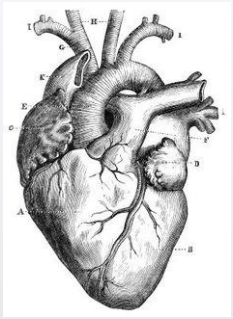
Can AI replace programmers?

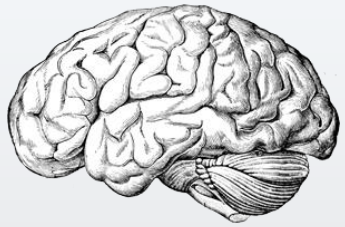
Frances Buontempo

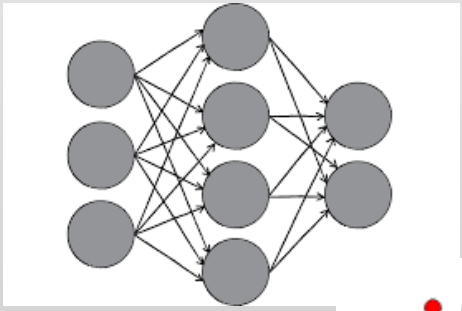
Yes

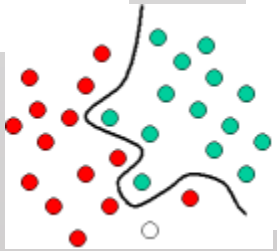
But…

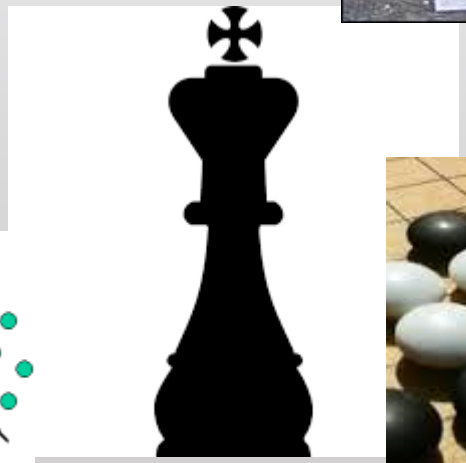
What is AI?











What is AI?

- Coined by John McCarthy in 1955
- “Reproduce human intelligence electronically”
- “What is real? How do you define what is real? Real is just electrical signals interpreted by your brain…if we don’t perceive something… is it not real? Does it not exist?”

  Morpheus, The Matrix

Ascribing Mental Qualities to Machines

- “Machines as simple as thermostats can be said to have beliefs, and having beliefs seems to be a characteristic of most machines capable of problem-solving performance.”
- John Searle responded in 1980 with his famous Chinese Room Argument

What is Machine Learning?

Arthur Samuel coined the term in 1959:

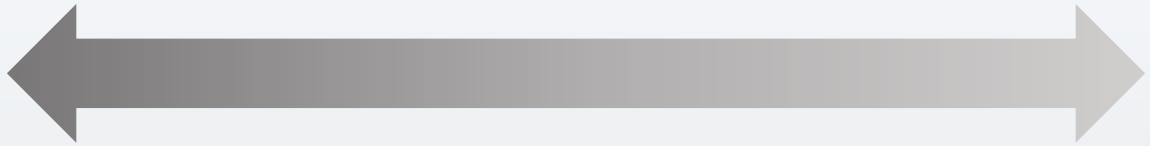
Machine learning is a

"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**)

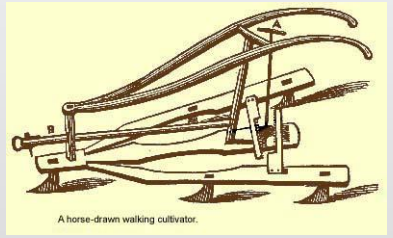
augment  **automate**

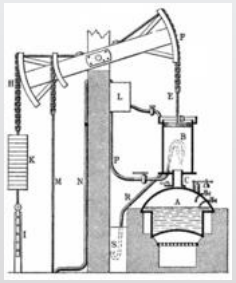
Computers helping people

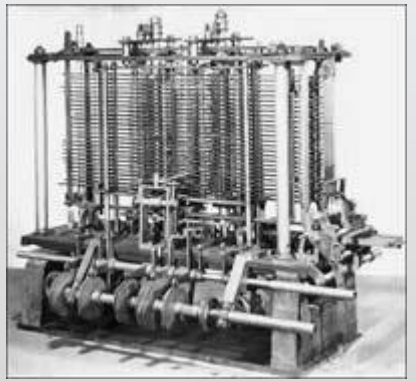
Computers replacing people

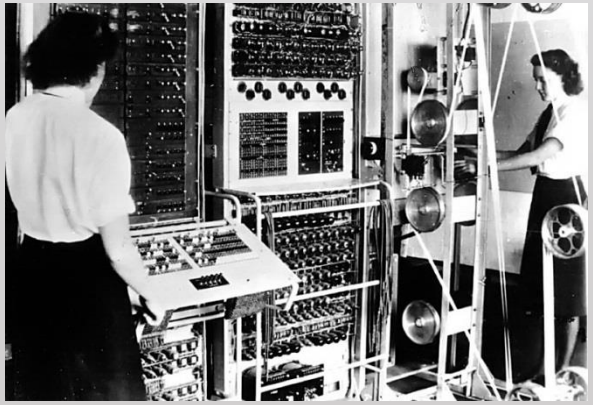
Automate everything!

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



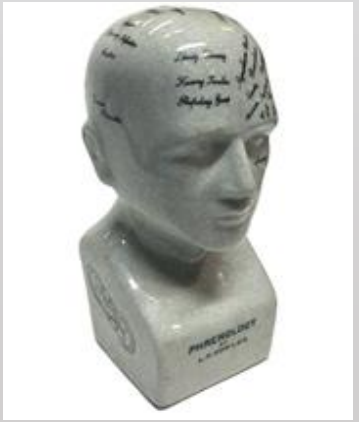




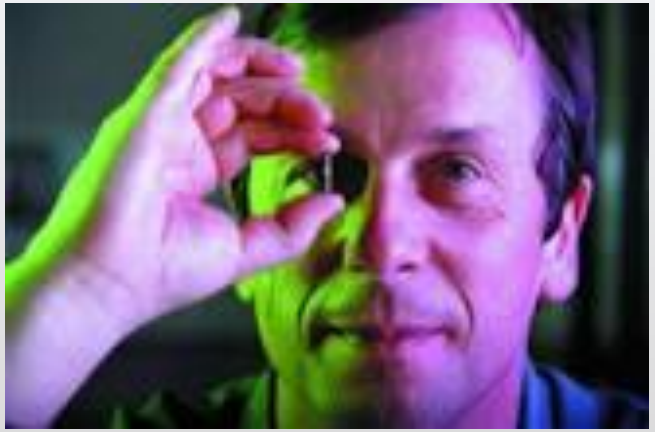


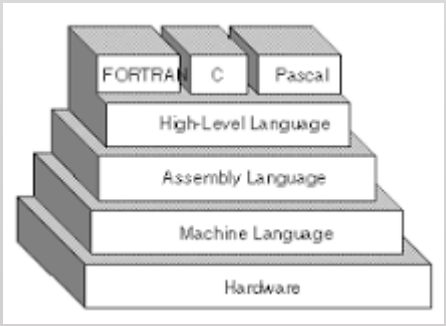
Automate everything?

- 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



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

You Retweeted

Dan Larremore
@DanLarremore

I wish my undergraduate students wanted to learn math and statistics instead of blasting carbon into the atmosphere to half-train a GAN before their free AWS credits run out.

9:36 PM · Oct 3, 2019 · Twitter Web App

Automation is magic

- (Or often involves wizards)
- “After you create a wizard, you typically want to add it to the Visual Studio integrated development environment (IDE) so that others can use it.”
  - https://docs.microsoft.com/en-us/visualstudio/extensibility/internals/wizards?view=vs-2019
- AI and machine learning “wizards”
  - Various online platforms
  - “No machine learning skills required”

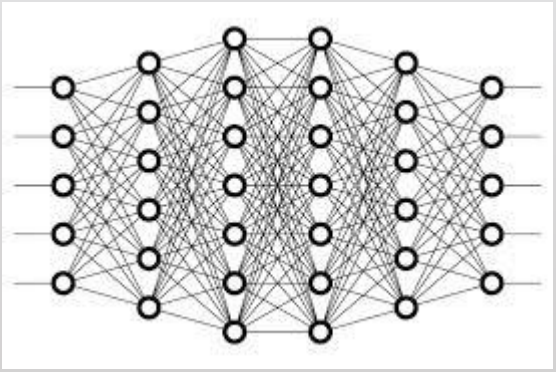

accu
2018
accu
2018

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:

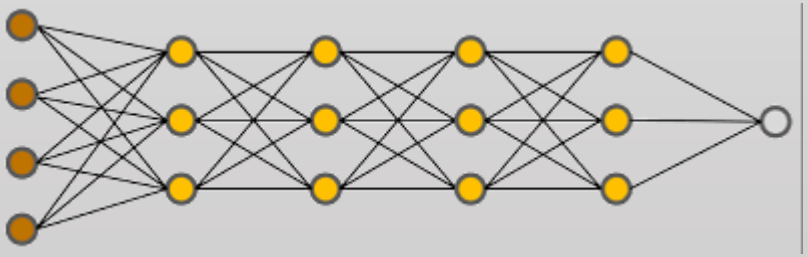
penalized resumes that included the word “women’s,” as in “women’s chess club captain.” And it downgraded graduates of two all-women’s colleges

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


You now have 20 seconds to comply.

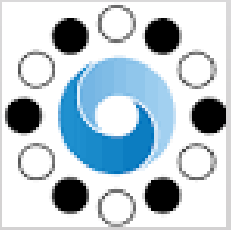
Build a brain and it will think

- 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

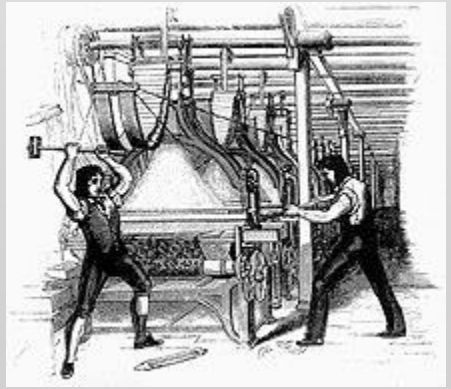


What is AI?

```
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”

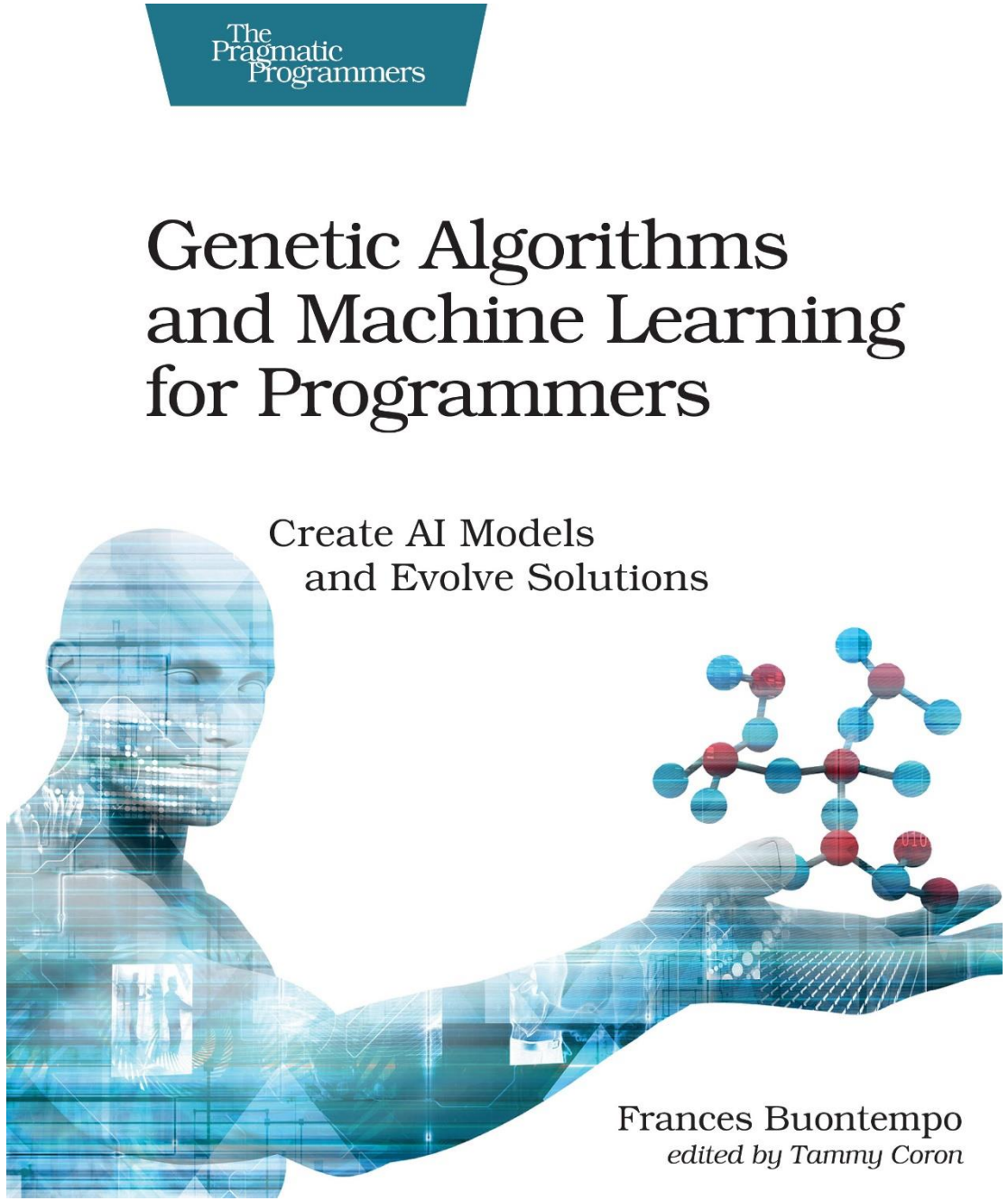


Can AI replace programmers?

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

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


The Pragmatic Programmers
Genetic Algorithms and Machine Learning for Programmers
Create AI Models and Evolve Solutions
Frances Buontempo
edited by Tammy Coron

Can you code your way out of a paper bag?

- Use heuristics and design fitness functions.
- Build genetic algorithms.
- Make nature-inspired swarms with ants, bees and particles.
- Create Monte Carlo simulations.
- Investigate cellular automata.
- Find minima and maxima, using hill climbing and simulated annealing.

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

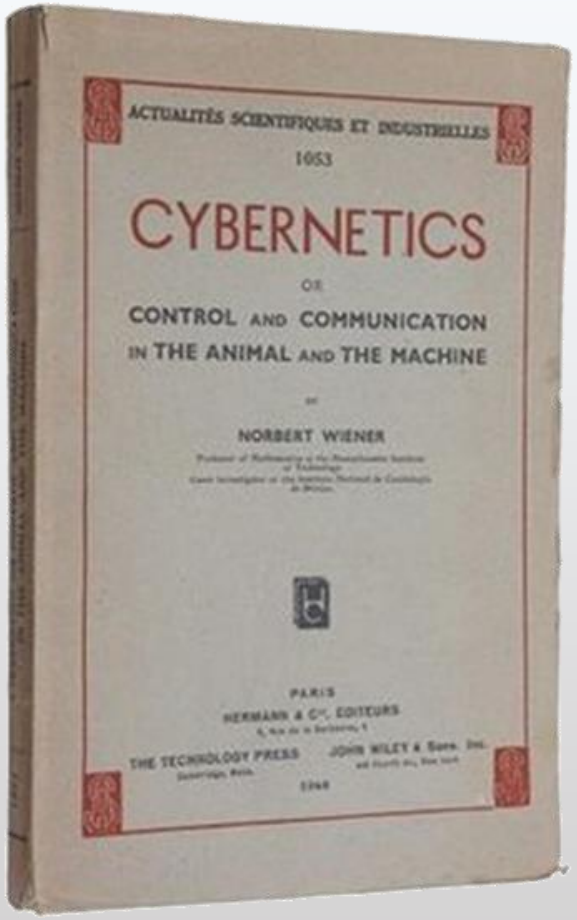
Cybernetics

"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

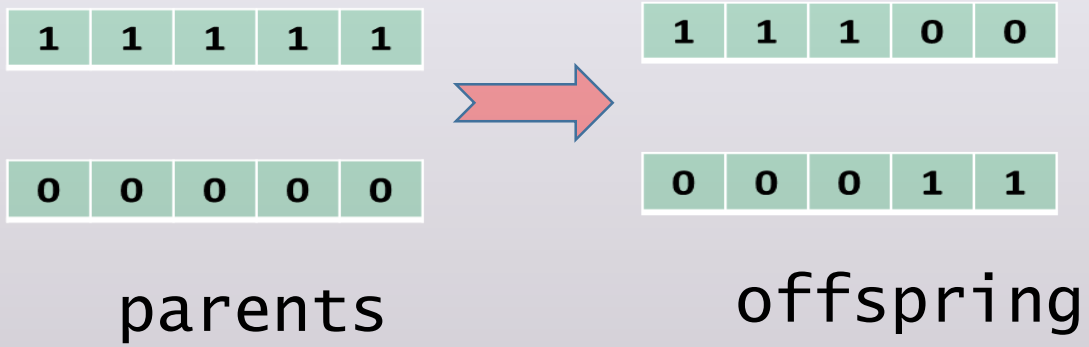
and was an important early step towards the development of modern AI"



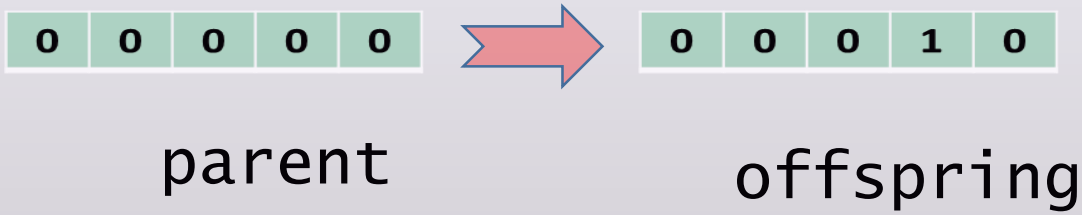
What is a genetic algorithm?

```
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



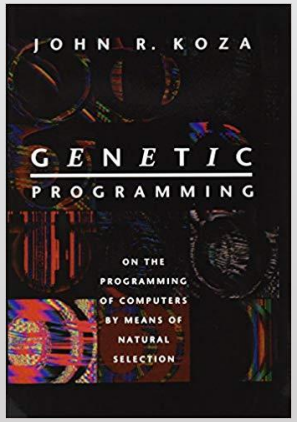
Mutation

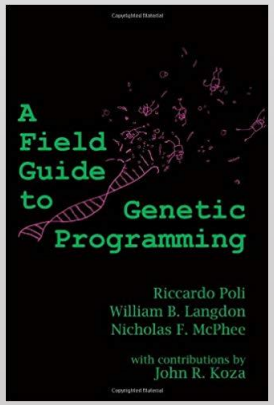


Genetic Programming (GP)-evolution of a tree structure

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

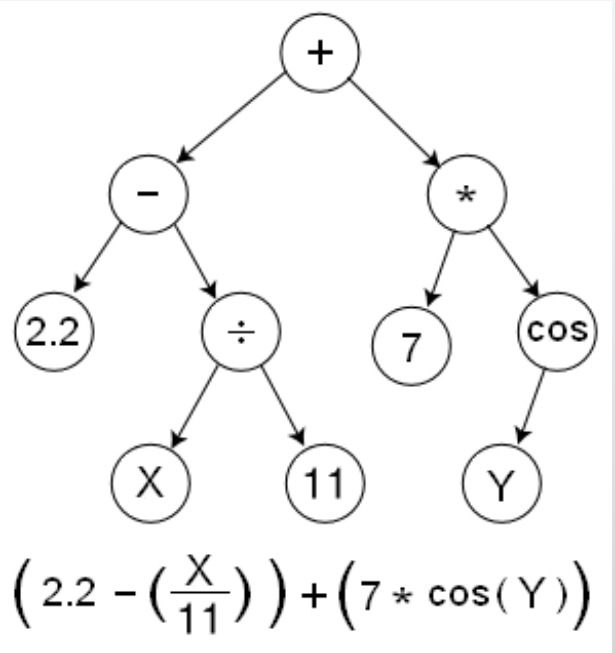
Each tree node is an *operator* or *variable*, or a *terminal node*.





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?

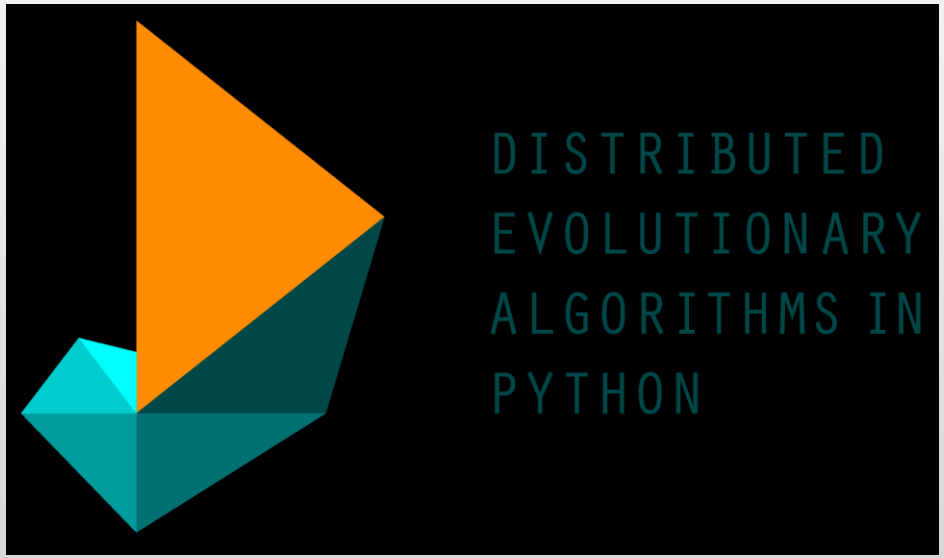
```
Generate some random trees
While not Done
  Test these
  Choose some better ones
    and create new trees by crossover
  Maybe mutate a few trees a bit
```

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(mul(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


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

Writing the tests is hard

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

AST

- DEAP didn’t use the AST
- Search: clang ast manipulation
- Transformation tasks
  - Optimisations e.g. loop unrolling
    - https://llvm.org/devmtg/2013-04/krzikalla-slides.pdf
  - Automatic C++ source code generation with clang - Sergei Sadovnikov [ACCU 2017]
    - https://www.youtube.com/watch?v=aPTyatTI42k&feature=youtu.be

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

LISP

- John McCarthy, 1961
- "Recursive Functions of Symbolic Expressions and Their Computation by Machine, Part I“ Communications of the ACM
  - Homoiconic
    - meta-programming
    - a program written in it can be manipulated as data using the language
    - “a term surrounded by much confusion”
      - https://www.expressionsofchange.org/dont-say-homoiconic/
  - Garbage collection

What, no C++?

Using LLVM-based JIT Compilation in Genetic Programming

https://arxiv.org/pdf/1701.05730.pdf

Using LLVM-based JIT Compilation in Genetic Programming

Michal Gregor*, Juraj Spalek†
Department of Control and Information Systems
Faculty of Electrical Engineering
University of Žilina, Žilina, Slovak Republic
Email: *michal.gregor@fel.uniza.sk, †juraj.spalek@fel.uniza.sk

***Abstract*—The paper describes an approach to implementing genetic programming, which uses the LLVM library to just-in-time compile/interpret the evolved abstract syntax trees. The solution is described in some detail, including a parser (based on FlexC++ and BisonC++) that can construct the trees from a simple toy language with C-like syntax. The approach is compared with a previous implementation (based on direct execution of trees using polymorphic functors) in terms of execution speed.**

library. Section V. shows how abstract syntax trees can be created by parsing sources in a simple toy language with C-like syntax. This is especially useful when we need to bootstrap evolution using hand-crafted solutions.

In section VI. we will give a description of the evaluation procedure used to measure the execution times. Finally, the actual empirical results will be given in section VII. for several variants of the proposed solution. The results will give valuable

Left as an exercise for the reader

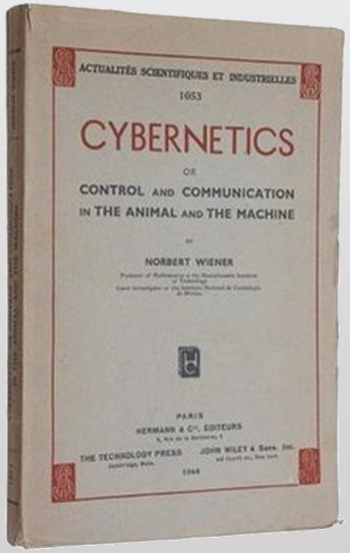
- Making this more a plea for help than a keynote
- Overload@accu.org
- https://accu.org/index.php/journal/overload_by_cover

AI: Done by machines

- Feedback and iteration are recurring themes
- Never forget the “Human in the loop”
- Notice before Artificial Intelligence (John McCarthy), we had **Computing Machinery** (Turing, 1950)
  - Can machines think?
  - The Turing test
  - https://www.csee.umbc.edu/courses/471/papers/turing.pdf

What kind of machines?

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



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, …


THE FLY
BE AFRAID.
BE VERY AFRAID.
BROOKSFILMS Presents A DAVID CRONENBERG Film THE FLY
JEFF GOLDBLUM GEENA DAVIS JOHN GETZ Music by HOWARD SHORE
Screenplay by CHARLES EDWARD POGUE and DAVID CRONENBERG
Produced by STUART CORNFELD Directed by DAVID CRONENBERG
R

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

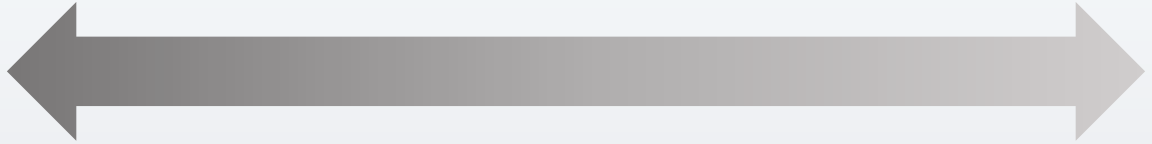
We are Borg

Cybernetics = steersman

Κυβερνητικός

Good at steering, good pilot

To what end?



augment

Computers helping people

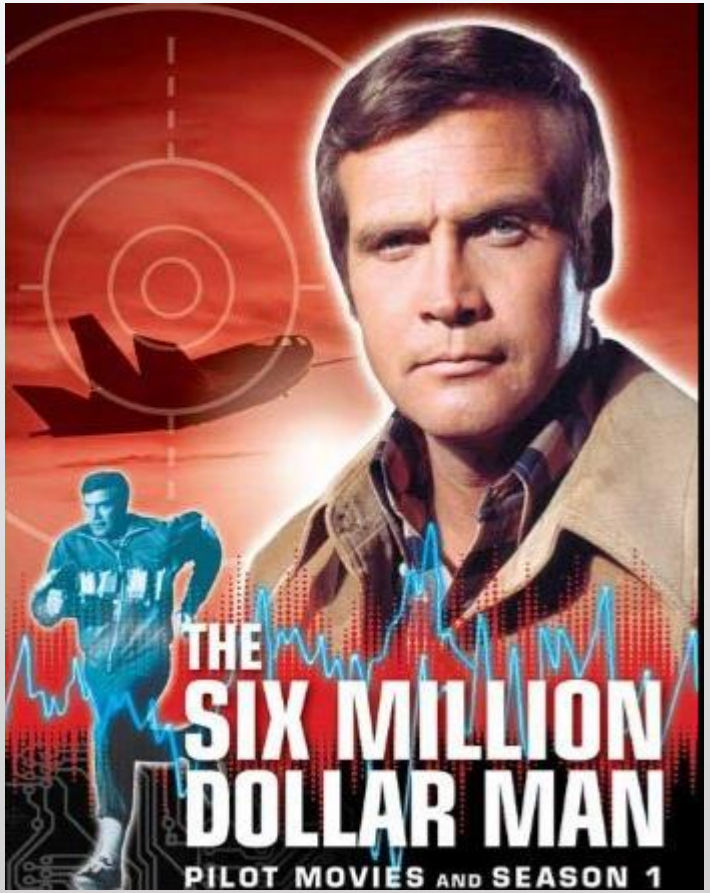
automate

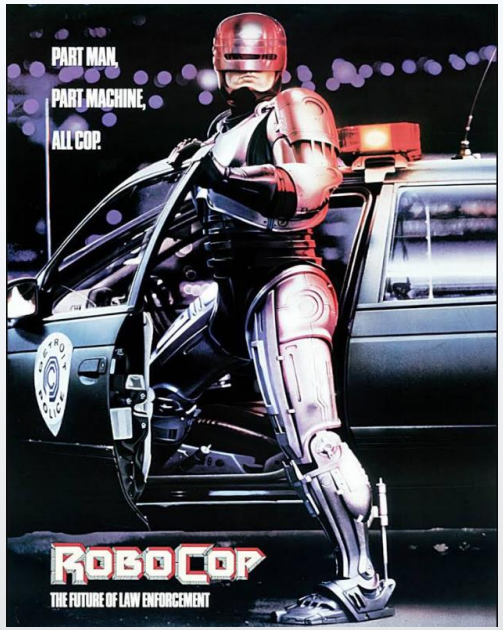
Computers replacing people

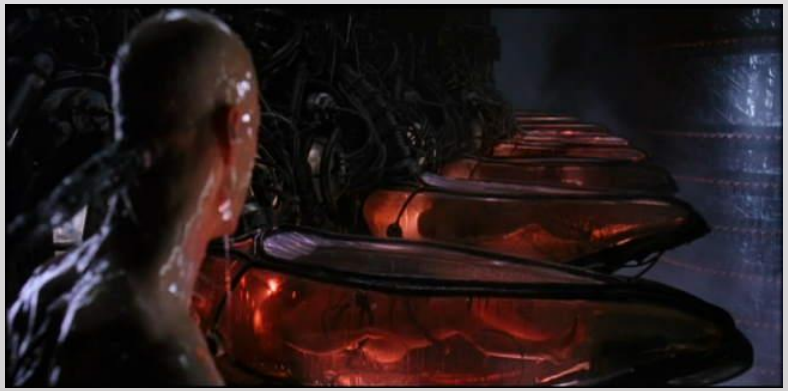
Purpose:

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

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
```

Could AI invent a programming language?

- Or create a compiler or interpreter?
- Where would it be without us?
- Actually, why would a machine bother with a high level language?

What is AI?

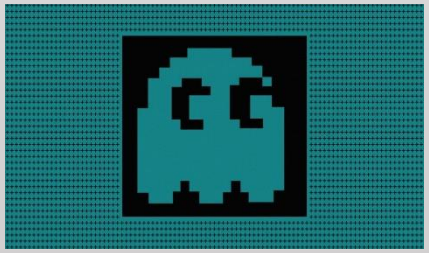
Almost Implemented

The AI effect:

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

Expert Systems AI “winter” Chatbots

Games



What is a programmer?

Originally, computers were people:

ENIAC's female computers included Jean Jennings Bartik

https://medium.com/@mjosefweber/the-first-computers-were-human-and-mostly-women-b0d9bbff5a98

When Computers were Women, Jennifer S Light

https://www.jstor.org/stable/25147356

ENIAC

In just 30 seconds, ENIAC could complete more calculations than Jean Bartik could do in 30 hours.

But that didn’t mean she was out of a job.

She was recruited, with 5 other women, to program the computer.

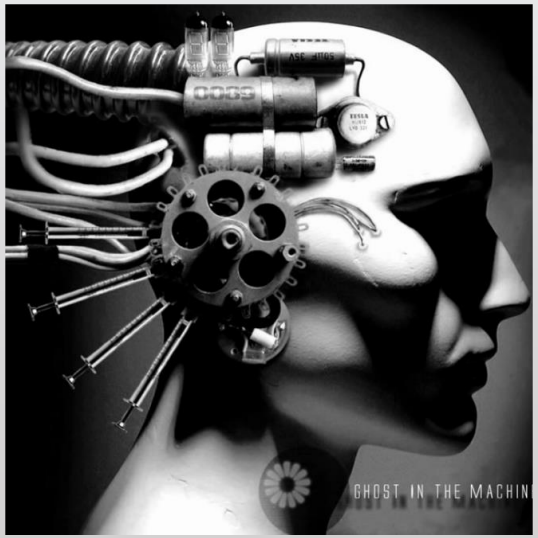
Can AI replace programmers?

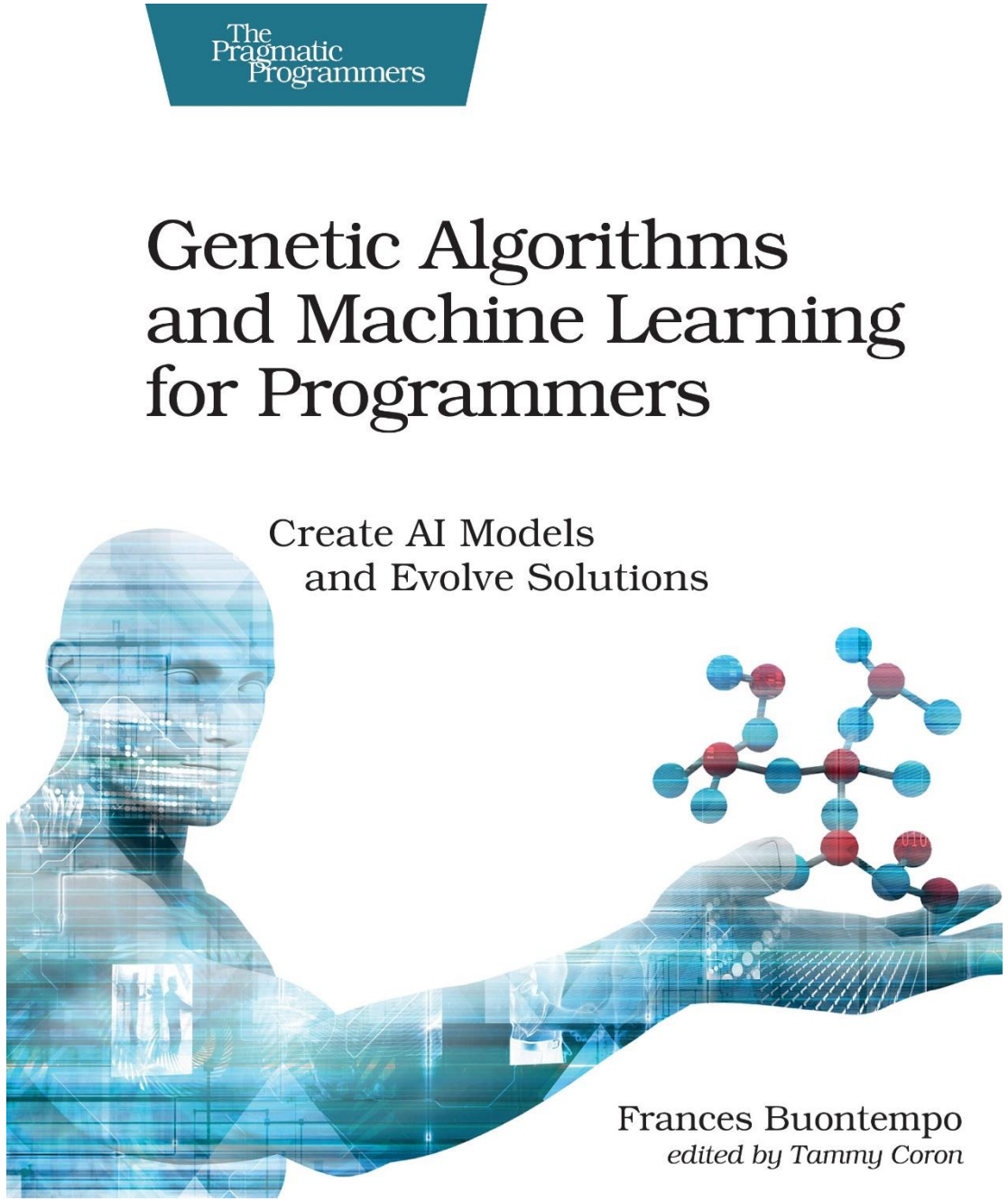
- Yes, but…
  - Languages,
  - AI frameworks,
  - Parameters,
  - Provide feedback,
  - Steer,
  - Tune the tests…
- Humans in the loop
- Sapiens in the machine?

Will AI replace programmers?

No

But…




The Pragmatic Programmers
Genetic Algorithms and Machine Learning for Programmers
Create AI Models and Evolve Solutions
Frances Buontempo
edited by Tammy Coron