

How To Program

An Overview

Or

A Reframing of the Question of Programming

An Exercise

Make a program that tells us that it is a program

How does one go about doing this?

What is a program?

- A set of instructions
 - Receive input, produce output
 - Do nothing
 -
- Instructions are written in whatever “language” the machine/device/person/biology can interpret
 - 1s and 0s
 - Protein sequences
 - English
 - Ruby/python/java/C++/visual basic, etc
 - Morse Code
 -
- Language is recognizable data (grammar)
 - Letters > words > sentences
 - Symbolics (hieroglyphics, Pictograms, etc)
 - Circuit arrangements
- Instructions are sequences of language components that prescribe doable actions
-

Possible Approaches

- Just write the program, if you know how to program
- Search through existing programs until an appropriate one is recognized
 - Use google to translate the exercise into finding descriptions of programs
 - Use machine learning and statistics to pattern recognize likely candidate programs
- Try random sequences of data (1s and 0s or strings etc depending on the programming language) to see if they do what we expect this program to do

These are all equivalent processes!

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E f t dfde dfeend ui(*, sdfu hleldo addnn ddjn adf *^klkjh(*&hlkjnn
fsoap87p;77ysdglggb78o0vvnvjv sdfgsdsdf 5 66 77 hnndj(*)!H sdfasdf
sadfp[oun;Inasdfasdfn sadf asdf as df asdf sadfv8op7ulknj(**&^*(%&^jnsdf6bn^n
kjysadfbnllkjsadfasdfy &(& 90&^!))_ dfssdf+)(?>:".LL<, JJK#### f8sadfolkj;l
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lf ($findaprogram == "true") {}!H sdfasdf sadfp[oun;Inasdfasdfn sadf as df sdfsdfsdfdf
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asdfsasdf Print "this is a program";dfgsdsdf 5 66 77 hnndj(*)!H sdfasdf
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kjysadfbnllkjsadfasdfy &(& 90&^!))_ dfssdf+)(?>:".LL<, JJK#### f8sadfolkj;l
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sadfp[oun;Inasdfasdfn sadf asdf as df asdf sadfv8op7ulknj(**&^*(%&^jnsdf6bn^n
kjysadfbnllkjsadfasdfy &(& 90&^!))_ dfssdf+)(?>:".LL<, JJK####
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sadv8op7ulknj(**&^*(%&^jnsdf6bn^n kjysadfbnllkjsadfasdfy &(& 90&^!))
```

Expert Programmer Programs

Search to Find Patterns in databases of programs

Generate All Sequences and Try Running them

```
E f t dfde dfeend ui(*, sdfu hleldo addnn ddjn adf *^klkjh(*&hlkjnn
fsoap87p;77ysdglggb78o0vvnvjv sdfgsdsdf 5 66 77 hnndj(*)!H sdfasdf
sadfp[oun;Inasdfasdfn sadf asdf as df asdf sadfv8op7ulknj(**&^*(%&^jnsdf6bn^n
kjysadfbnllkjsadfasdfy &(& 90&^!))_ dfssdf+)(?>:".LL<, JJK#### f8sadfolkj;l
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sadv8op7ulknj(**&^*(%&^jnsdf6bn^n kjysadfbnllkjsadfasdfy &(& 90&^!))_
dfssdf+)(?>:".LL<, JJK)!H sdfasdf sadfp[oun;Inasdfasdfn sadf as)!H sdfasdf
asdfsasdf Print "this is a program";dfgsdsdf 5 66 77 hnndj(*)!H sdfasdf
sadfp[oun;Inasdfasdfn sadf asdf as df asdf sadfv8op7ulknj(**&^*(%&^jnsdf6bn^n
kjysadfbnllkjsadfasdfy &(& 90&^!))_ dfssdf+)(?>:".LL<, JJK#### f8sadfolkj;l
dfgsdsdf 5 66 77 hnndj(*)!H sdfasdf sadfp[oun;Inasdfasdfn sadf asdf as df asdf
sadv8op7ulknj(**&^*(%&^jnsdf6bn^n kjysadfbnllkjsadfasdfy &(& 90&^!))_
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sadv8op7ulknj(**&^*(%&^jnsdf6bn^n kjysadfbnllkjsadfasdfy &(& 90&^!))_
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90&^!))_ dfssdf+)(?>:".LL<, JJK#### f8sadfolkj;ldfgsdsdf 5 66 77 hnndj(*)!H
sdfasdf sadfp[oun;Inasdfasdfn sadf asdf as df asdf
sadv8op7ulknj(**&^*(%&^jnsdf6bn^n kjysadfbnllkjsadfasdfy &(& 90&^!))
```

Programming is.....

Figuring out how to create and execute instructions in a substrate that can understand them.....

Figure out what instructions we need -> Write Instructions -> Load Them -> Execute -> Validate Behavior / Output -> Repeat

Expert Programmer

- Instructions – expert programmers have learned the common instruction sets used in computer programming
- Language – expert programmers have learned the common languages (recognizable sets of data) computers can interpret
- Doable Actions – expert programs have experience with what actions computers can actual take

Search through known programs

- Instructions – a large set of common instruction sets used in computer programming have already been made available on the Web, in books and other documents
- Language – The common languages (recognizable sets of data) computers can interpret are well represented on the Web
- Doable Actions – the Web has lots of information on what actions computers can actual take

Try Random Sequences

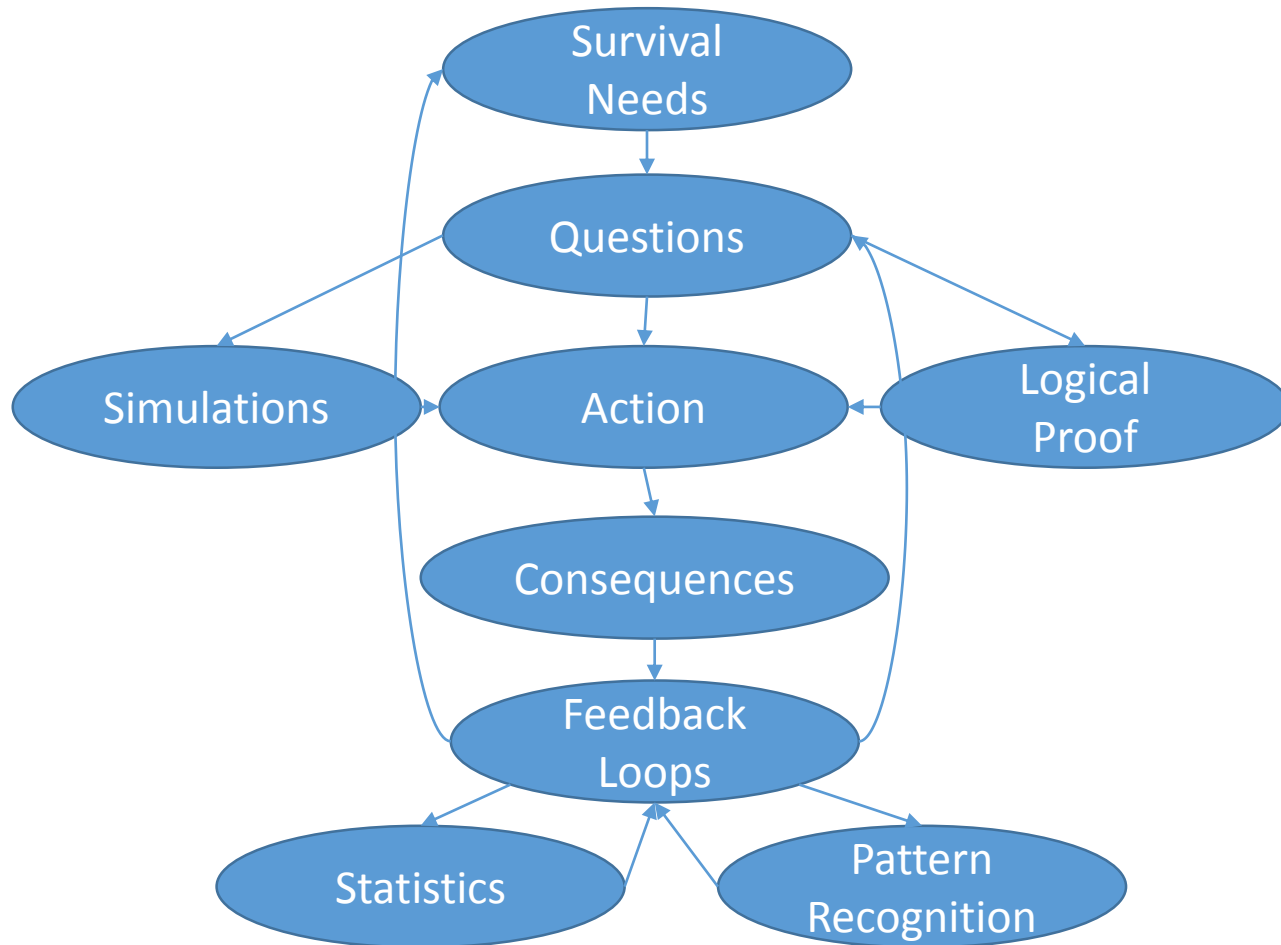
- Instructions – machine learning on large clusters is now efficient enough to recognize valid instruction sets
- Language – machine learning has made it possible for large clusters to write and interpret the common languages (recognizable sets of data) human and computer and otherwise
- Doable Actions – Computers are fast and available enough to do brute force trial and error of actions computers can actually take

Which is the best approach?

- It depends!
 - What's the definition of best? Faster? More computationally efficient? Clever? Beautiful?
 - How common is the program we wish to use?
- Cost Functions!
 - Expert programmers are often viewed as extremely efficient, but it's not really the case
 - Take a lot of learning/training
 - Typically only efficient in localized/project by project basis
 - The complexity of desired programs is increasing beyond a particular person or team of people to be able to fully harness it all
 - Really to determine an efficient approach have to factor in the amount of time and resources that goes into reducing the search space for reasonable programs

Let's Get Meta

What IS Programming? for real this time.



I need to eat

Where is food, What is food

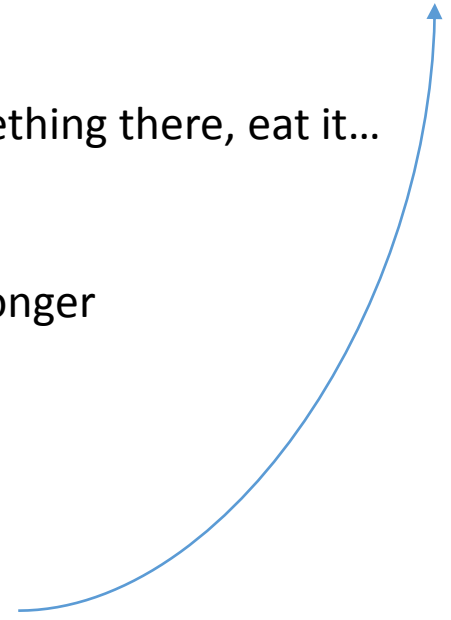
Should I go to store?

Go to fridge, if something there, eat it...

Hunger growing stronger

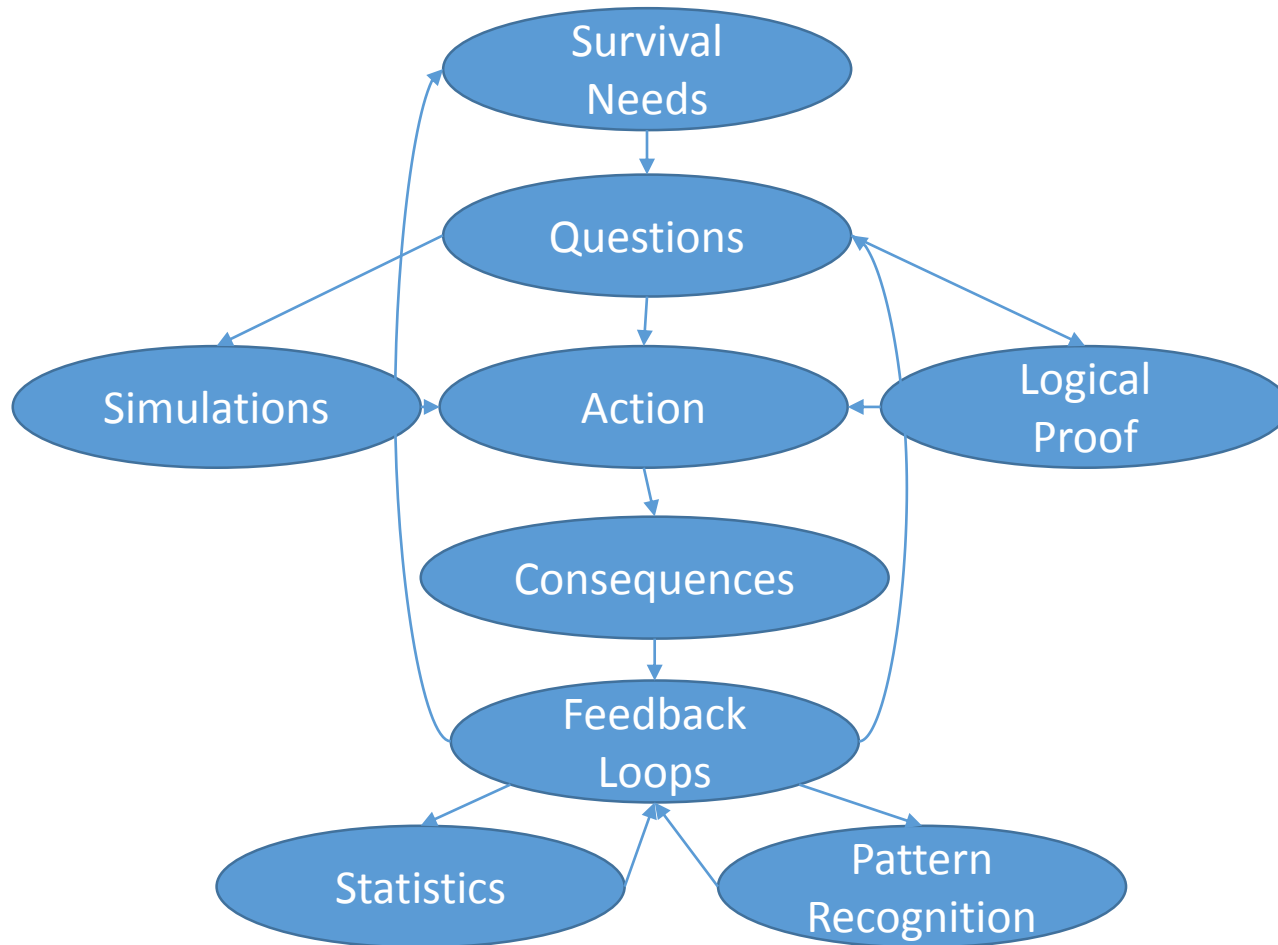
No food in fridge

Food is usually here



Another example...

What IS Programming? for real this time.



Must make money

Should we make more? Close up?

What product should we make, sell?

Make products, test them, ask people about them, market them

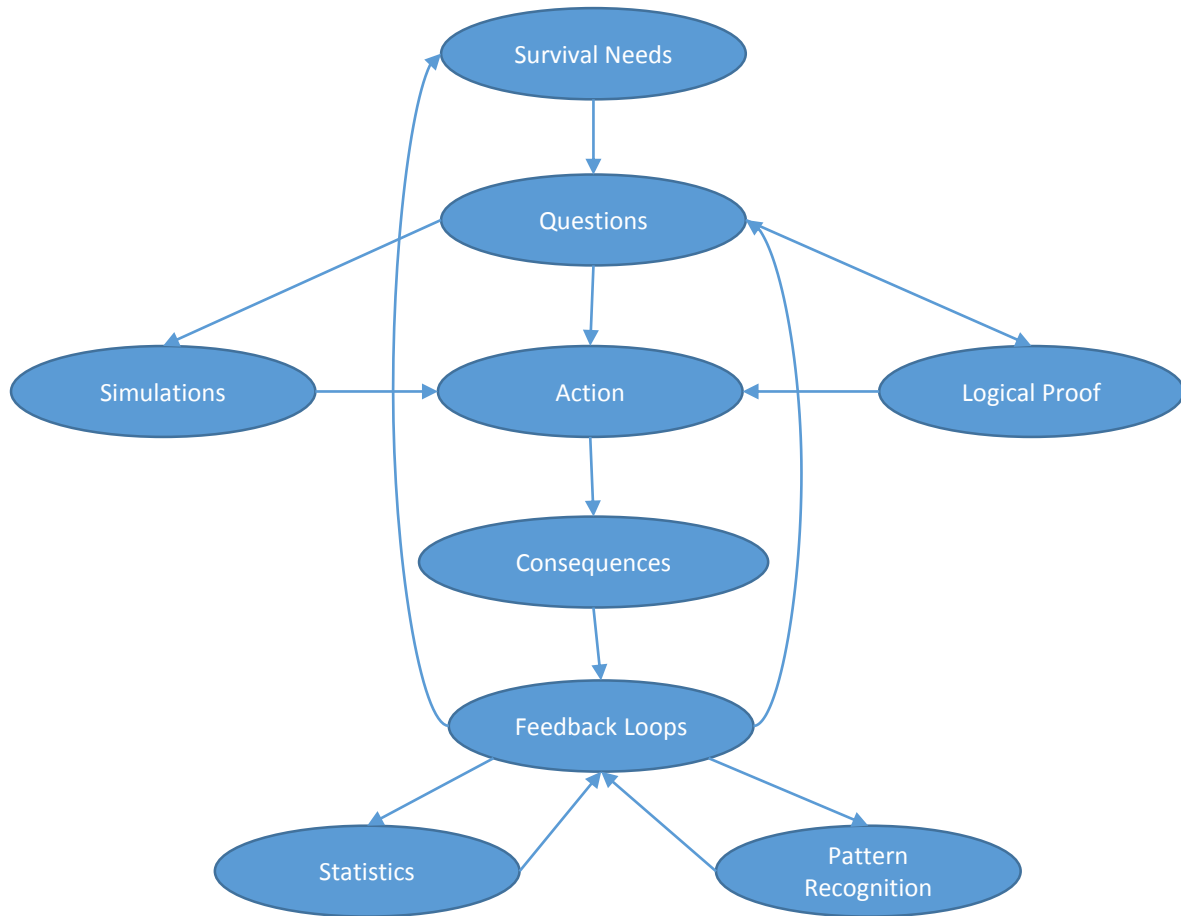
People buy or don't buy

sales, complaints, reviews, word of mouth

Money is running out/increasing



And what is it all?



DATA

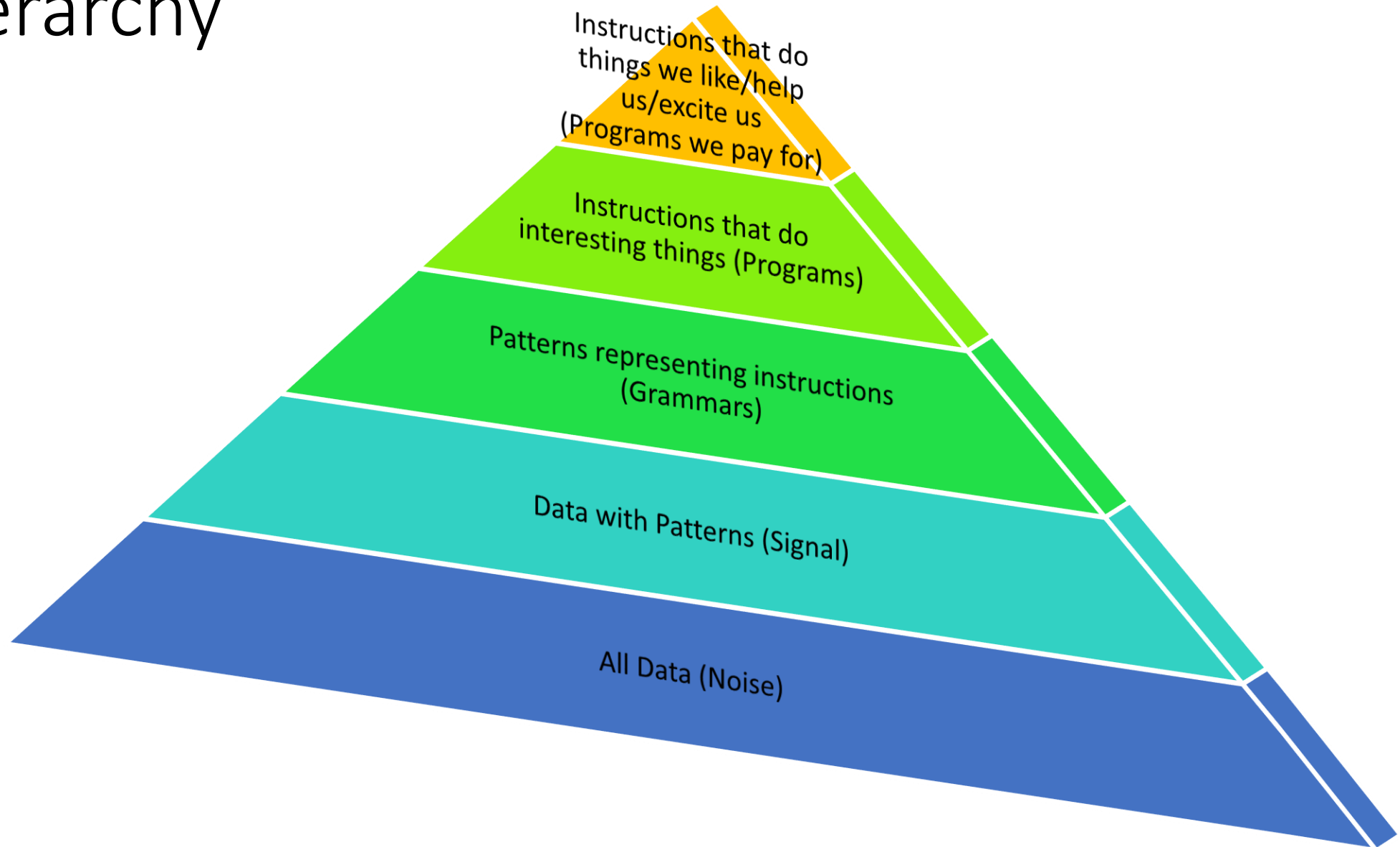
Substrates

Chemicals
Biology
Machines
....

A Few Statements

- Programs are made of Data
- Programs = Usable Patterns of Data
- Programming = Data Mining = Searching Through Patterns of Data
- Programs Generate Data
- Programs Generate Programs
- Data Generates Data
- In everyday thinking, a large data set is simply a program (or collection of programs) fully executed
- Implication!
 - The more capable we get with REALLY LARGE DATA the more obvious that programming is a SEARCH exercise becomes.

Hierarchy



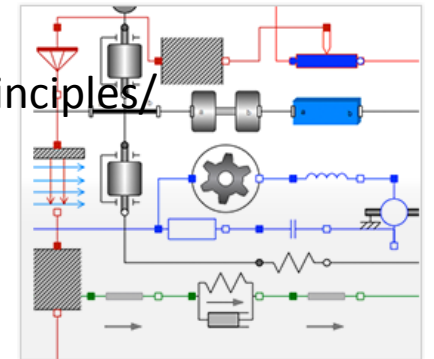
Some Recent Illustrative Examples of Programming Reframed

<http://www.trifacta.com/product/platform/>

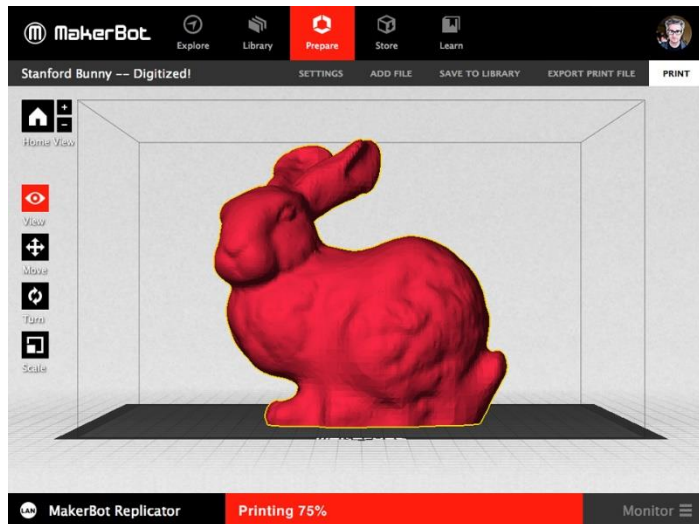


<http://www.wolfram.com/system-modeler/features/analysis-mathematica.html#model-creation>

<http://www.wolfram.com/language/principles/>



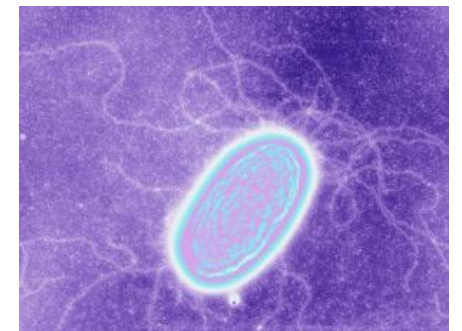
<http://www.makerbot.com/>



<https://plus.google.com/+GoogleSelfDrivingCars/posts>



<http://www.newscientist.com/article/dn25894-meet-the-electric-life-forms-that-live-on-pure-energy.html#.U910QfldWhM>



What's the Point? Or rather some points...

- We're all programmers... we're made of programs...
- Self Reference is important concept
 - http://en.wikipedia.org/wiki/Self-reference_effect
 - http://en.wikipedia.org/wiki/Strange_loop
 - http://en.wikipedia.org/wiki/G%C3%B6del's_incompleteness_theorems#Role_of_self-reference
 - <http://w3.math.uminho.pt/~jes/AnoTuring/SlidesKozen.pdf>
- Language is weird
 - http://en.wikipedia.org/wiki/Context-free_grammar
 - <http://cs.haifa.ac.il/~shuly/teaching/08/nlp/complexity.pdf>
- Some of us prefer the silicon based substrate to run our programs, some prefer paper, some prefer chemicals, some prefer soundwaves, some prefer paint...
 - http://en.wikipedia.org/wiki/DNA_sequencing_theory
 - <http://www.inmotionmagazine.com/eno1.html>
 - http://en.wikipedia.org/wiki/Music_theory
 - http://en.wikipedia.org/wiki/Formal_analysis
 - <http://www.quantumdiaries.org/2013/08/19/a-fresh-look-for-the-standard-model/>
 - http://en.wikipedia.org/wiki/Proof_theory
 - http://en.wikipedia.org/wiki/Herbert_A._Simon