Question: Can one instance of a TM simulate another? (yes!) Is there a TM that will simulate all Turing Machines? (yes!) This "universal" TM will simulate any TM given the latter's quintuples and a copy of its tape.

A. Encoding States, Symbols, and Directions:

1. List out all states, symbols, and the directions (L, R).
2. Assign unary notation values to states, symbols and directions

<table>
<thead>
<tr>
<th>States</th>
<th>Symbols</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - 1</td>
<td>blank - 1</td>
<td>L - 1</td>
</tr>
<tr>
<td>B - 11</td>
<td>a - 11</td>
<td>R - 11</td>
</tr>
<tr>
<td>C - 111</td>
<td>b - 111</td>
<td></td>
</tr>
</tbody>
</table>

3. Encode quintuples, tape, current state, current symbol, and current head position on the tape of a Universal TM.

1. Encode quintuples separating their elements by a 0 and the quintuples by 00. End with 000.
2. Encode tape separating symbols with a 0. The position of the tape head is marked by a P in front of the tape symbol it is currently on.
3. Encode the current state, current symbol using a W followed by the current state followed by a 0 followed by the current symbol.

Example: The above set of quintuples for a TM with initial tape abba with the tape head on the first symbol would be encoded as

```
A a b A R A b a A R A _ _ B L B a a B L B b b B L
101101110101100101110101010110100110110101101001101101111011011001100110110110100
<- Quintuples ...

B _ _ C R a b b a A a
1101010111011000001101110111011101110110111001101101110110100
^ ...
```

B. Executing the Universal Turing Machine

1. Find the quintuple which matches the current state/symbol in Work Area
2. Change state in Work Area
3. Write symbol in Tape Area
4. Move head in Tape Area
5. Copy new tape symbol to current symbol in Work Area
6. Repeat

Observe: Every Turing Machine can be encoded as a binary integer!