Games, graphs, and machines

October 4, 2024

All are equivalent

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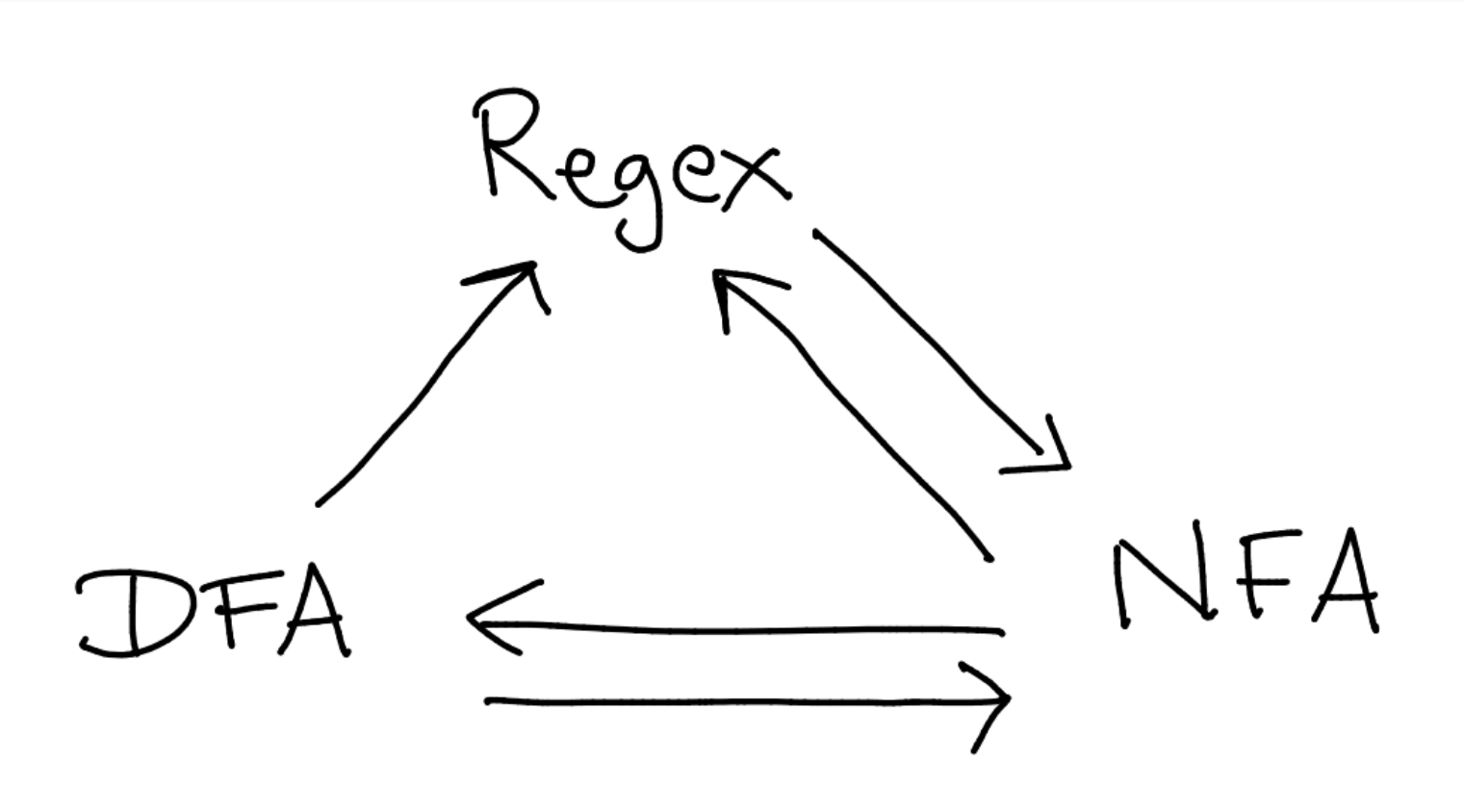

Language?

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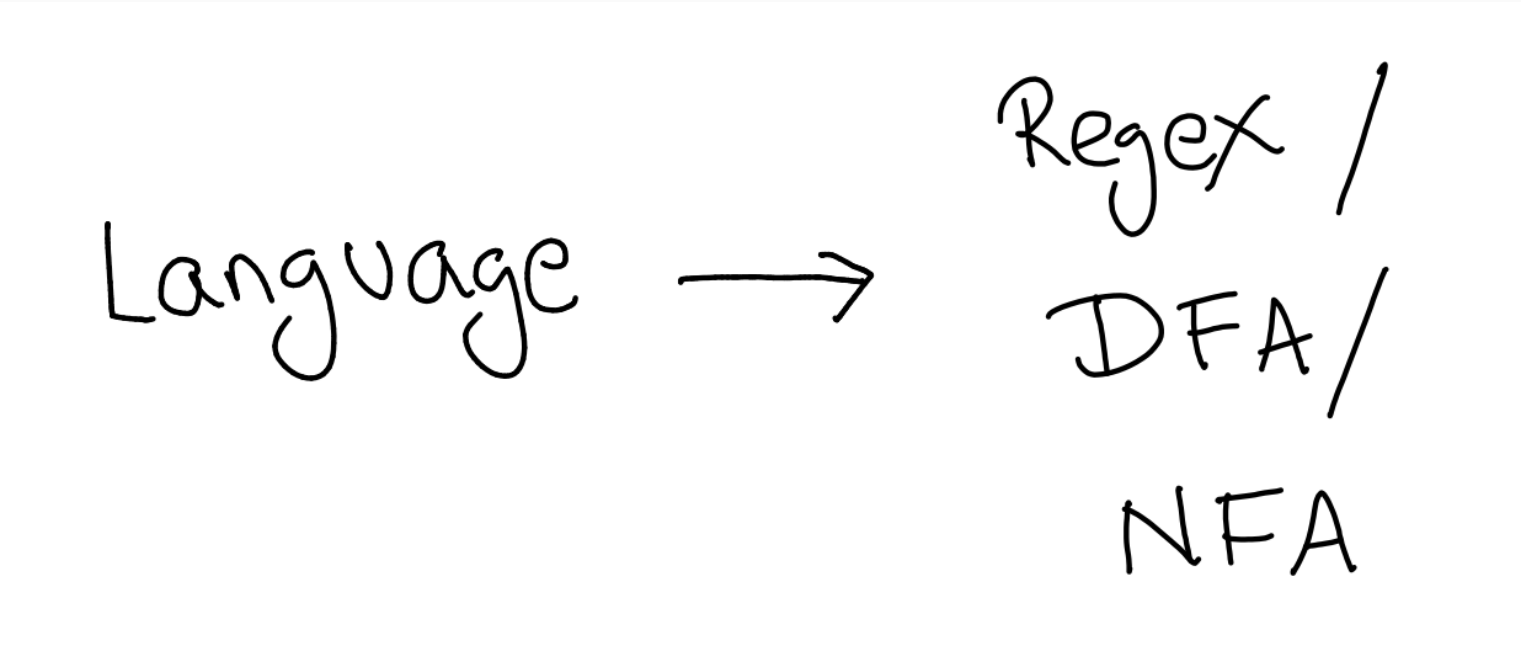

Sometimes impossible!

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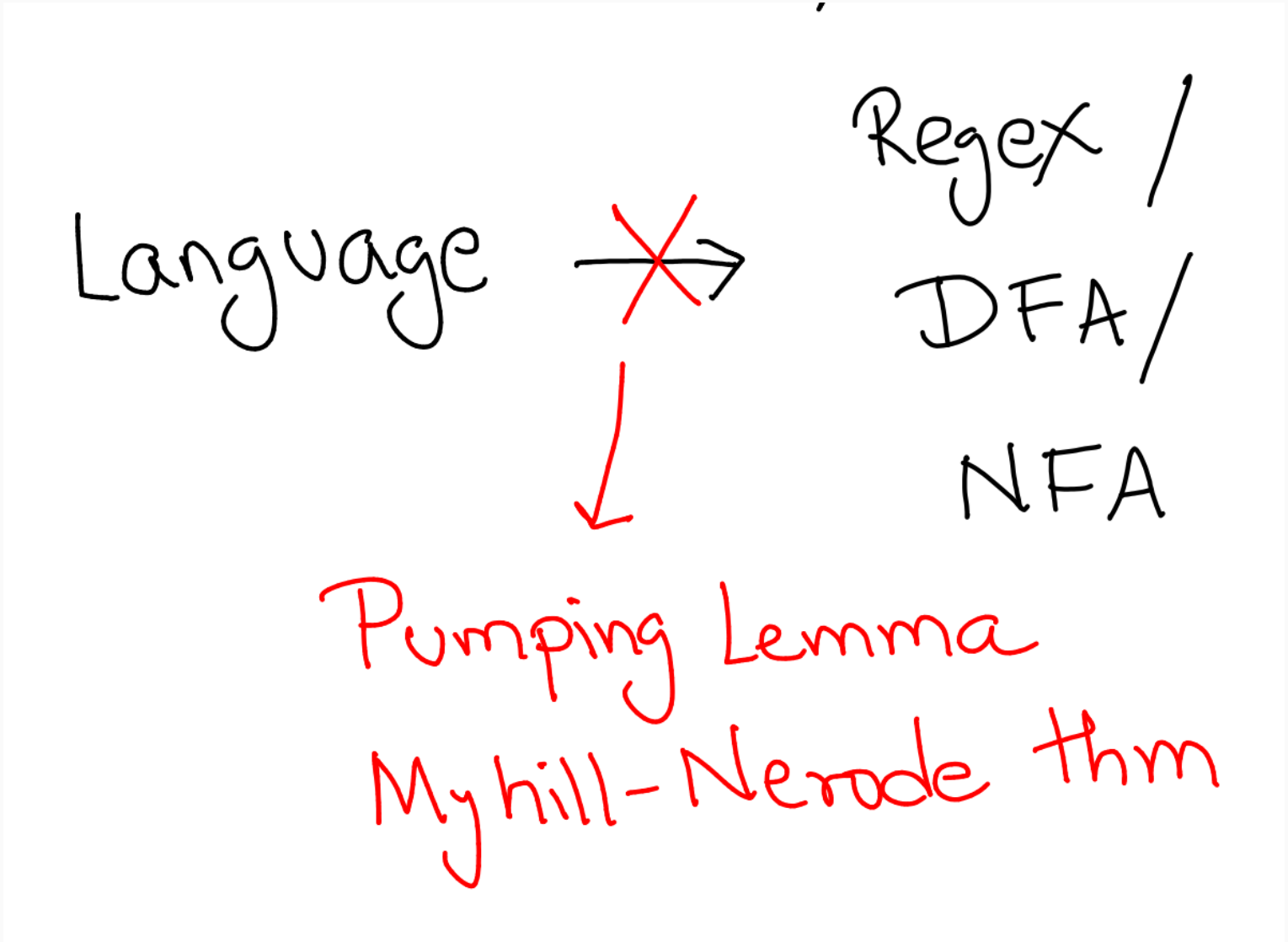

Automatons are very limited

Even “easy” patterns are beyond automatons!

What about. . .

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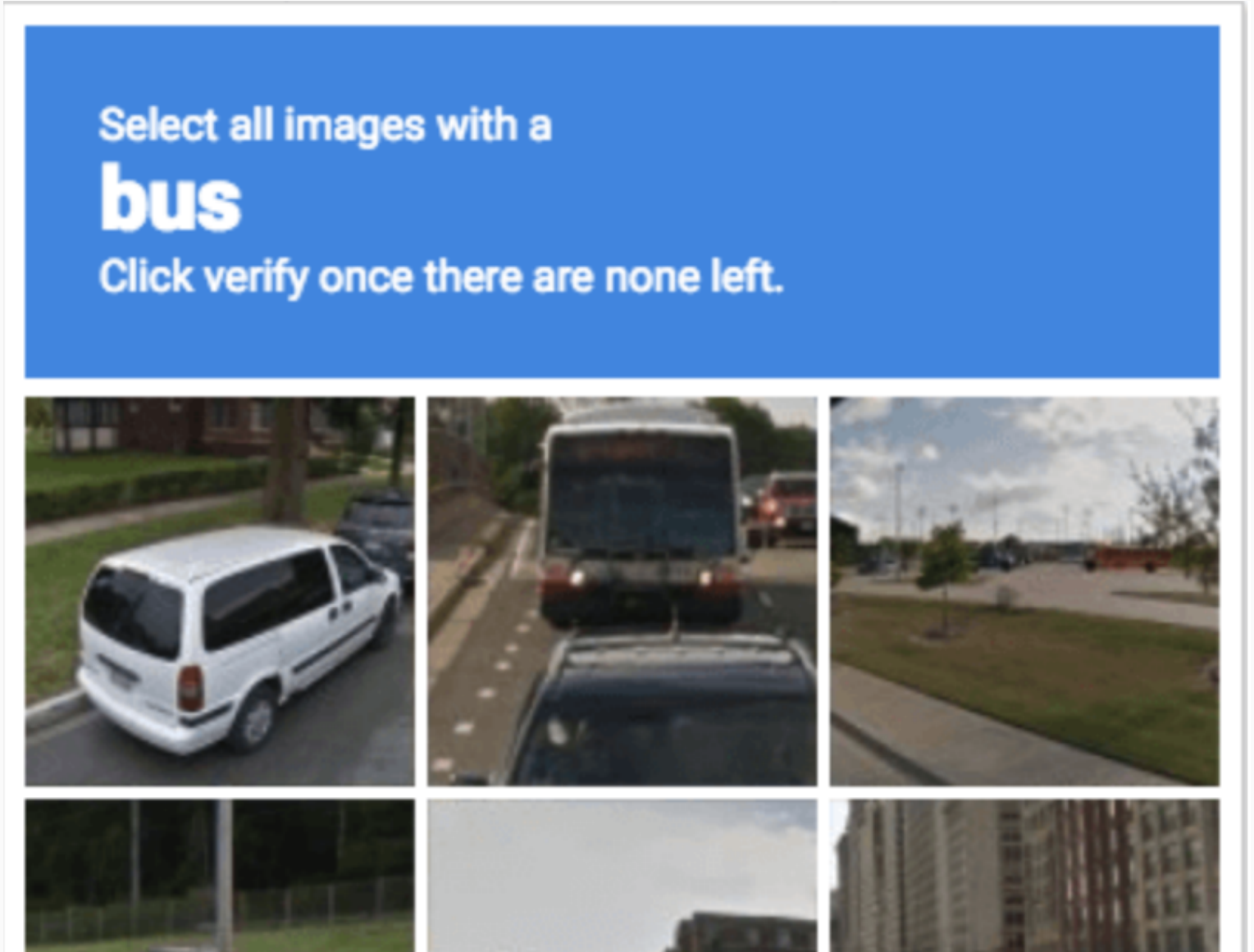

What about. . .

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Using machine learning to identify undiagnosable cancers

A new model that maps developmental pathways to tumor cells may unlock the identity of cancers of unknown primary.

Turing machines

Turing machine = Finite automaton + memory

Turinger machines?

- Two dimensional memory
- Many reading heads
- Random-access memory
- Non-determinism
- Parallelism
- Cellular automata
- Crystalline automata
- ...

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... are all equivalent to a Turing machine!

Church-Turing thesis

Anything that is computable is computable by a Turing machine.

Non-computable patterns?

- Truth vs falsehoods
- Correct vs incorrect computer programs

Further developments

How efficiently computable?

- Polynomial time versus exponential time?

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- Multiplying $n \times n$ matrices: best method takes about $n^{2.37}$ operations. Can we do faster?

Further developments

How efficiently computable?

- Polynomial time versus exponential time?
- Multiplying $n \times n$ matrices: best method takes about $n^{2.37}$ operations. Can we do faster?
- Can we do faster with parallelisation? Quantum computers? Probabilistic computation?

Futher questions

- Are there any physical processes that are more capable than a Turing machine?
- Is the human brain (theoretically) more capable?