

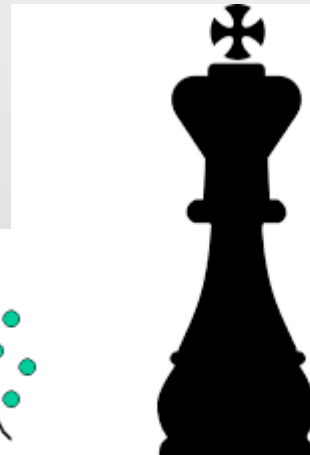
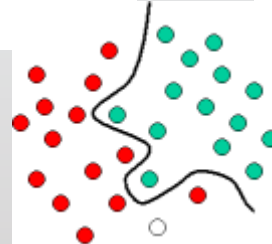
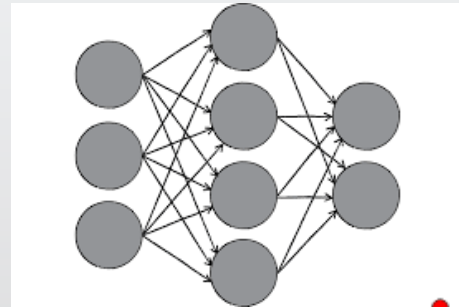
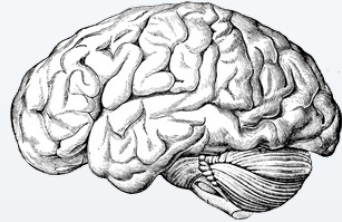
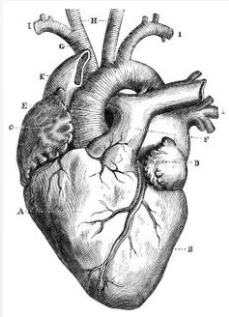
Can AI replace programmers?

Frances Buontempo

Yes

But...

What is AI?



What is AI?

- Coined by John McCarthy in 1955
- **“Reproduce human intelligence electronically”**
- Later said in 2004
- **“the science and engineering of making intelligent machines, especially intelligent computer programs”**
- Turing asked in the 1950s
- **“Can machines think?”** (c.f. the Turing test)
- What is intelligence?

What is Machine Learning?

Arthur Samuel coined the term in 1959:

Machine learning is a

"Field of study that gives computers the ability to learn without being explicitly programmed"

Playing Games

Samuel believed “teaching computers to play games was very fruitful for developing tactics appropriate to general problems”

Use a scoring function (**feedback**) to choose moves, and this can change over time (**iteration**)



augment

Computers
helping
people

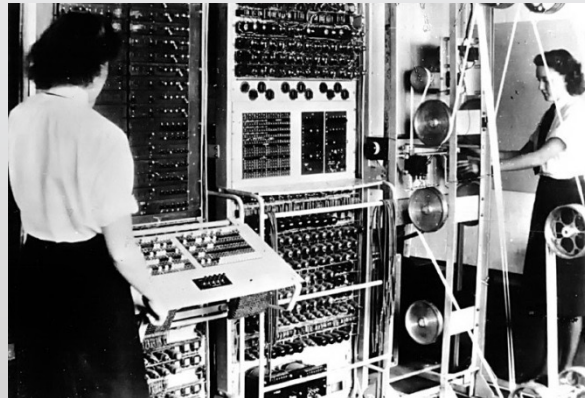
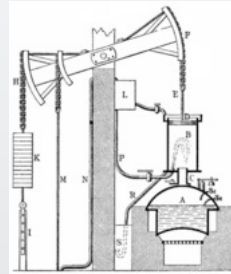
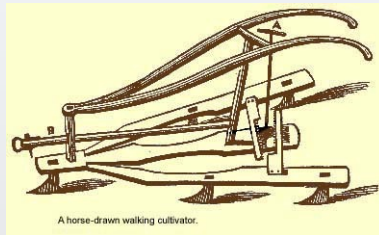


automate

Computers
replacing
people

Automate everything!

- Steam engines, electricity, computers
 - Faster -> smarter
- **Automatic != intelligence**



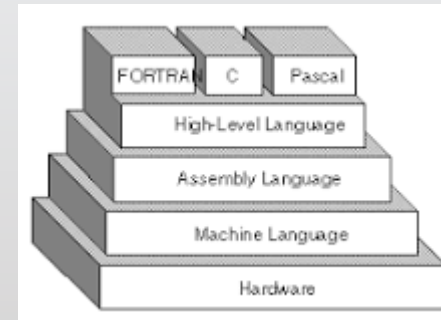
Automate everything?

- Chat bots; remember Tay?
 - “AI systems feed off of both positive and negative interactions with people.”
- Prisoner sentence length
 - “... several statistical and technical **errors** such as mis-specified regression models, mis-defined classification terms and measures of discrimination, the incorrect interpretation and use of model errors, ...”
- Automated inference on criminality using face images
 - “discriminating structural features for predicting criminality”
- Pictures
 - Gorilla blunder
- Words
 - father: doctor, mother: nurse,
 - man: computer programmer, woman: home-maker



Garbage In -> Garbage Out
Bias In -> Bias Out

Augment everything

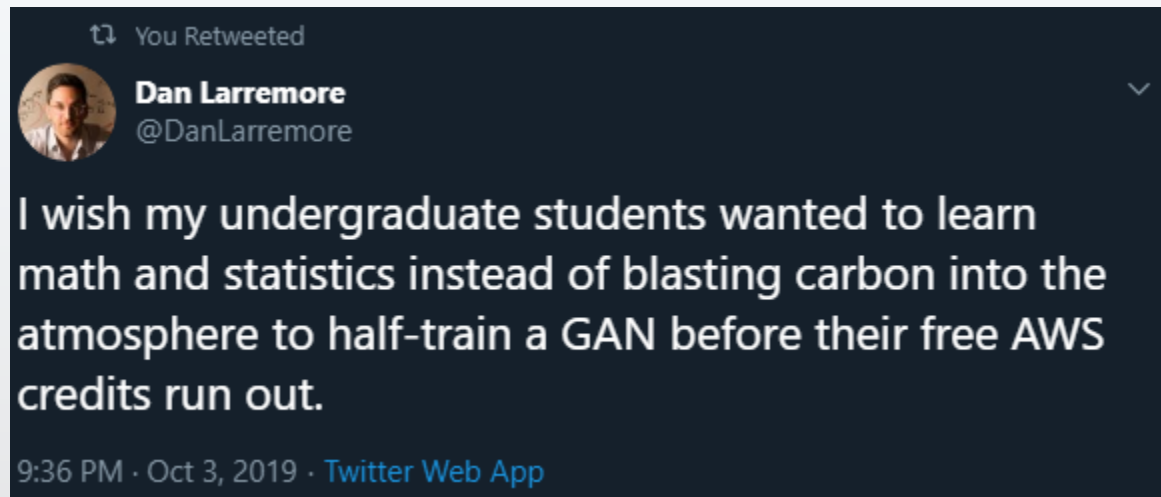


Automation is a Good Thing

- Sometimes
 - Automatic doors
 - CI, deployment scripts, ...
- But
 - Automatic taps?
 - Automatic flushing toilets?
 - Self-driving cars?!



Automation has a carbon footprint

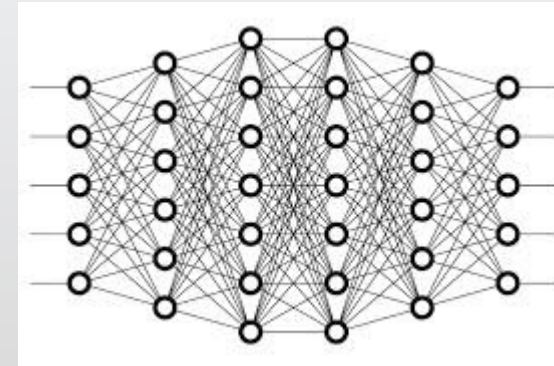


Automation is useful

- Automatic formatters
- ORM libraries
- Compilers

**Programmers rely on their computers
to do a lot of work for them already**

Automation is not AI



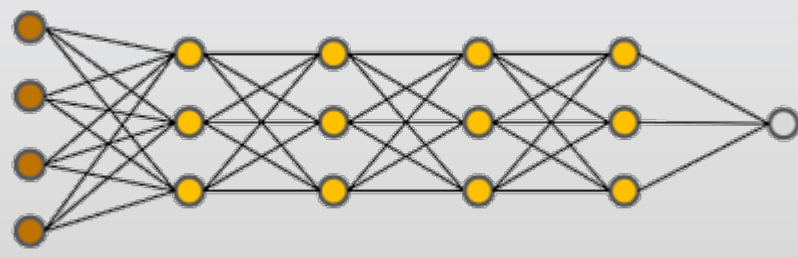
Automate what we already do?

- OK, but also, bias
- Sexist recruitment AI:
 - penalized resumes that included the word “women’s,” as in “women’s chess club captain.”
 - And it downgraded graduates of two all-women’s colleges

**If you automate what you do now,
will anything ever change?**

Build a brain and it will think

- Do deep learning neural networks think or learn?
- Could they pass the Turing test?
- How many cat and dog images do they need as training data?
- Do they enjoy playing Go?



Draughts, Chess, Go,...

- Brute force examining all (or most) possible moves
- But what if there might be 10^{170} possible moves?
- Alpha Go **“learnt by playing against itself, starting from completely random play”**
 - <https://deepmind.com/research/case-studies/alphago-the-story-so-far>



What is AI?

While not Done

Try a few things at random

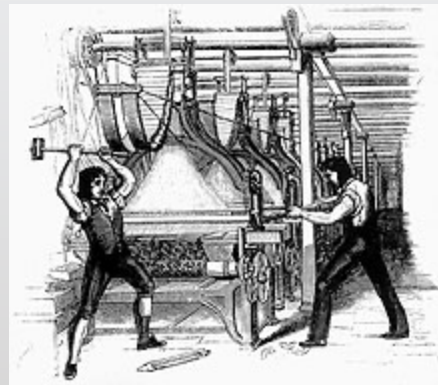
Possibly in conjunction with a heuristic

Test these

Remember the better things

Can AI replace people?

- Can machines replace people?
- Luddites “protesting against the use of machinery in a **fraudulent and deceitful manner**” to get around standard labour practices”



Can AI replace programmers?

- Can AI code?
- Can a machine generate code for Fizz Buzz?
- Let's see...

Fizz Buzz

- 1
- 2
- Fizz
- 4
- Buzz

- Fizz
- 7
- 8
- Fizz
- Buzz

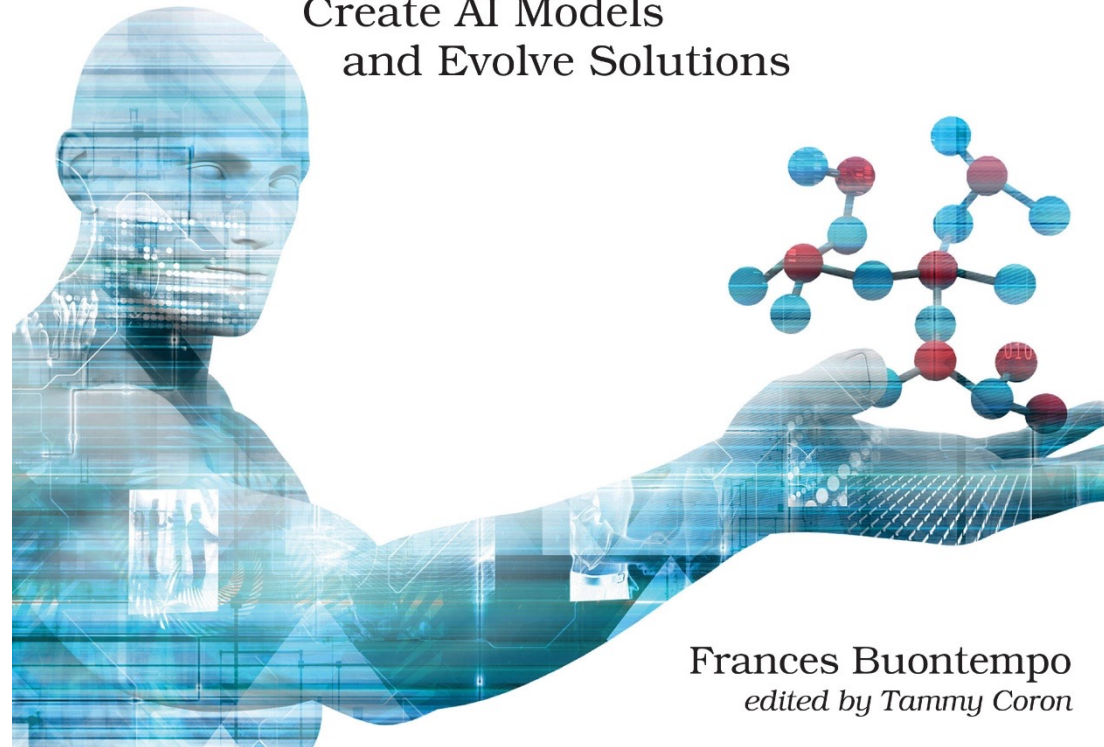
- 11
- Fizz
- 13
- 14
- FizzBuzz ...

Can AI code FizzBuzz, automatically?

- Yes, using **genetic programming** to generate a syntax tree for a language.
- Based on **genetic algorithms**, which finds an optimal list/array of values.
 - Find several randomly
 - Test them
 - Pick a few better ones, and form new arrays
 - Maybe mutate a few values
 - Iterate

Genetic Algorithms and Machine Learning for Programmers

Create AI Models
and Evolve Solutions



Frances Buontempo
edited by Tammy Coron

Genetic algorithms

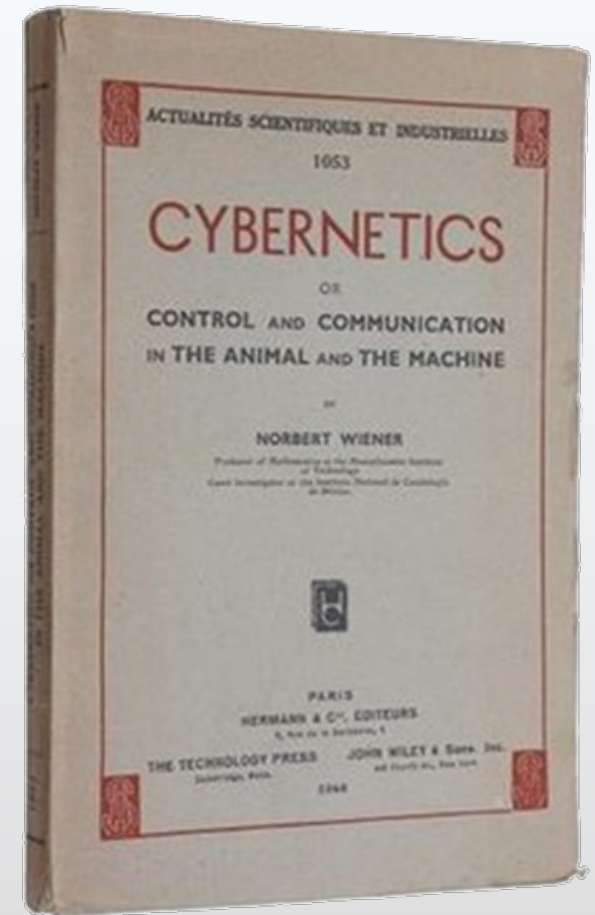
Evolution:

Driven by a **feedback mechanism** caused by the success or otherwise in surviving and reproducing; and modifications of behaviour over a lifetime in response to experience.

https://en.wikipedia.org/wiki/Cybernetics:_Or_Control_and_Communication_in_the_Animal_and_the_Machine

Cybernetics

“Norbert Wiener is credited as being one of the first to theorize that **all intelligent behavior was the result of feedback mechanisms,** that could possibly be simulated by machines and was an important early step towards the development of modern AI”



What is a genetic algorithm?

Generate some random arrays

While not Done

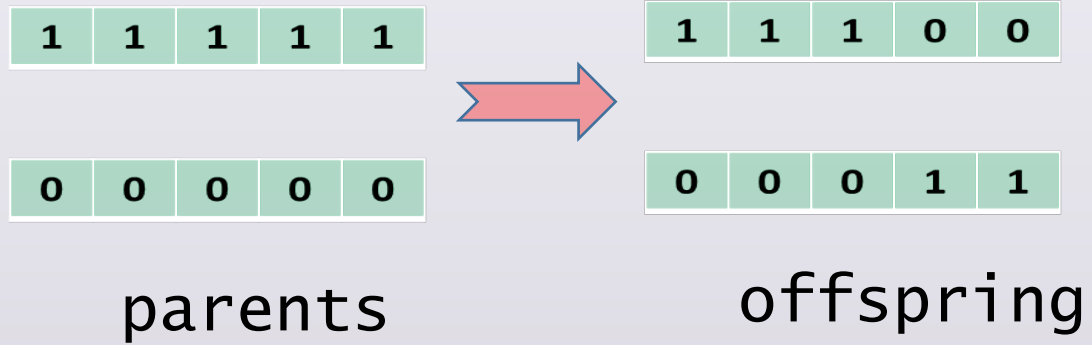
 Test these

 Choose some better ones

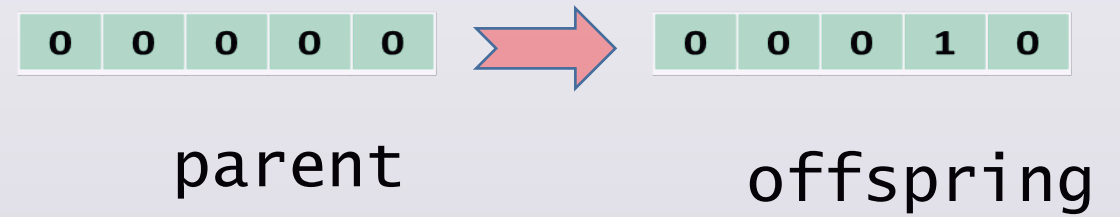
 and create new arrays by crossover

 Maybe mutate a few arrays a bit

Crossover



Mutation



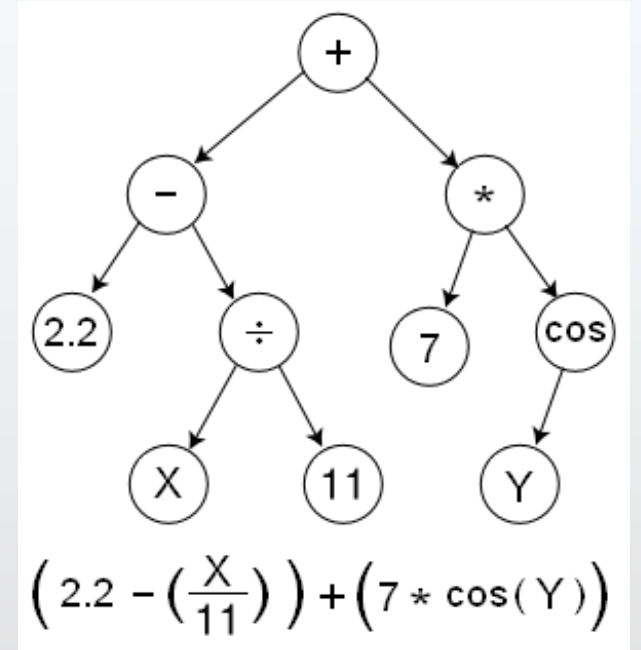
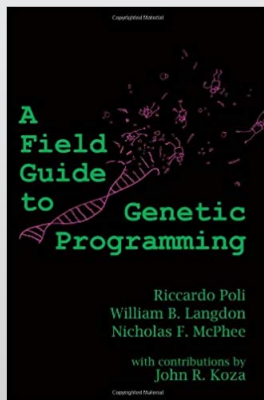
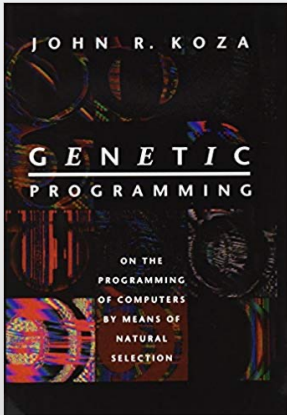
Genetic Programming (GP)-evolution of a tree structure

Evolves the ‘innards’ (white box) of a function or expression

Each tree node is an *operator* or *variable*, or a *terminal node*.

Used widely to evolve functions for

- Curve fitting
- Circuit board design
- Data modelling
- Symbolic regression
- Feature selection
- Classification



https://en.wikipedia.org/wiki/Genetic_programming#/media/File:Genetic_Program_Tree.png

What is genetic programming?

Generate some random trees

While not Done

Test these

Choose some better ones

and create new trees by crossover

Maybe mutate a few trees a bit

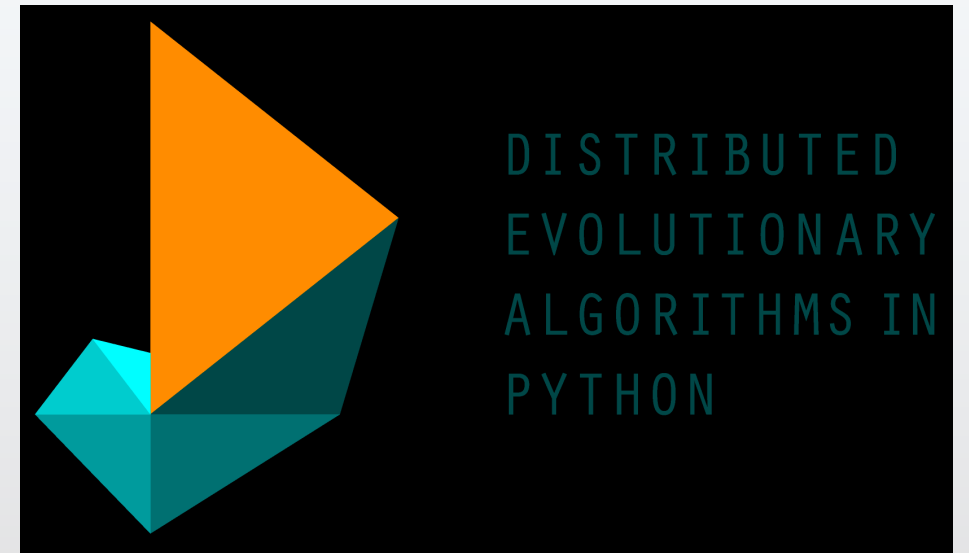
*every result is 'Fizz', 'Buzz', 'FizzBuzz' or a decimal string,
every decimal result corresponds to its ordinal position,
every third result contains 'Fizz',
every fifth result contains 'Buzz',
every fifteenth result is 'FizzBuzz',
the ordinal position of every 'Fizz' result is divisible by 3,
the ordinal position of every 'Buzz' result is divisible by 5,
the ordinal position of every 'FizzBuzz' result is divisible by 15*



Tests are feedback for AI

DEAP <https://github.com/DEAP/deap>

- Have to choose operators/functions
- Choose parameters
 - How many trees
 - How often it recombines
 - How often it mutates
- It keeps track of the best
 - AKA the Hall of Fame
- It took days to get 100% test passes!



The Hof

```
if_then_else(mod15(if_then_else(if_then_else(mod15(x,
'FizzBuzz'), 'Fizz', 'Buzz'), x, if_then_else('Buzz',
'FizzBuzz', mod3(x))))), 'FizzBuzz',
if_then_else(both(if_then_else(if_then_else(mod15(x),
either('FizzBuzz', 'FizzBuzz'), 'FizzBuzz'),
if_then_else('FizzBuzz', mod15(mod5(x)), 'Buzz'),
'Buzz'), if_then_else('Fizz', 'Buzz',
if_then_else('FizzBuzz',
if_then_else(if_then_else('Buzz',
if_then_else(if_then_else(mod3(x), x, 'FizzBuzz'),
if_then_else(x, x, either('Buzz', 'Buzz')), x, 'Fizz'),
'Fizz', x), if_then_else(either(if_then_else(x, x,
mod3(x)), 'FizzBuzz'), 'Fizz', 'Fizz'))),
if_then_else(mod15(x), either('FizzBuzz', either('Buzz',
x)), if_then_else(mod3(x), 'Fizz', x)), 'Buzz'))
```

The Hof(f)

```
if_then_else(mod15(if_then_else(if_then_else(mod15(x),  
'FizzBuzz'),  
'FizzBuzz'),  
if_then_else(mod15(x),  
either('Fizz',  
if_then_else(mod15(x),  
'Buzz'),  
if_then_else(mod15(x),  
if_then_else(mod15(x),  
if_then_else(mod15(x),  
'Fizz', x)),  
mod3(x)),  
if_then_else(mod15(x), either('FizzBuzz', either('Buzz',  
x)), if_then_else(mod3(x), 'Fizz', x)), 'Buzz'))
```



A human way

```
#!/usr/bin/env python

for x in range(1,101):
    s = ""
    if x % 3 == 0:
        s += "Fizz"
    if x % 5 == 0:
        s += "Buzz"
    if s == "":
        s = x
    print s
```

Writing the tests is hard

- Tests, AKA fitness or objective functions in machine learning, are
 - vital
 - hard to write
 - forming a necessary and sufficient set of tests up front is hard
- Having a **human in the loop** to allow
 - iteration,
 - Refinement
 - and change is a better alternative

Why use a high level language?

“The notion of using programs to modify programs has been around a long time. The original idea came from [John von Neumann](#) in the form of stored-program computers. But machine code modifying machine code in arbitrary ways is pretty inconvenient.”

<https://softwareengineering.stackexchange.com/questions/257266/c-metaprogramming-with-a-compiler-api-rather-than-with-c-features>

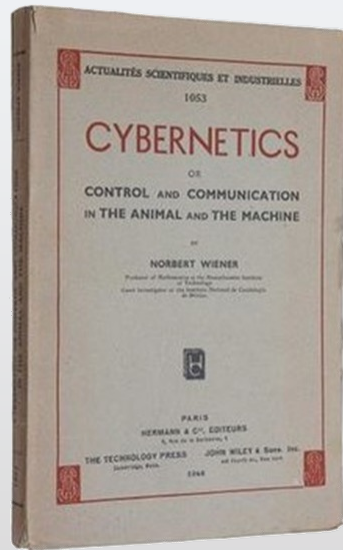
AI: Done by machines

Feedback and iteration are
recurring themes

Never forget the
“Human in the loop”

What kind of machines?

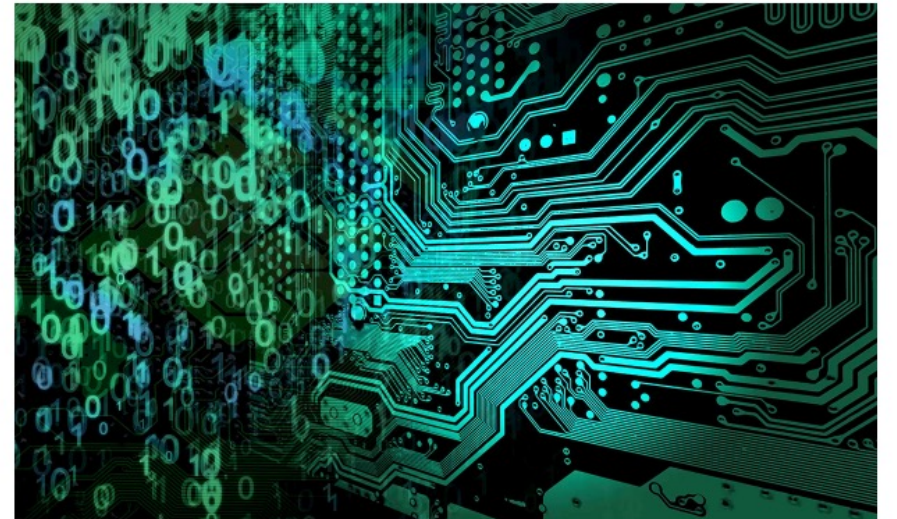
Turing said “digital computers”, but now
AI can code, and design hardware



Startup JITX Uses AI to Automate Complex Circuit Board Design

AI has the potential to take much of the dull complexity out of designing custom circuit boards

By Evan Ackerman



Hardware

- Does AI need a “physical body”?
 - Morphological computation
 - is thought independent of the body?
- Could a person exist in “cyberspace”?
 - SciFi; whole brain emulation, mind uploading, ...



**“I am Locutus, of Borg. Resistance... is futile.
Your life as it has been is over.”**



We are Borg

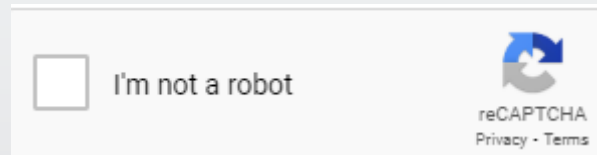
Cybernetics = steersman

Κυβερνητικός

Good at steering, good pilot



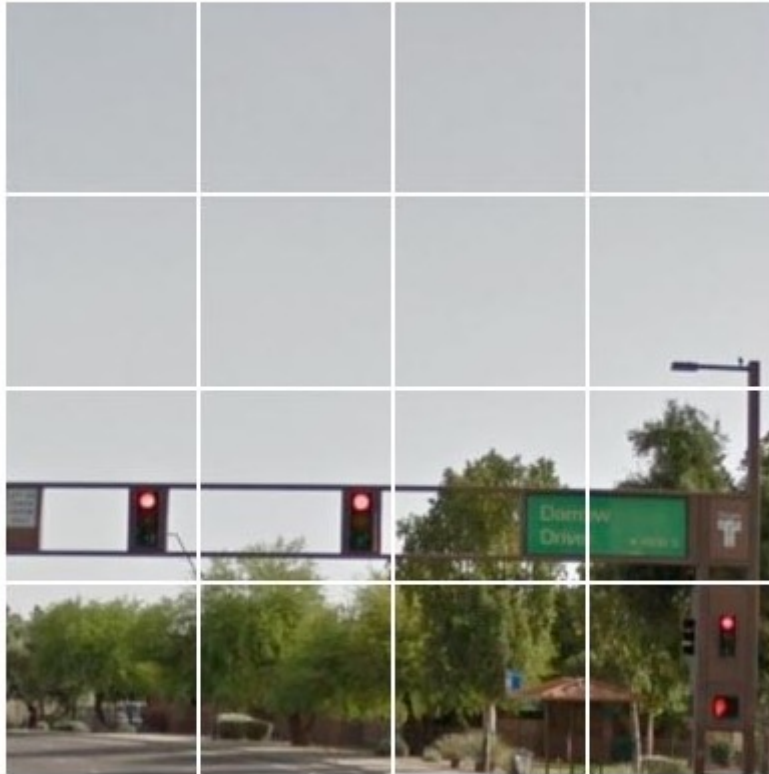
Human in the loop



Select all squares with

traffic lights

If there are none, click skip



SKIP

ReCAPTCHA V2 crowd-sources problems the Google Maps algorithm can't solve while fighting comment spam

Mechanical Turk



Companies using Mechanical Turk for machine training are likely to be paying a fraction of what it would cost to have full-time employees sort and click through pictures.

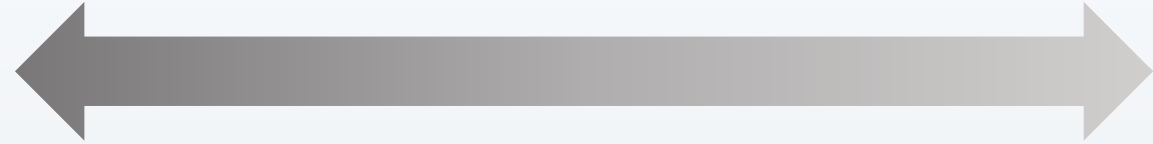
Wages on the platform, where workers are paid per task rather than per hour, are usually below the US federal minimum wage of \$7.25 per hour. The Pew survey found about half of Turkers make less than \$5 per hour. Nearly two-thirds of the tasks posted on the site pay 10 cents or less.

- <https://www.ft.com/content/17518034-6f77-11e6-9ac1-1055824ca907>

To what end?

augment

Computers
helping
people

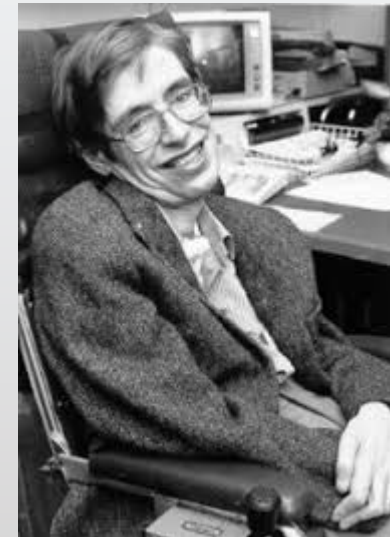
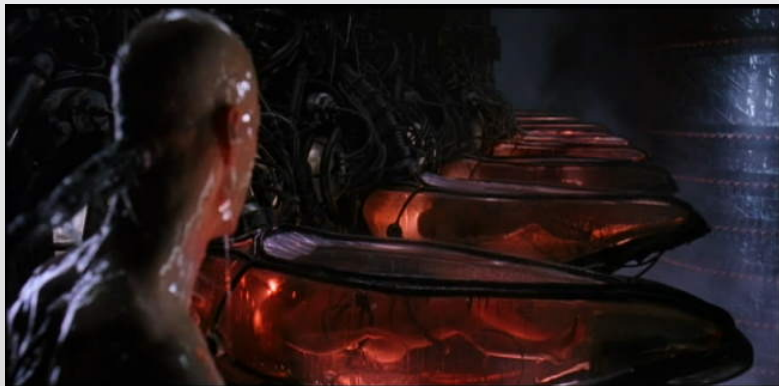
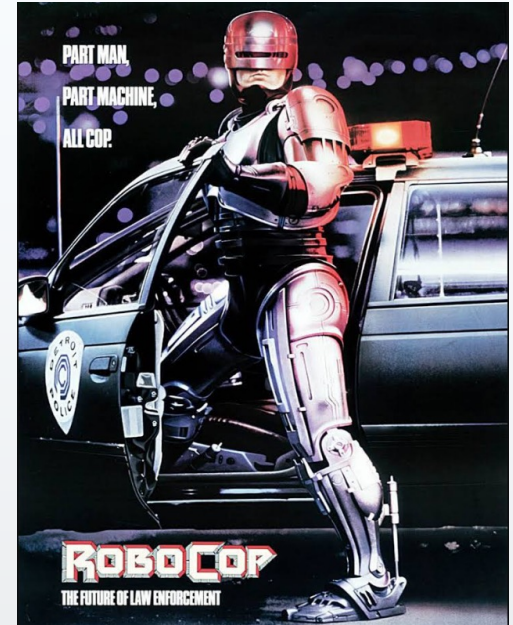
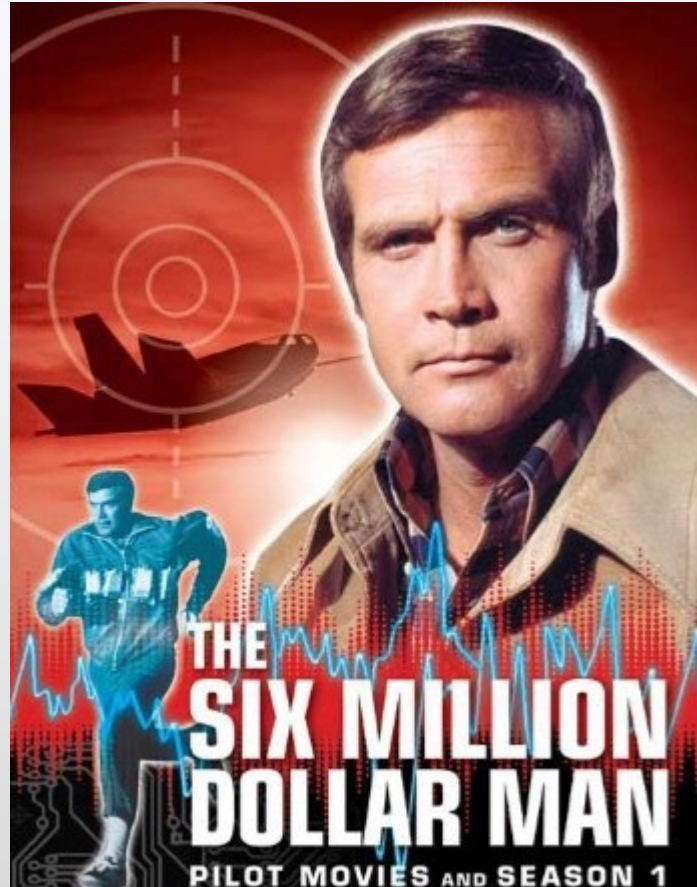


automate

Computers
replacing
people

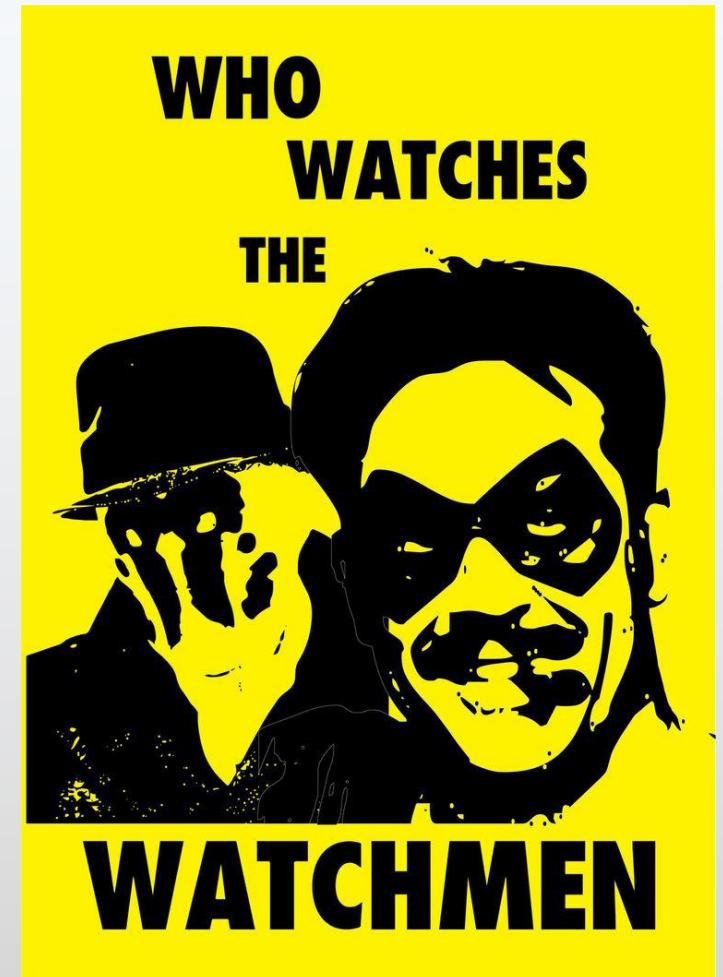
Purpose:
Keep asking, "Why?"

AI for accessibility



Testing, testing ...

- Mutation testing
 - Change the code to find tests that still pass
 - @sephdebusser
 - https://www.youtube.com/watch?v=M-5_M8qZXaE&feature=youtu.be
- Property based testing
 - State properties rather than magic numbers
- Fuzzers
 - Try random inputs



Program Synthesis

Program synthesis is the task of automatically finding a program in the underlying programming language that satisfies the user intent expressed in the form of some specification. Since the inception of AI in the 1950s, this problem has been considered the holy grail of Computer Science.

<https://www.microsoft.com/en-us/research/publication/program-synthesis>

Tests are should be feedback for AI

AI and prediction

- Predictive text
- In IDEs...
 - Predictive Intellisense
- BAYOU
 - Uses deep learning to write code for programmers
 - <https://www.techrepublic.com/article/developers-rejoice-now-ai-can-write-code-for-you/>
 - “search engine for coding”

Results

```
1 import java.io.*;
2 import java.util.*;
3
4 public class TestList {
5
6     String FizzBuzz() {
7         {
8             String s2;
9             StringBuffer sb1;
10            Integer i1;
11            AbstractStringBuilder asb1;
12            String s1;
13            int i2;
14            sb1 = new StringBuffer();
15            s1 = (i1 = new Integer(new String())).toString();
16            asb1 = sb1.append(s1);
17            if ((i2 = sb1.length()) != 0) {
18                s2 = sb1.toString();
19            } else {
20            }
21            return s2;
22        }
23    }
24 }
25
```



How do I write Hello, world in Python?



To write "Hello, world!" in Python, you can use the `print()` function. Here's an example:



```
python Copy code  
  
print("Hello, world!")
```

When you run this code, it will output "Hello, world!" to the console.

You can also store the "Hello, world!" string in a variable and then print the variable using the `print()` function, like this:

```
python Copy code  
  
message = "Hello, world!"  
print(message)
```

This will produce the same output as the first example.

Note that Python is sensitive to indentation. Make sure to use consistent indentation in your code, as this can affect how it is interpreted by the Python interpreter. In particular, each block of code that is indented to the same level is treated as a single unit.

Question

- Do you trust a computer to mark its own homework?
- People often ask ChatGPT for code then ask for tests afterwards

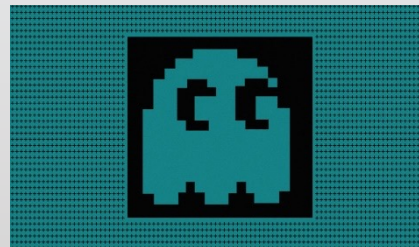
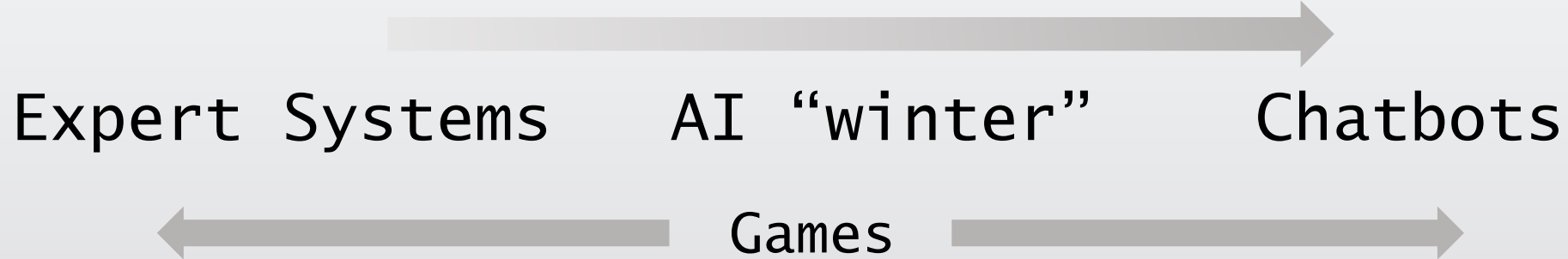
**Always try to break stuff to
check it really works**

What is AI?

Almost Implemented

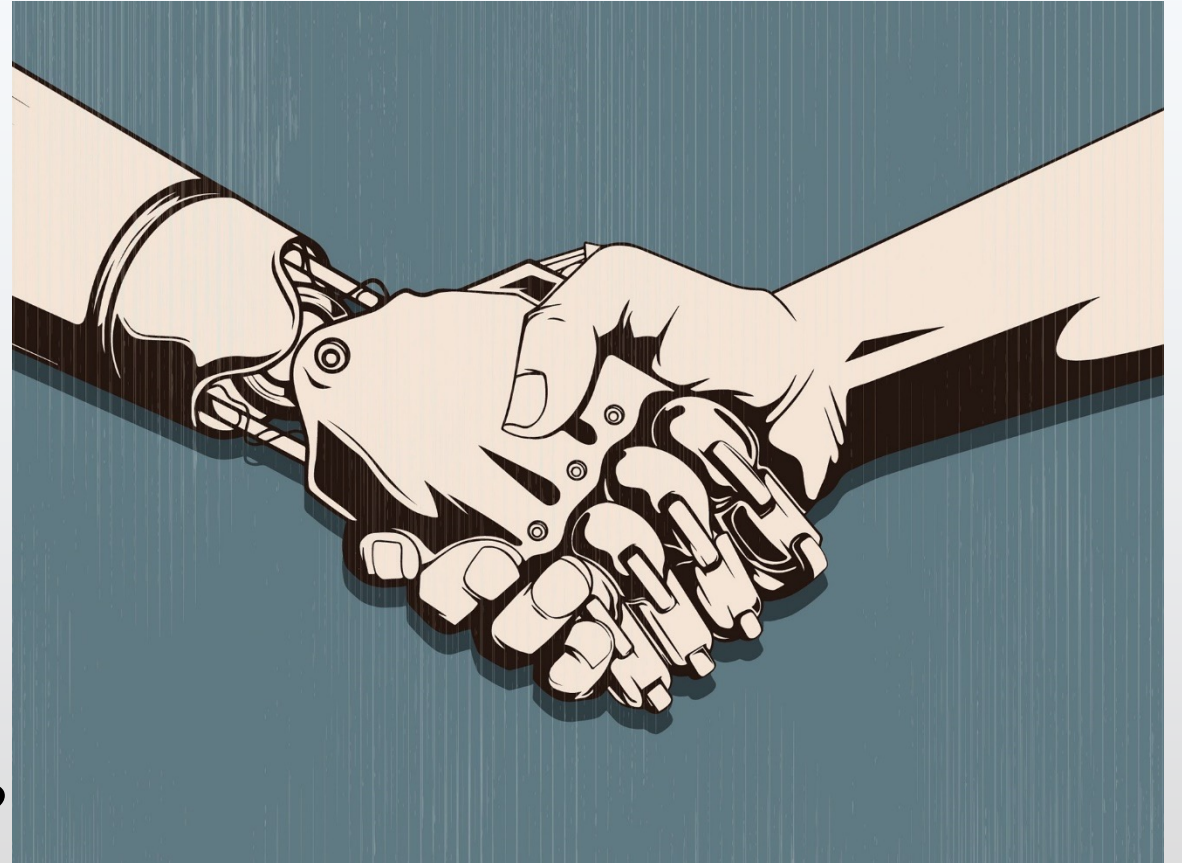
The AI effect:

As soon as AI successfully solves a problem,
the problem is no longer a part of AI



Can AI replace programmers?

- Yes, but...
 - Languages,
 - AI frameworks,
 - Parameters,
 - Provide feedback,
 - Steer,
 - Tune the tests...
- Humans in the loop
- Sapiens in the machine?



Will AI replace programmers?

No
But...

