Semantics (II)

What is the program state?
- The state of a program is the binding of all variables to their current values.
- A variable and its value can be modeled as an ordered pair, e.g. \(<i, 5>\)
- A state is a set of ordered pairs (dictionary)

\[
\text{state} = \{ <\text{var}_1, \text{val}_1>, <\text{var}_2, \text{val}_2>, \ldots <\text{var}_m, \text{val}_m> \}
\]

- A program can have more than one states.
  - A state is a snapshot of the memory of the variables used by a program. After each statement execution, the program will have a new snapshot.

Example
- The program calculates factorial. Show the states of this program.

<table>
<thead>
<tr>
<th>Snapshot</th>
<th>Before Statement</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 int main () {</td>
<td>4</td>
<td>(&lt;a, \text{undef}&gt;, &lt;b, \text{undef}&gt;)&gt;</td>
</tr>
<tr>
<td>2 int a, b;</td>
<td>5</td>
<td>(&lt;a, 1&gt;, &lt;b, \text{undef}&gt;)&gt;</td>
</tr>
<tr>
<td>3 a = 1;</td>
<td>7</td>
<td>(&lt;a, 1&gt;, &lt;b, 2&gt;)&gt;</td>
</tr>
<tr>
<td>4 b = a + b;</td>
<td>9</td>
<td>(&lt;a, 1&gt;, &lt;b, 3&gt;)&gt;</td>
</tr>
<tr>
<td>5 return 0;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 }</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Meaning Function of Clite
- We know that the input of the semantics analysis stage of compilation is an abs syntax tree.
- So, to determine the meaning of a abs tree, we will figure out the precise meaning of each node/subtree of its abs tree.
Consider an assignment statement. What do assignment statements do?

- Modify the “state” of the program or the contents of the computer’s memory.
- How do we indicate that mathematically?
  \[ \text{old state} \rightarrow \text{new state} \]
- This sounds like a function with input and output. An assignment statement is just a function that takes a state as input and outputs a state.
  \[ M(\text{assignment}, \text{oldstate}) = \text{newstate} \]
- \( M \) stands for “meaning”. The above function reads as “the meaning of this assignment statement in this state is this new state”