FINITE STATE MACHINES: A DESIGN PATTERN FOR FPGAS AND REACT

Tessa Bradbury

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WHY THIS TOPIC?

REACT?

REACT?

```
Greeting = ({ name }) => (
  <p className="awesomest-font">
    Hello {name}! Welcome to LCA!
  </p>
)
```

REACT?

```
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  <p className="awesomest-font">
    Hello {name}! Welcome to LCA!
  </p>
)
```

```
<Greeting name={currentName}/>
```

REACT STATE

```
class Greeting extends React.Component {
  state = { name: '' }

  updateName = event => {
    this.setState({ name: event.target.value })
  }

  render() (
    <div>
      <label for="name">Name</label>
      <input id="name" onChange={this.updateName}/>
      <Greeting name={this.state.name}/>
    </div>
  )
}
```

FPGA?

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Field Programmable Gate Array

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```
always @(posedge sysclk) begin
  red_led <= ~red_led
end
```

FPGA?

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```

```
# sysclk=sysclk
NET "sysclk" LOC = "C9";
# led_5=red_led
NET "red_led" LOC = "D11" | IOSTANDARD = LVTTL | SLEW = SLOW |
```

FINITE STATE MACHINE?

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1. A finite set of states

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   - (state, event) => state

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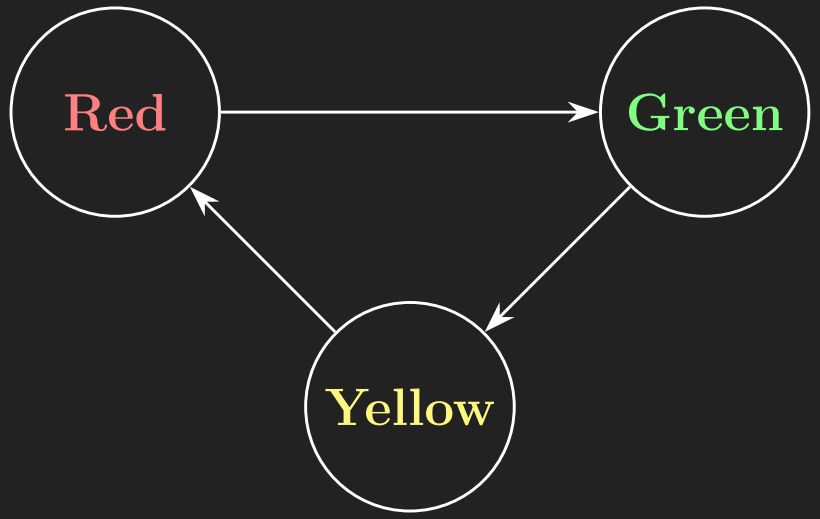
   * Not part of official definition

TRAFFIC LIGHTS


Red
Green
Yellow

WHAT ELSE?

WHAT ELSE?

- TCP

WHAT ELSE?

- TCP
- Bug tracker

WHAT ELSE?

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- Bug tracker
- Registration wizard

WHAT ELSE?

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- Bug tracker
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- Games

WHAT ELSE?

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- Bug tracker
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- …

WHAT DO THESE HAVE IN COMMON?

- States make sense
- Different behaviour in different states
- Clear transitions between states

If FSMs are everywhere, why are they so central to React and FPGAs?

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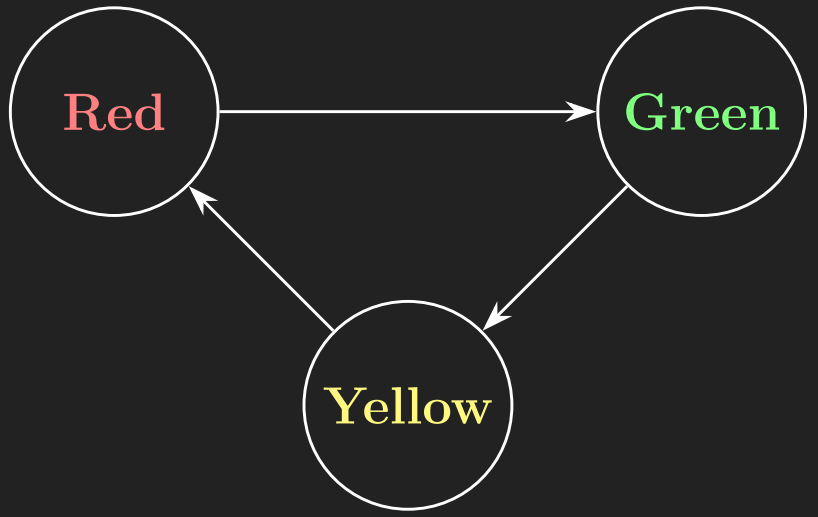
Event orientated systems

TRAFFIC LIGHTS — DEEP DIVE



ASIDE: WHAT'S THE EVENT?

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- Platform dependent
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Focus on the transition function

REACT

S

REACT

```
updateLights = event => {
  this.setState(state => {
    if (state === RED) {
      return GREEN
    } else if (state === GREEN) {
      return YELLOW
    } else if (state === YELLOW) {
      return RED
    } else {
      return state
    }
  }
}
```

S

VERILOG

```
always @(*) begin
  if (update_lights)
    case(state)
      `RED:
        next_state = `GREEN;
      `GREEN:
        next_state = `YELLOW;
      `YELLOW:
        next_state = `RED;
    endcase
  else
    next_state = state;
end
```

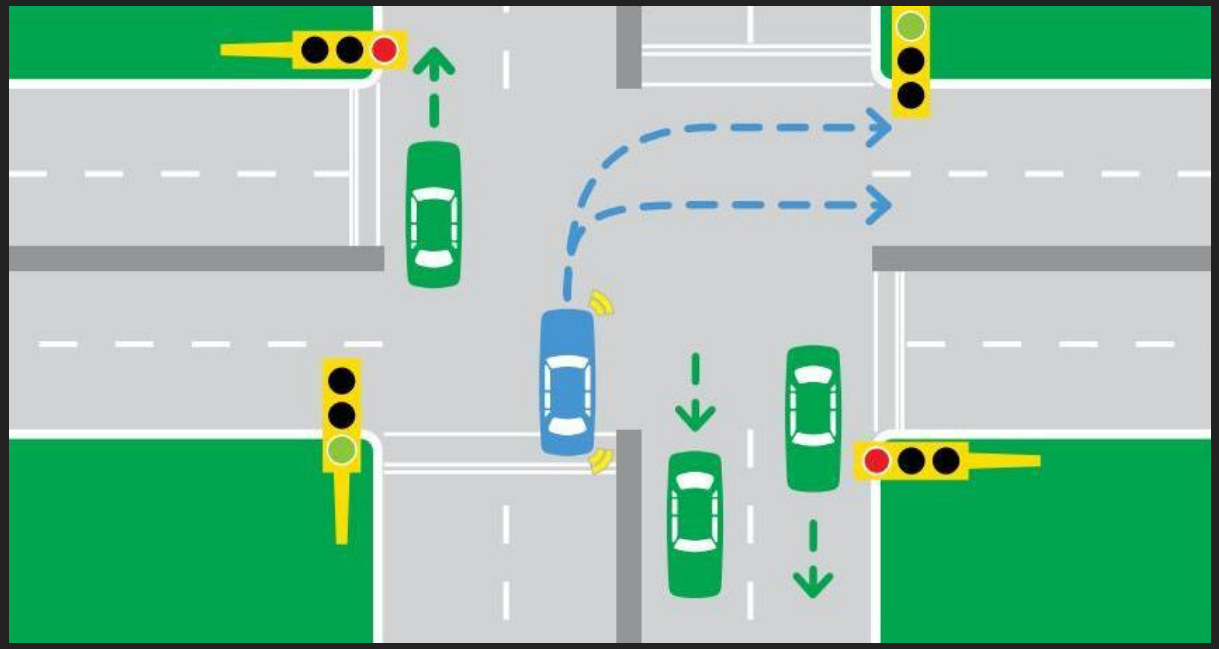
```
always @(posedge sysclk) begin
  state <= next_state
end
```

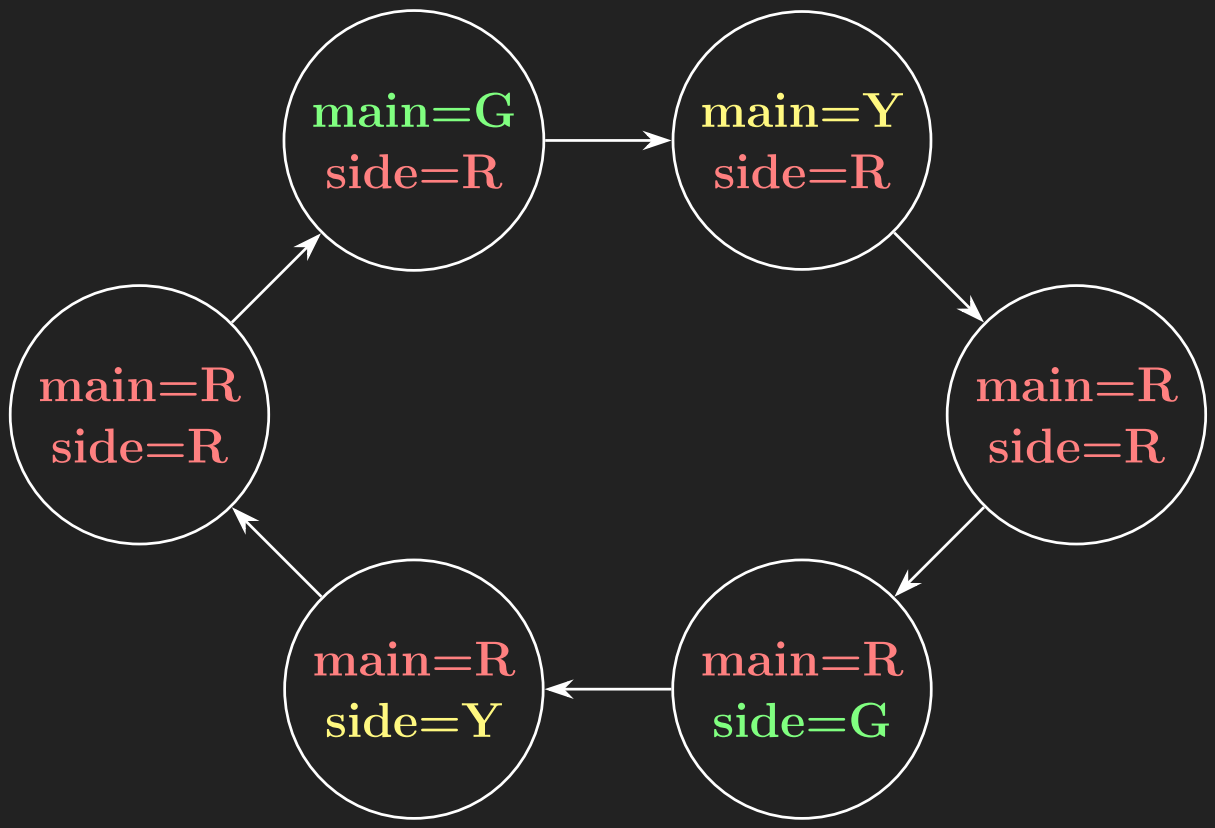
Outputs

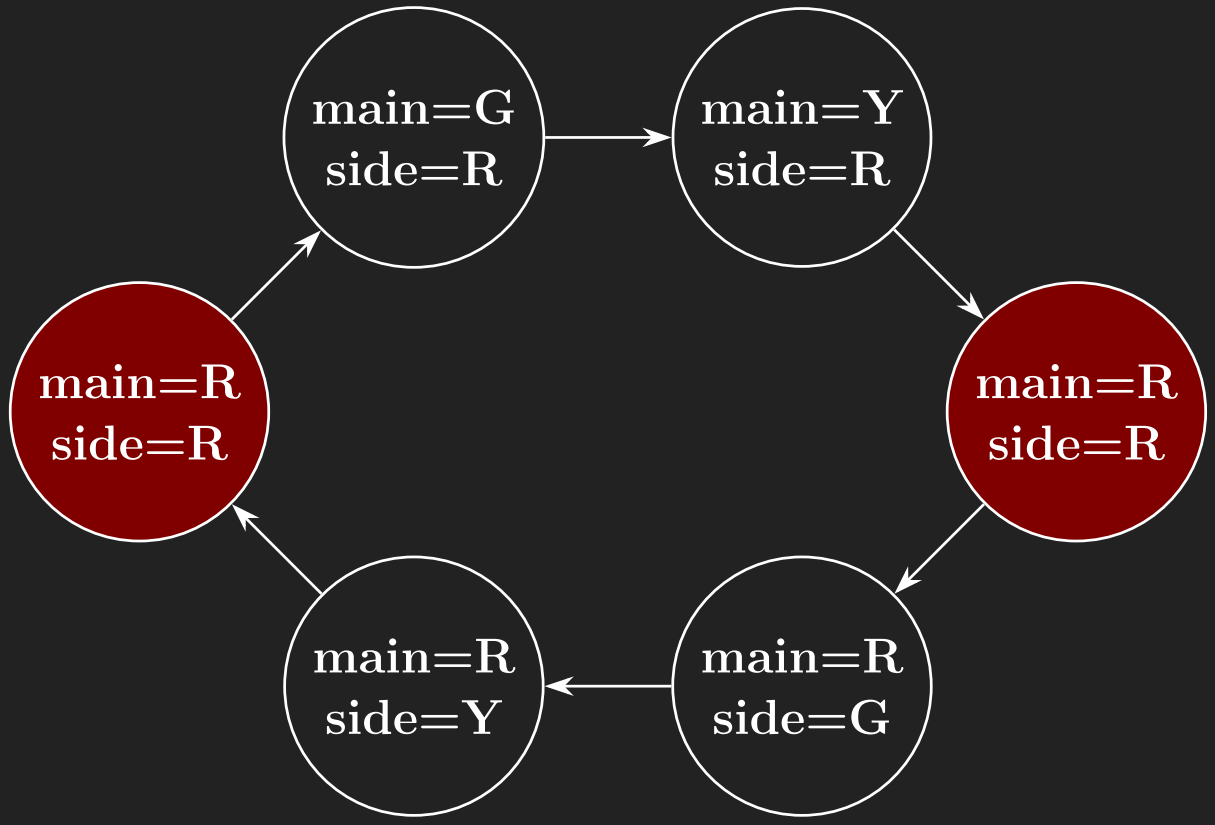
```
TrafficLight = function(state) {
  return (
    <div>
      <Light colour="red"    lit={state == RED}/>
      <Light colour="yellow" lit={state == YELLOW}/>
      <Light colour="green"  lit={state == GREEN}/>
    </div>
  )
}
```

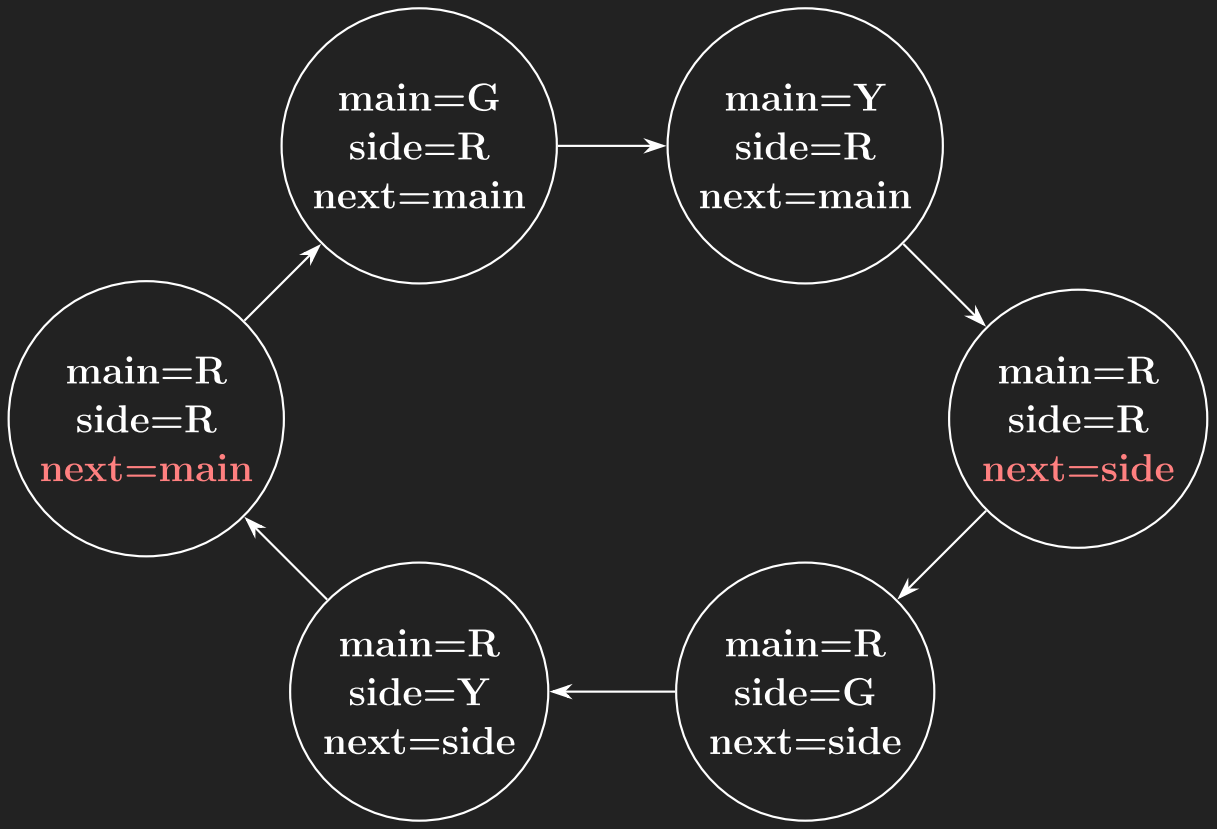
```
assign main_red_light    = state == `RED;
assign main_yellow_light = state == `YELLOW;
assign main_green_light  = state == `GREEN;
```

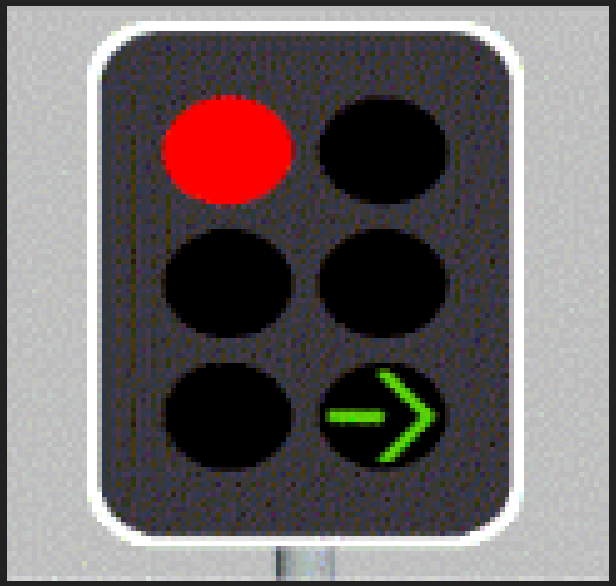
INTERSECTIONS

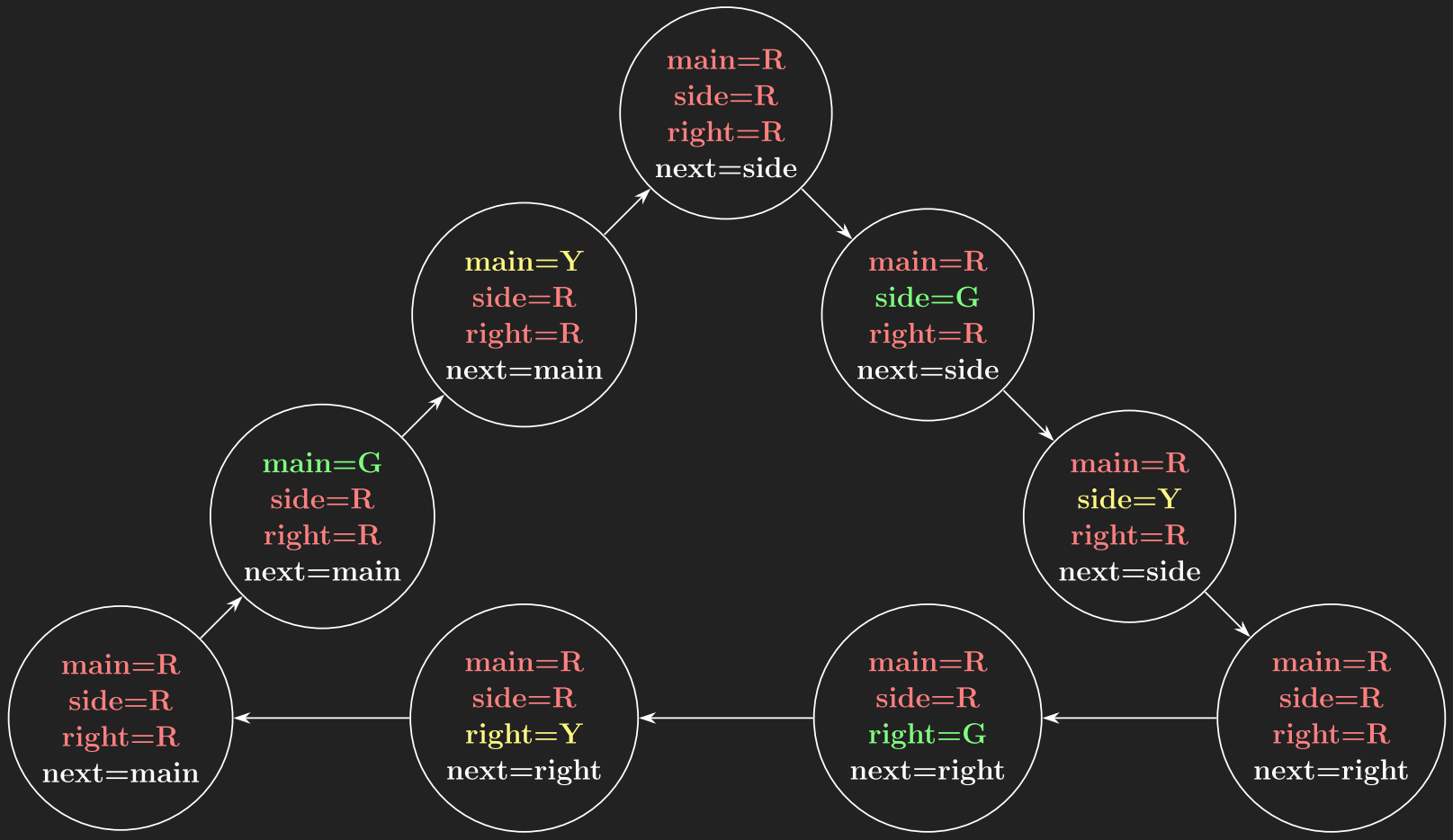



main=G
side=R
main=Y
side=R
main=R
side=R
main=R
side=G
main=R
side=Y
main=R
side=R


main=G
side=R
main=Y
side=R
main=R
side=R
main=R
side=R
main=R
side=Y
main=R
side=G


main=G
side=R
next=main
main=Y
side=R
next=main
main=R
side=R
next=side
main=R
side=G
next=side
main=R
side=Y
next=side
main=R
side=R
next=main



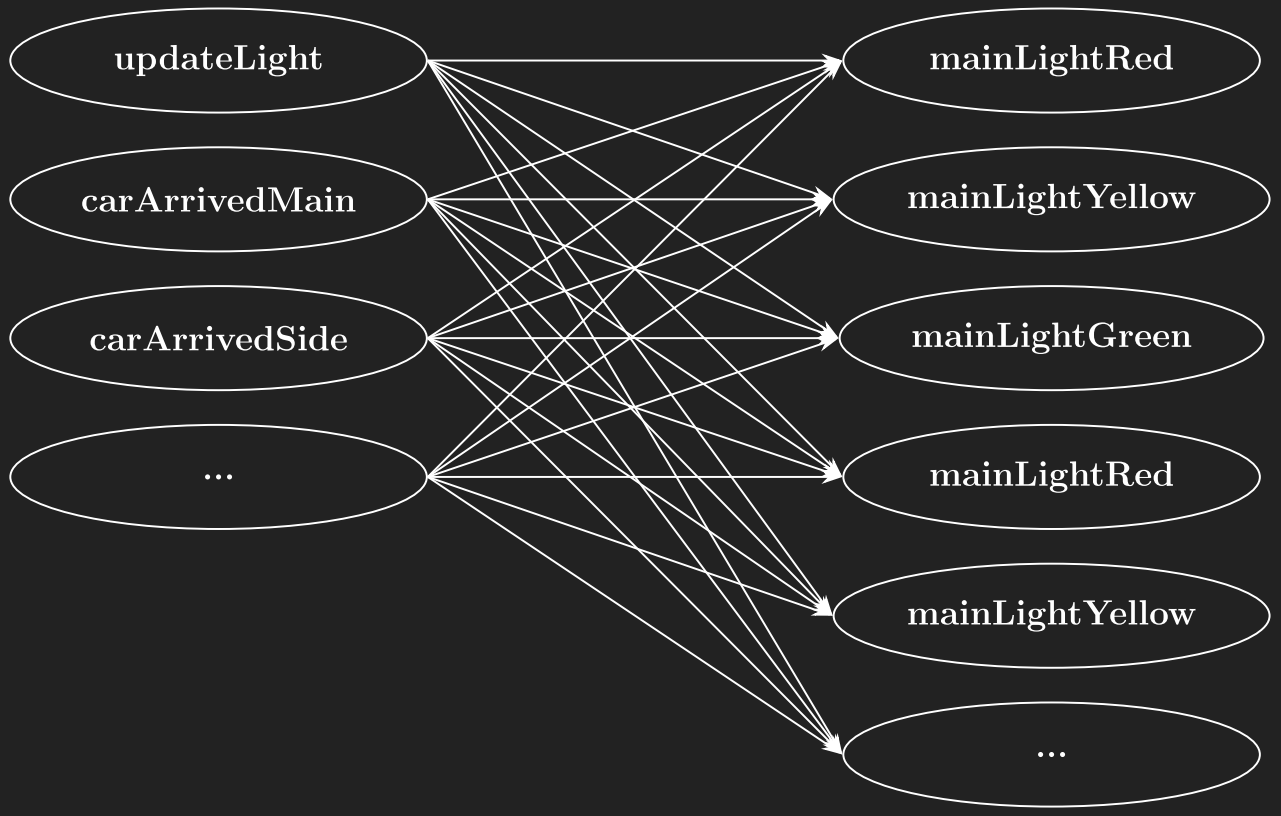

main=R
side=R
right=R
next=side
main=R
side=G
right=R
next=side
main=R
side=Y
right=R
next=side
main=R
side=R
right=R
next=right
main=R
side=R
right=G
next=right
main=R
side=R
right=Y
next=right
main=R
side=R
right=R
next=main
main=G
side=R
right=R
next=main
main=Y
side=R
right=R
next=main

SO WHAT DOES THIS GIVE US?

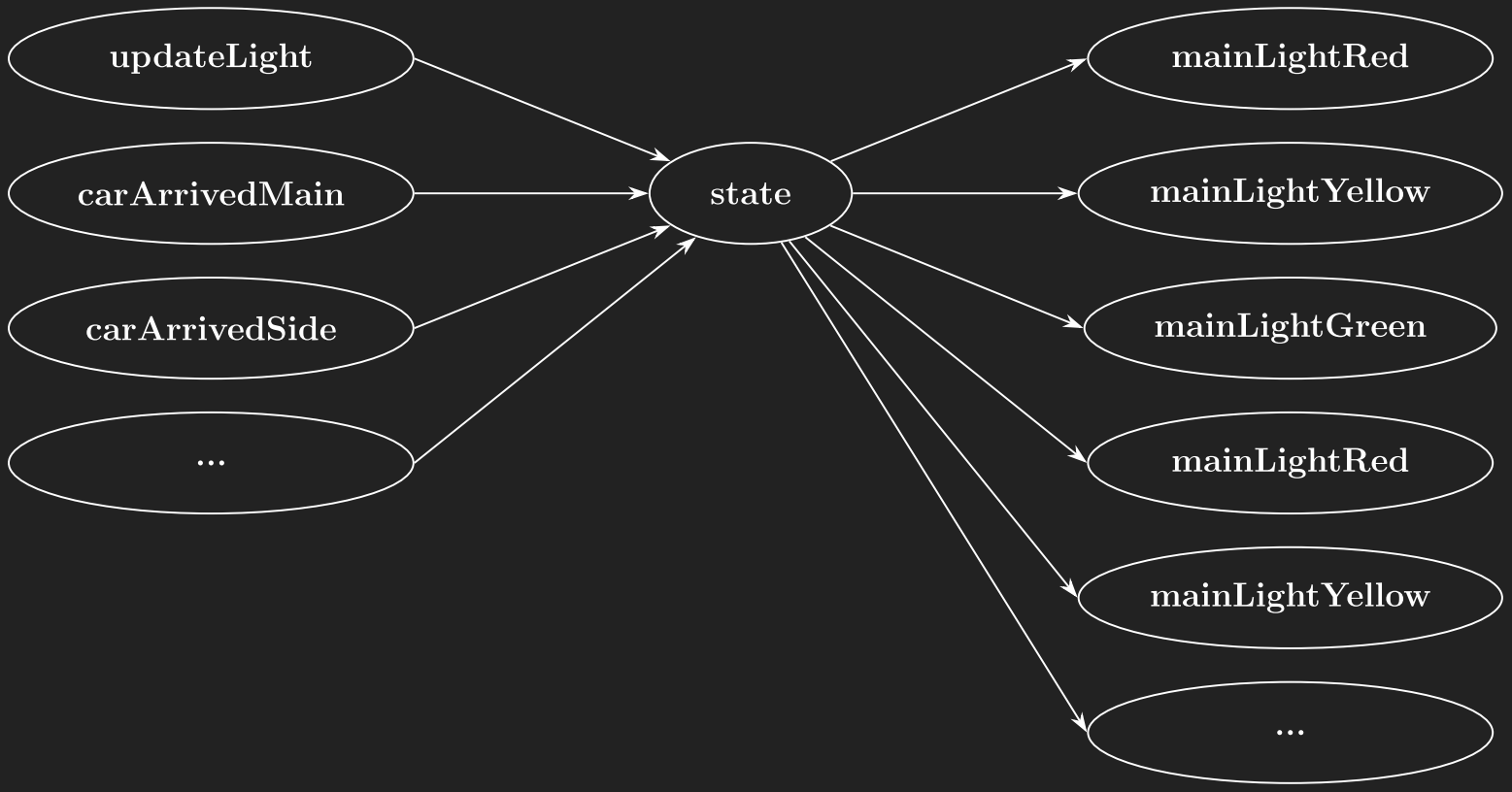
MOAR FEATURES!

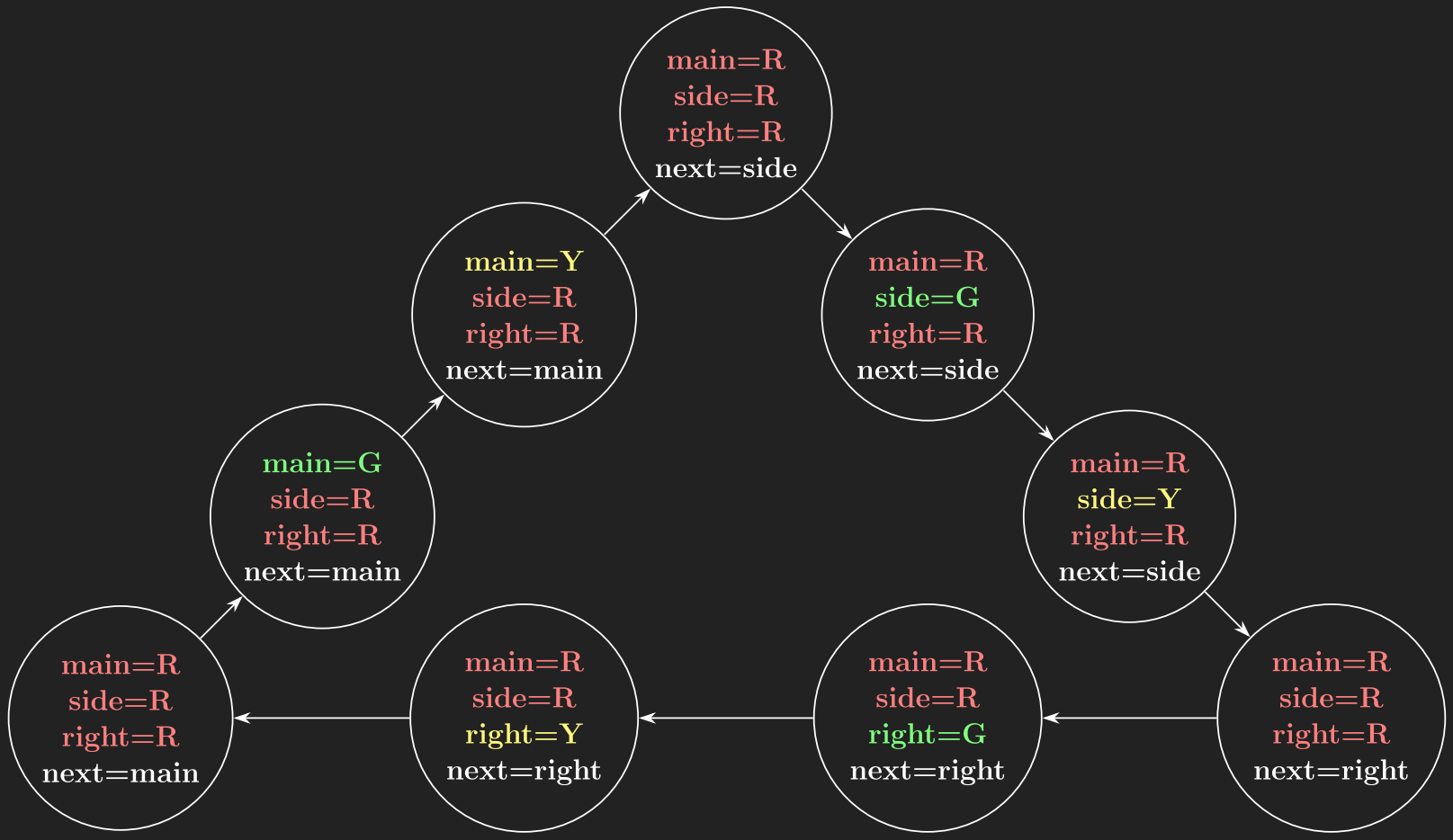
- Pedestrian lights
- Car arrival detection
- Different directions combinations
- …

WITHOUT STATE



WITH STATE


updateLight
carArrivedMain
carArrivedSide
...
state
mainLightRed
mainLightYellow
mainLightGreen
mainLightRed
mainLightYellow
...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side=G
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side=R
right=R
next=right
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next=right
main=R
side=R
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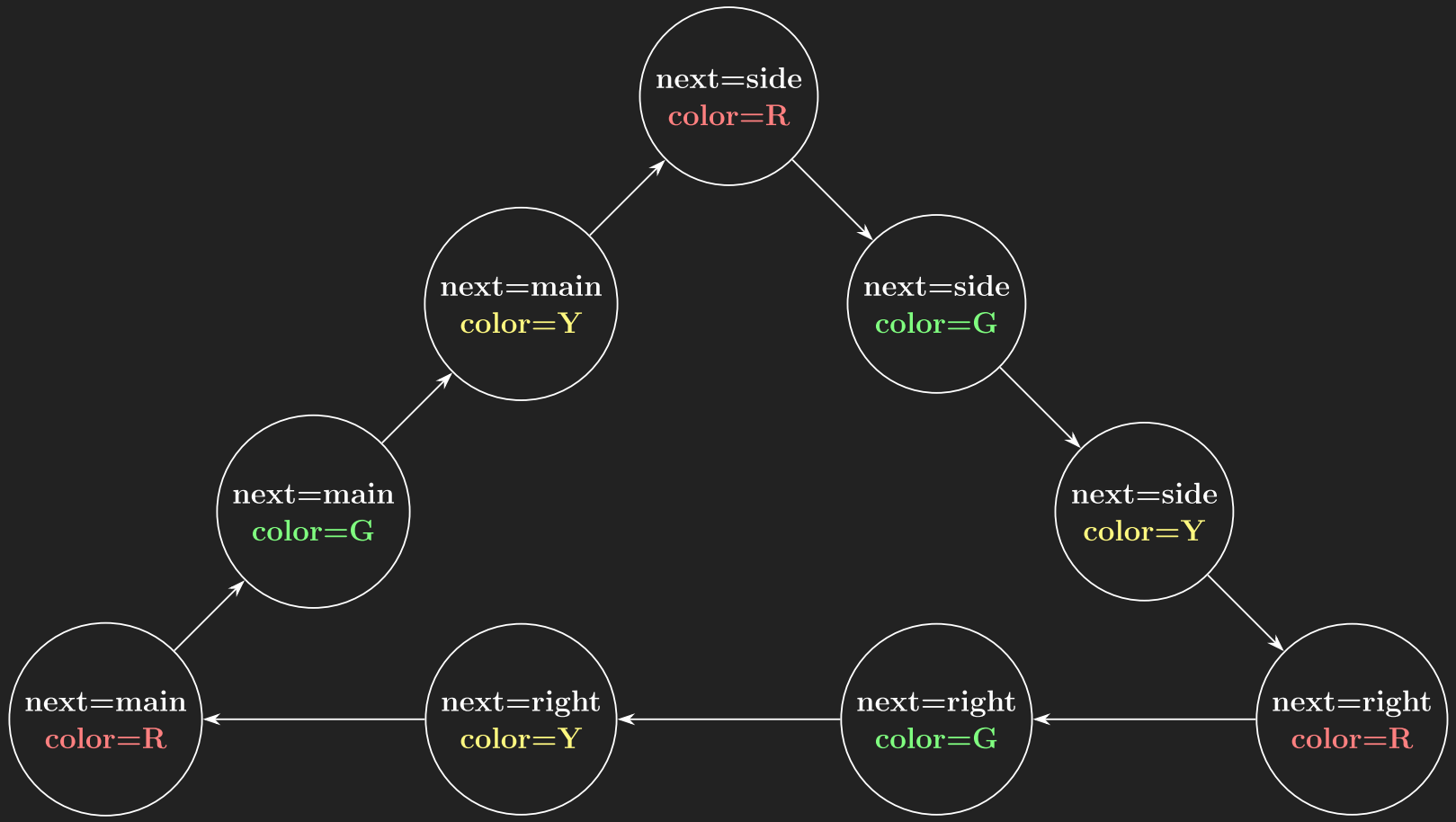
next=side
color=R
next=side
color=G
next=side
color=Y
next=right
color=R
next=right
color=G
next=right
color=Y
next=main
color=R
next=main
color=G
next=main
color=Y

REMEMBER

- Be intentional about your
  - States
  - Events
  - Transitions
- Draw a diagram!

Finite state machines provide a useful abstraction to help us reason about the complex behaviour of our systems

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There are a lot more similarities between disciplines than you might think

THANK YOU!

github.com/tessereth/talks