### Data Races

```c
void foo() {
    int x = 1;
    spawn(bar);
    lock(M);
    x++;
    unlock(M);
    print(x);
    // Prints 3 or 4
}
```

### Deadlocks

```c
void foo() {
    int x = 1;
    spawn(bar);
    lock(N);
    lock(M);
    x++;
    unlock(M);
    unlock(N);
}
```

### The Problem with SHIM: Deadlock

```c
void main() {
    chan int a, b;
    { // Task 1
        a = 15; b = 10;
        send a;
        send b;
    } // Task 2
    int c;
    recv a;
    recv b;
    c = a + b;
    // value of c is 25
}
```

### Results

<table>
<thead>
<tr>
<th>Example</th>
<th>Lines</th>
<th>Channels</th>
<th>Tasks</th>
<th>Result</th>
<th>Runtime</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source/Sink</td>
<td>35</td>
<td>2</td>
<td>11</td>
<td>No Deadlock</td>
<td>0.2 s</td>
<td>3.3 MB</td>
</tr>
<tr>
<td>Pipeline</td>
<td>30</td>
<td>7</td>
<td>13</td>
<td>No Deadlock</td>
<td>0.1 s</td>
<td>2.0 MB</td>
</tr>
<tr>
<td>Prime Sieve</td>
<td>35</td>
<td>51</td>
<td>45</td>
<td>No Deadlock</td>
<td>1.7 s</td>
<td>25.4 MB</td>
</tr>
<tr>
<td>Berkeley</td>
<td>40</td>
<td>3</td>
<td>11</td>
<td>No Deadlock</td>
<td>0.2 s</td>
<td>7.2 MB</td>
</tr>
<tr>
<td>FIR Filter</td>
<td>100</td>
<td>28</td>
<td>28</td>
<td>No Deadlock</td>
<td>0.4 s</td>
<td>13.4 MB</td>
</tr>
<tr>
<td>Bitonic Sort</td>
<td>130</td>
<td>65</td>
<td>167</td>
<td>No Deadlock</td>
<td>8.5 s</td>
<td>63.8 MB</td>
</tr>
<tr>
<td>Framebuffer</td>
<td>220</td>
<td>11</td>
<td>12</td>
<td>No Deadlock</td>
<td>1.7 s</td>
<td>11.6 MB</td>
</tr>
<tr>
<td>JPEG Decoder</td>
<td>1020</td>
<td>7</td>
<td>15</td>
<td>May Deadlock</td>
<td>0.9 s</td>
<td>85.6 MB</td>
</tr>
<tr>
<td>JPEG Modified</td>
<td>1025</td>
<td>7</td>
<td>15</td>
<td>No Deadlock</td>
<td>0.9 s</td>
<td>85.6 MB</td>
</tr>
</tbody>
</table>

### Conclusions

- SHIM: A deterministic concurrent model
- We can statically detect deadlocks
- Using synchronous methodologies to verify asynchronous systems.
- Future Work:
  - Increase channel buffer size to increase performance and avoid deadlocks
  - Convince the world: SHIM's philosophy: Deadlocks are better than data races