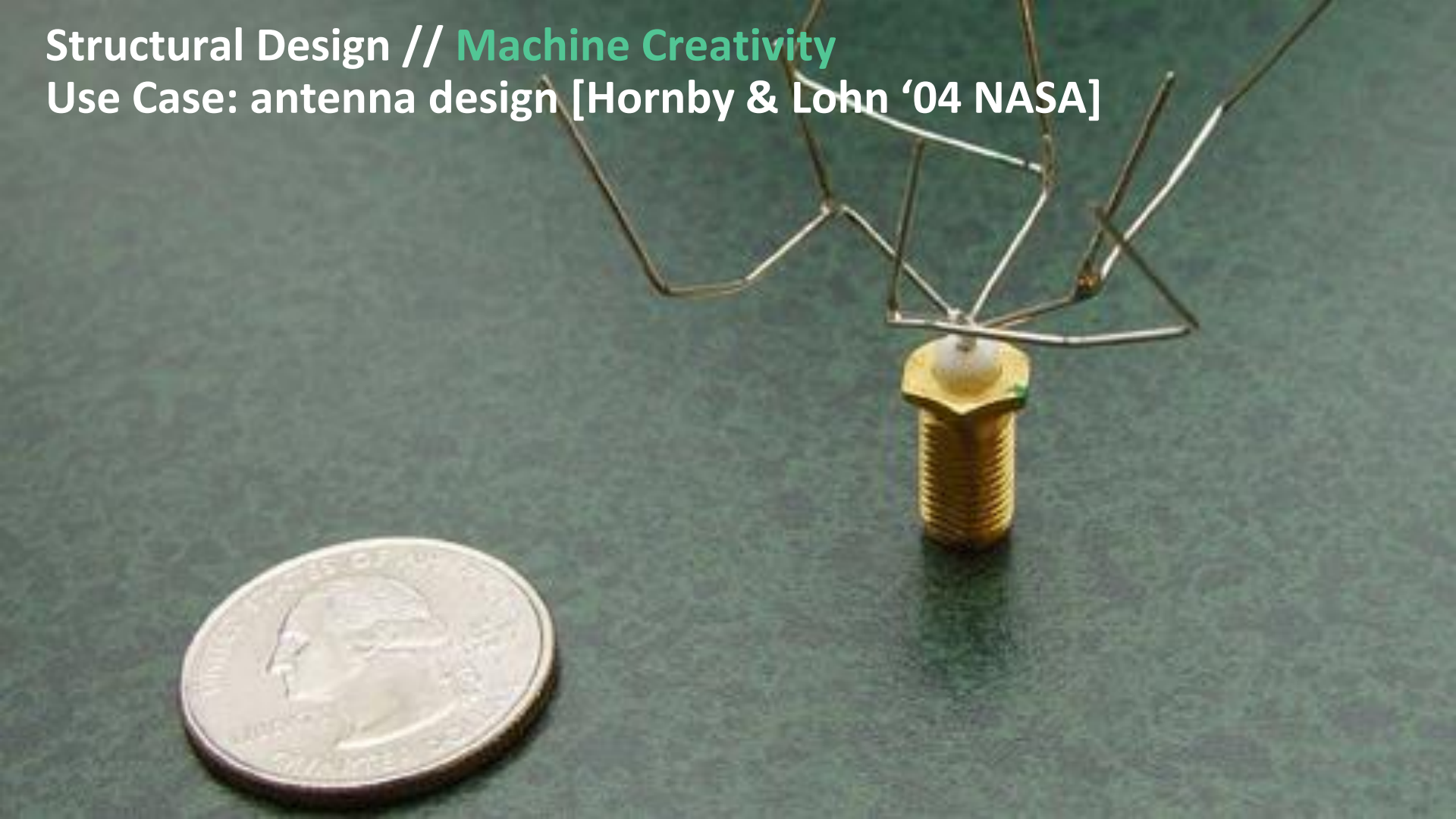
Optimization

Use Case: Interactive Circuit Design [McC ’12 Solido]

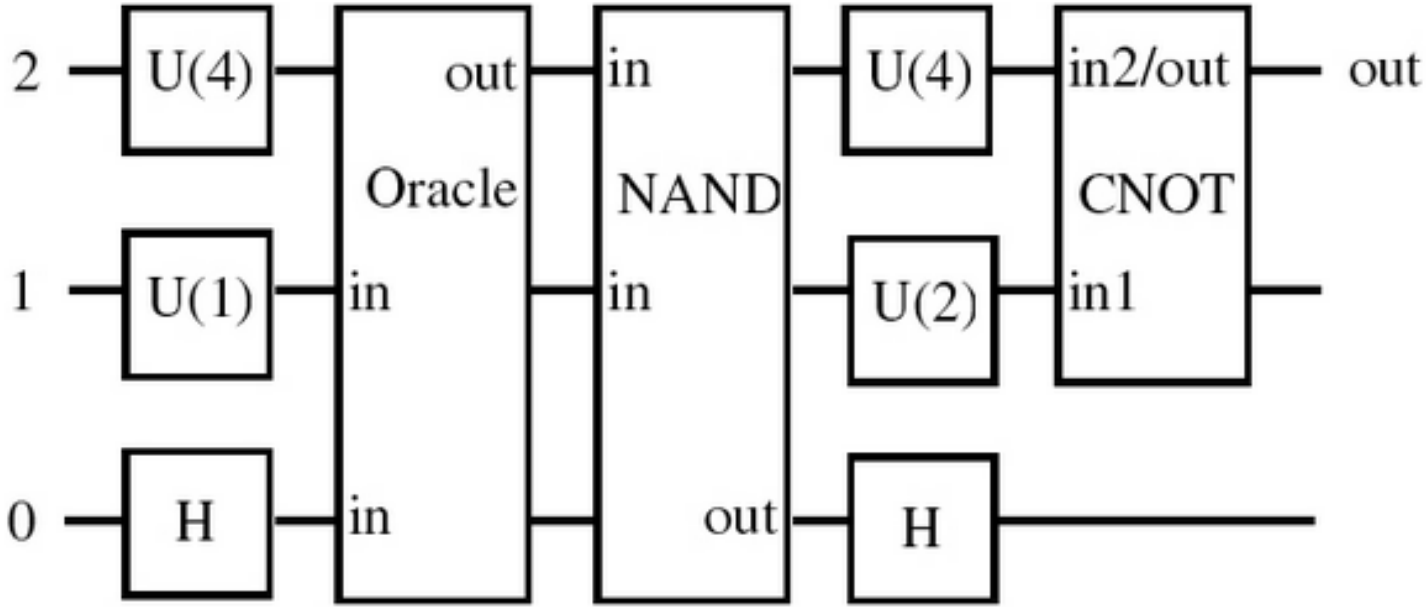
Under the hood, a machine learning engine adaptively samples the space of possible decisions, and measures outcomes.



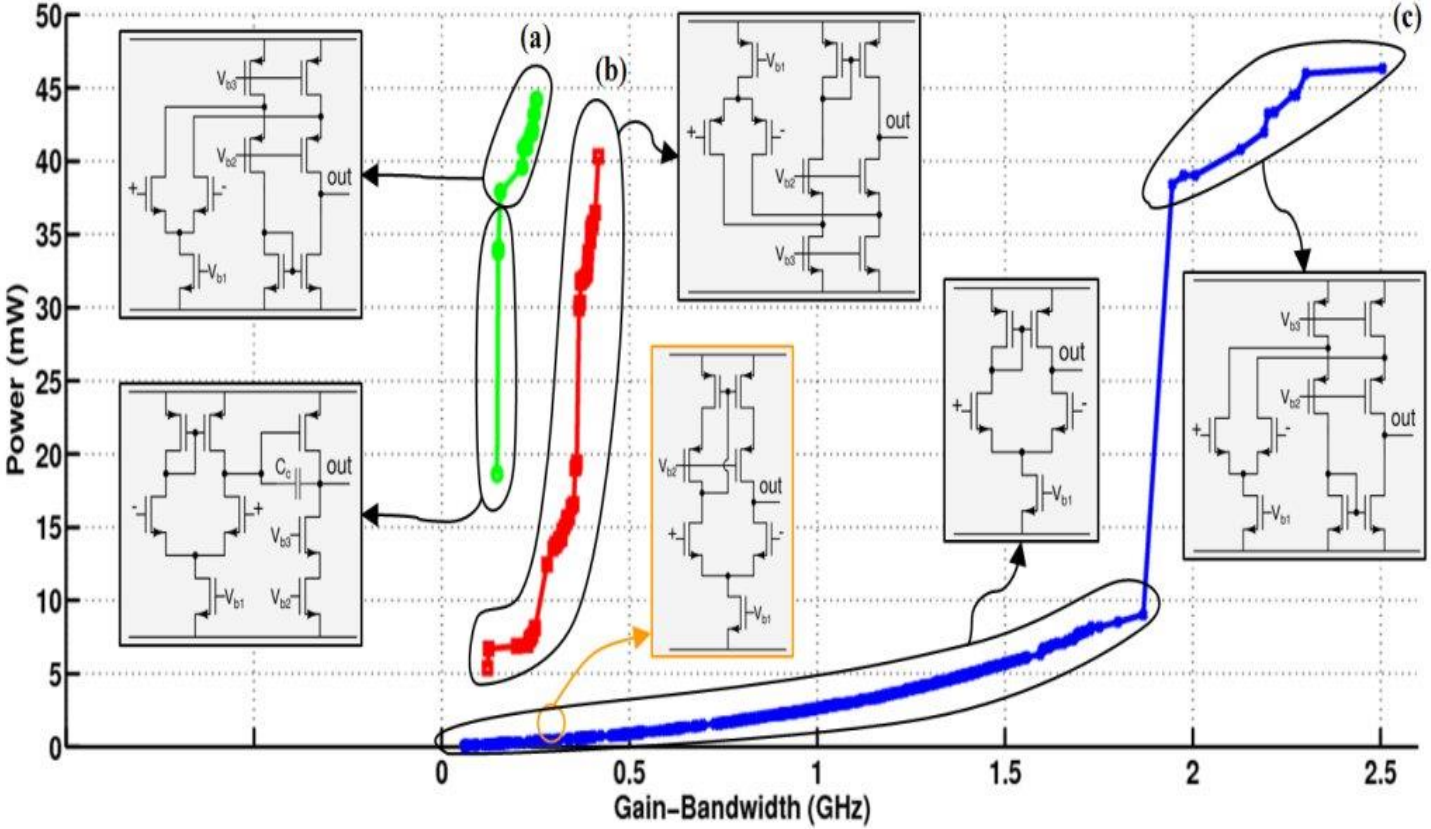
Structural Design // Machine Creativity
Use Case: antenna design [Hornby & Lohn ‘04 NASA]



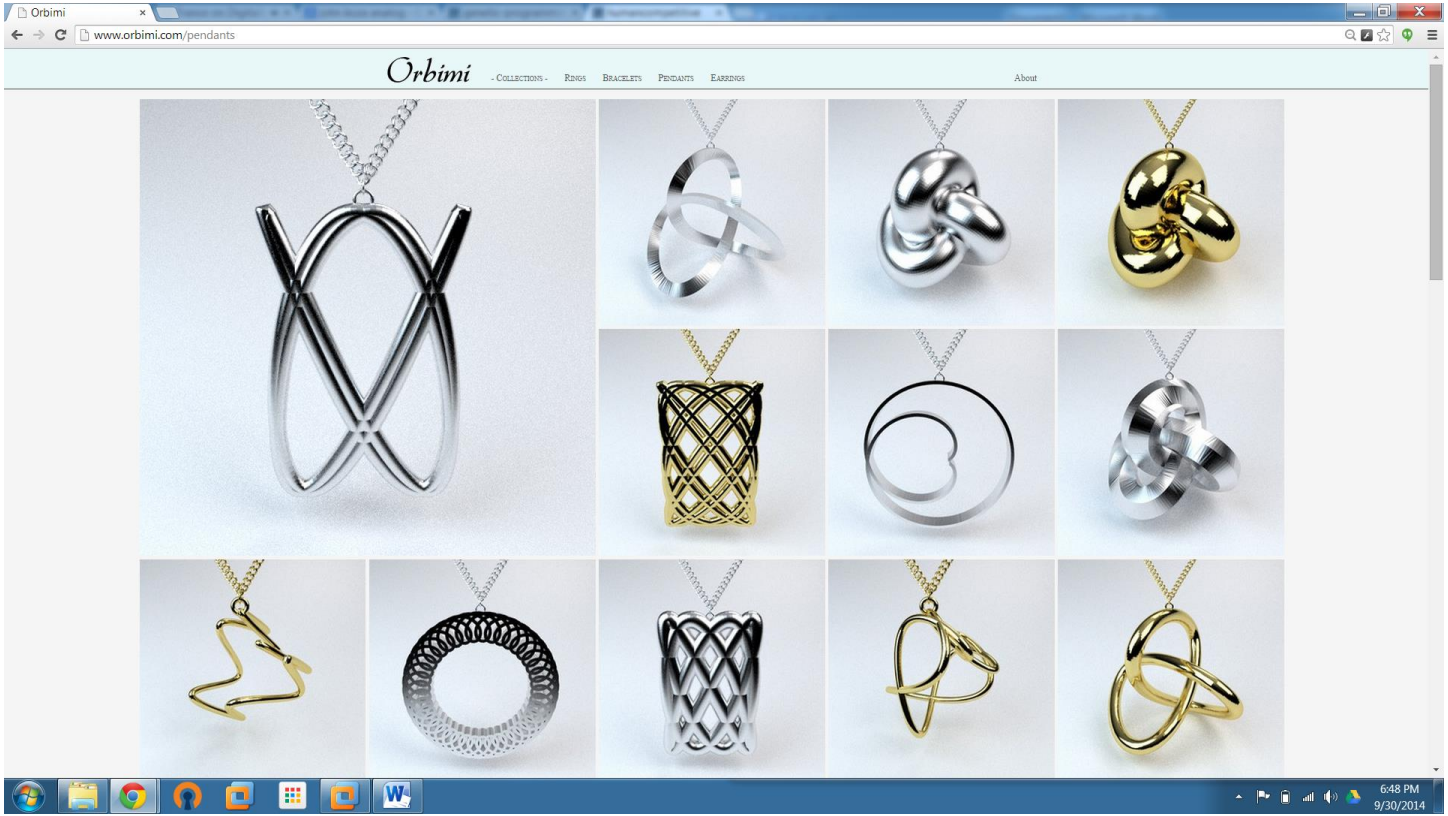
Structural Design // Machine Creativity
Use Case: quantum computing algorithm design [Spector ’04]



Structural Design // Machine Creativity
Use Case: circuit topology design [McC '06 KUL]



Structural Design // Machine Creativity
Use Case: jewelry design [Hornby ‘11 Orbimi]



Machine Creativity:
Art via genetic programming


Machine Creativity:
Art via deep learning – deep dreams

Machine Creativity:
Art via deep learning - style transfer

AGI: Artificial *General* Intelligence

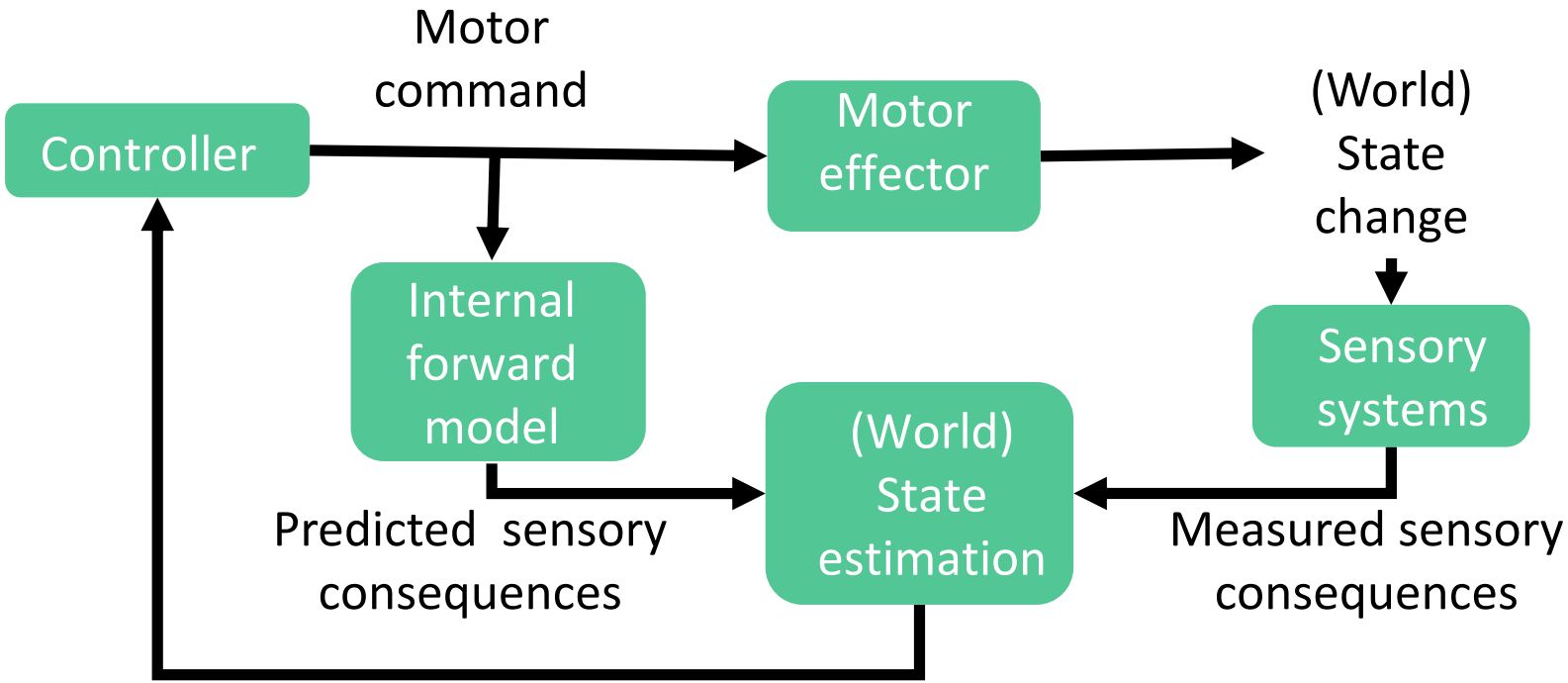
Microsoft will now let anyone test their AI creations in Minecraft

By Russell Brandom on July 8, 2016 10:36 am Email @russellbrandom

AGI: Artificial General Intelligence

"AI meets Feedback Control Systems"

Update internal state based on estimate of world state



Recap so far

AI has a toolbox of ways to solve:

- Classification
- Regression
- Knowledge extraction
- Optimization
- Structural design
- …

Example biz benefits:

- Shorter time to market
- Lower cost
- Higher yield
- New features possible

AI Sub-Fields

- machine learning
- neural networks / deep learning
- evolutionary computation (GAs, GP, ES, ..)
- swarm algorithms (ACO, PSO, ..)
- artificial general intelligence (AGI)

Strong relations to:

- statistics ("ML *is* modern statistics"), probability
- linear algebra ("flow of tensors" – TensorFlow)
- nonlinear programming, optimization
- control systems / cybernetics
- Monte Carlo methods
- philosophy, ethics (friendly AIs, AI rights, ..)