CSE322: Models

Why do we need (so many of ) them?

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The main goal of this course

- Models for computation
  - Ones with different powers
  - Ultimately model the computer

Why should we study models?

- Addition of numbers
  - Add numbers “one” and “two”
- One way
- Another way

Good qualities of models

- Simple
- Capture “reality”
- Abstract
- Once we understand the model, we can do more complex things with it
  - Area of a circle of radius \( r = \pi r^2 \)
  - Try computing the area with

What have we seen so far

- Regular languages
- DFAs
  - State Diagrams
  - Formal description \( M=(Q,\Sigma,\delta,s,F) \)
- Why have formal definitions?
  - More “general” \( L_k=\{w| k^{\text{th}} \text{ last symbol is } 1\} \)
  - “Easier” to code up (for eg if DFA is an input)

Two sides of the same coin

- NFAs
- (equivalent to) DFAs
- Why do we need two different models?
A very vaguely related analogy

- But we know it is the same person

The rationale behind multiple models

- Different models are useful for different things
- Storing a sequence of numbers
  - Linked Lists vs Arrays
  - What is the 3rd element?
- Insert 99 before the 3rd element

Let’s compare NFAs and DFAs

<table>
<thead>
<tr>
<th>NFA</th>
<th>DFA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to construct</td>
<td>Harder to construct</td>
</tr>
<tr>
<td>Cannot code it up</td>
<td>Can code it up</td>
</tr>
</tbody>
</table>

Uses of Equivalence

- Use closure constructions
- Can have many extra states

In other words

- Constructive equivalence results
  - Shows that two different models are the same
  - A method to convert from one model to another

In the next 3 weeks…

- Next week (week 4)
  - Study limits of DFAs
  - Languages that are not regular
  - Pumping Lemma
- The week after (week 5)
  - DFA minimization
  - Myhill-Nerode theorem
  - Another way to prove certain languages are not regular
Coming up next….

- Yet another model for Regular languages
- Regular expression
  - Equivalent to DFAs
- Very short description