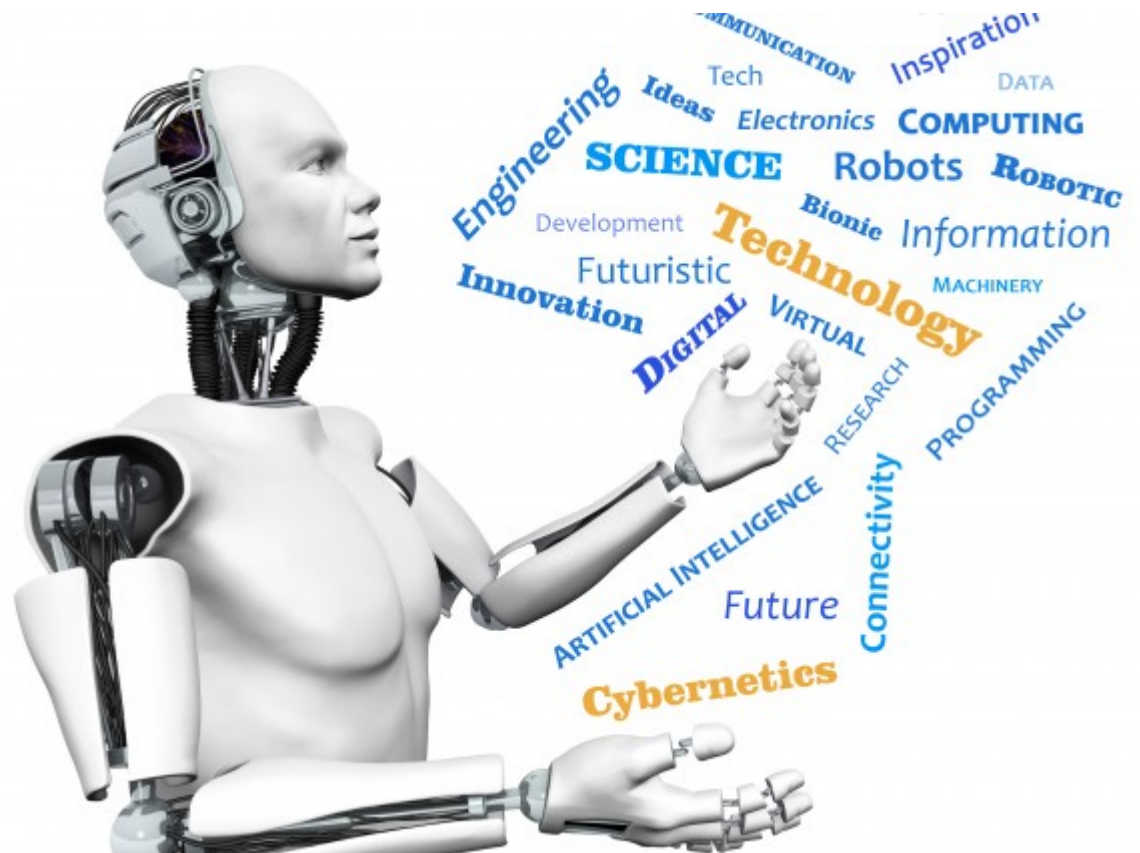


15-494/694: Cognitive Robotics

Dave Touretzky

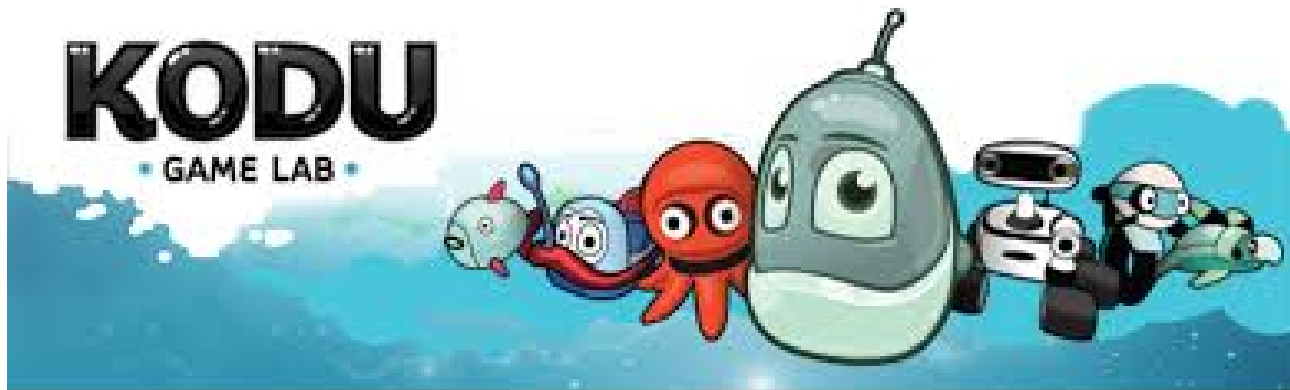
Lecture 14:

Calypso (Kodu for Robots)



Microsoft's Kodu Game Lab

- Children's programming language: make your own computer games.
- Developed by Microsoft FUSE Labs.
- Released in 2009 for Xbox 360 and Windows.
- Inspired by behavior-based robotics.



Kodu Worlds

Full 3D, with physics and sound effects.



“Parallel” WHEN-DO Rules



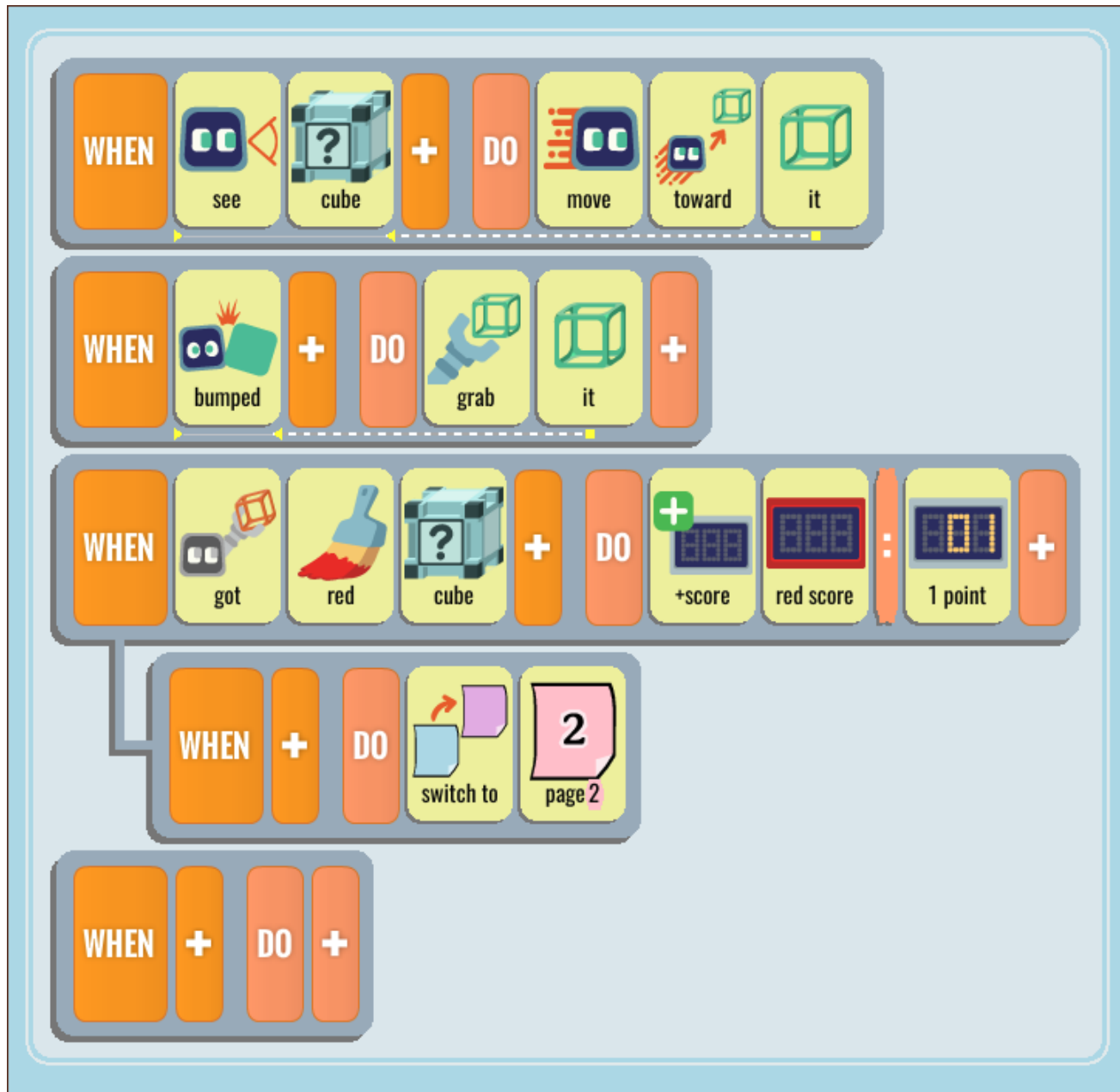
Menu Selection



Calypso: Kodu for Robots



Sample Calypso Program



Context-Sensitive Petal Menus

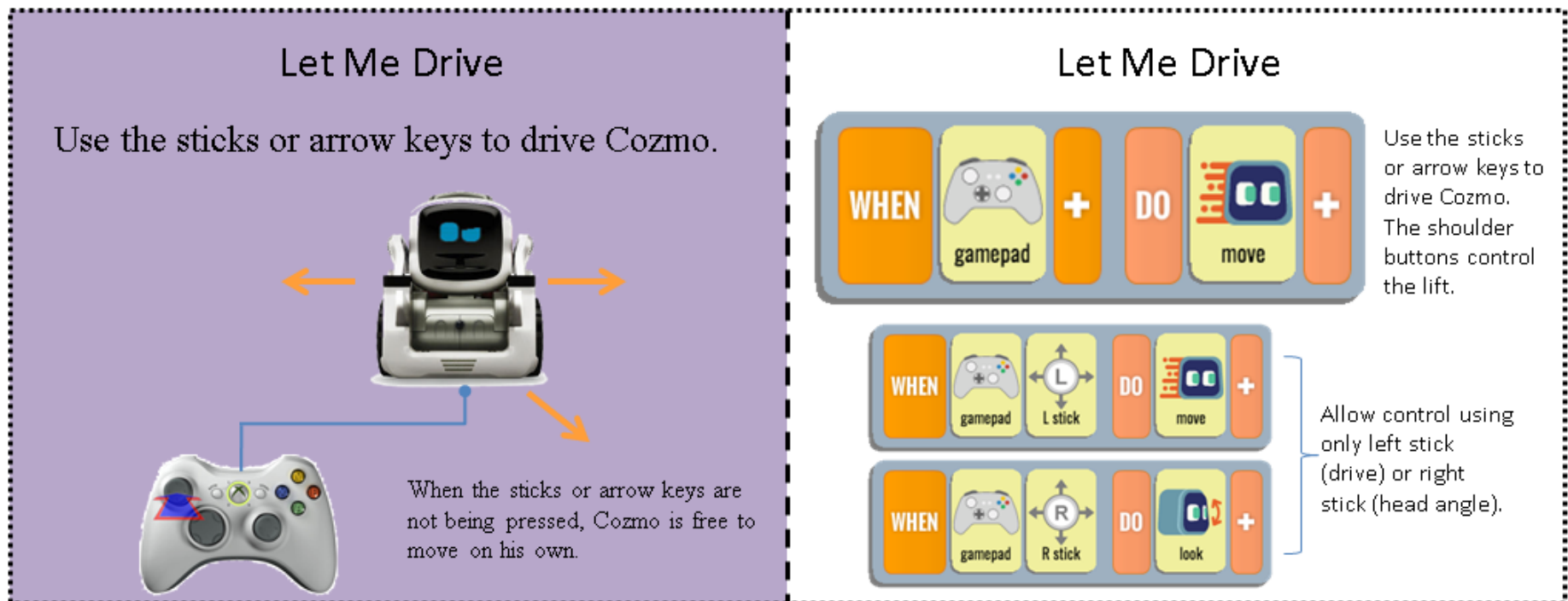


The Robot's World Map

The screenshot displays the Calypso 0.9.04 interface. The top browser window shows the URL `127.0.0.1:43125/Calypso/index.html`. The interface is divided into several sections:

- Control Panel (Left):** Includes buttons for "Stop program", "State machine view" (Ctrl ↑), "Switch characters" (Ctrl ← →), "Map editor view" (Ctrl ↓), and "Scroll up/down" (Esc).
- Scripting Area (Center-Left):** Features two rows of logic blocks. The top row is active and shows a "WHEN" block followed by "see" (robot icon), "cube" (cube icon), a "+" sign, a "DO" block, "move" (robot icon), "toward" (arrow icon), and "it" (cube icon). The bottom row is inactive and shows "WHEN", "bumped" (robot icon), "cube", "+", "DO", "grab" (robot icon), "it", and "+".
- World Map (Right):** A large white area representing the robot's environment. It contains a robot icon at the bottom, a red line representing a path or sensor range, and several small square icons representing objects or landmarks.
- Video Feed (Bottom-Left):** A black and white camera view of the robot's environment. Two small white cubes are visible on the floor, labeled "Lightcube 2 id=1" and "Lightcube 2 id=2".
- Status Bar (Bottom):** Displays battery levels: "Cozmo's battery 4 volts", "Cube1 batt 1.28V (56%)", and "Cube3 batt 1.08V (16%)".

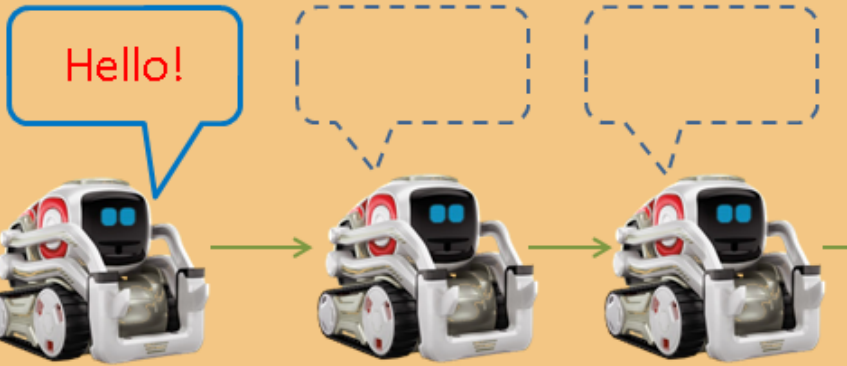
Calypso Idioms (Design Patterns)



Calypso Idioms (Design Patterns)

Once Is Enough

Do something one time instead of repeatedly.

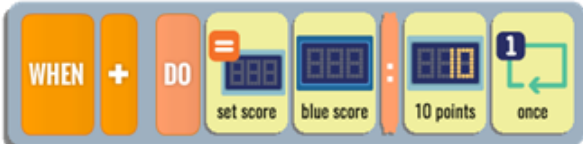


WHEN DO say "Hello!" once


WHEN **condition** DO **action** once

Once Is Enough


Set the blue score to 10 once; don't try to change it after that:



Act playful when you first see a green cube:



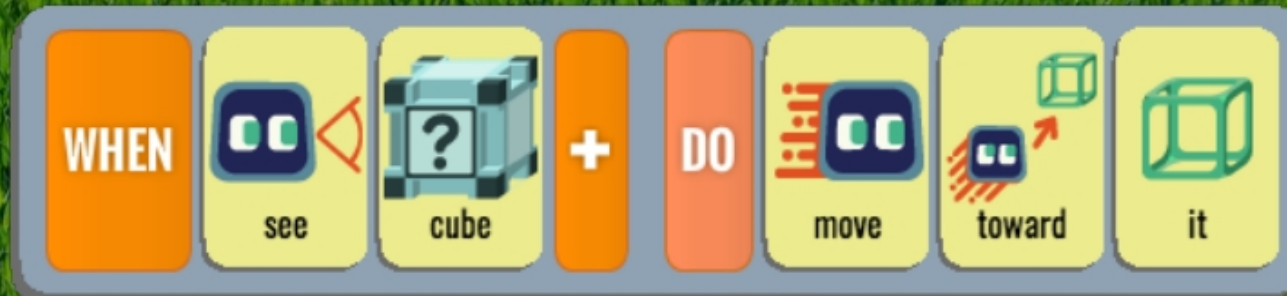
Score one point when you go from "no cube visible" to seeing a cube:



First Law of Calypso

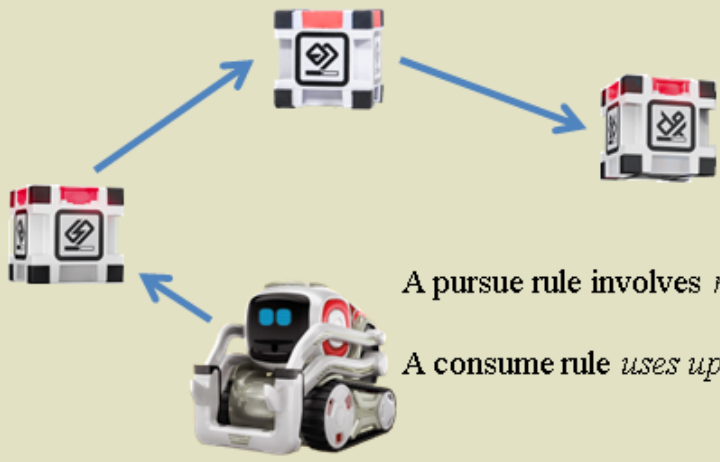
First Law of *Calypso*

Each rule picks the closest matching object.



Calypso Idioms (Design Patterns)

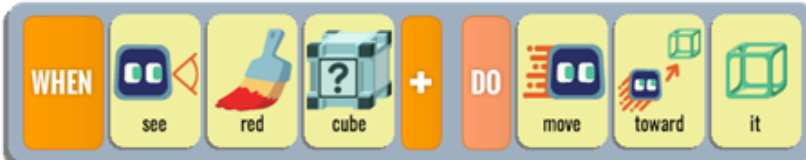
Pursue and Consume
Make Cozmo extinguish all the red cubes.




A pursue rule involves *motion*.
A consume rule *uses up* the object.

Pursue and Consume

Pursue rule



Consume rule



General Form:
WHEN see *thing* DO move toward it
WHEN bumped *thing* DO *consume* it

Second Law of Calypso

Second Law of *Calypso*
Any rule that can run, will run.

The diagram illustrates the Second Law of Calypso with three rule blocks and a robot. The top block is a grey rule: WHEN bumped red cube DO grab it. The middle block is an orange rule: WHEN see red cube DO move toward it. The bottom block is a grey rule: WHEN bumped red cube DO grab it. A red dotted arrow points from the robot to the top block, labeled "Seeing + Moving". A blue dotted arrow points from the middle block to the top block, labeled "same behavior as:". The robot is labeled "Not Bumping".

WHEN bumped red cube DO grab it

WHEN see red cube DO move toward it

WHEN bumped red cube DO grab it

Seeing + Moving

same behavior as:

Not Bumping

Third Law of Calypso

Third Law of *Calypso*
When actions conflict, the earliest wins.

The diagram illustrates the Third Law of Calypso with two conflicting action sequences and a robot in a game environment. The top sequence is active, while the bottom one is faded.

WHEN	see	red	cube	+	DO	move	toward	it
Active	Active	Active	Active	Active	Active	Active	Active	Active
Faded	Faded	Faded	Faded	Faded	Faded	Faded	Faded	Faded

The bottom sequence is faded, indicating it is not the earliest action.

At the bottom, a robot is shown in a game environment. A blue dashed arrow points from the robot to a blue cube on the left, and a red dashed arrow points from the robot to a red cube on the right, illustrating the conflict between the two actions.

Calypso Idioms (Design Patterns)

Default Value

When the A button is pressed, glow red.
Otherwise glow blue.



situation → DO **action1** **value**
otherwise → DO **action1** **default-value**

Default Value

When the A button is pressed, glow red; otherwise glow blue.



General Form:

```
WHEN situation DO action1 value  
WHEN DO action1 default-value
```

The default case must come *after* the specific case. The action must be the same in both rules; only the value is different. For different actions, use the If-Then-Else idiom.

Fourth Law of Calypso

Fourth Law of *Calypso*

An indented rule can run only if its parent's action succeeds.

A Kodu block with a yellow background. It starts with a 'WHEN' block (orange), followed by 'bumped' (robot bumping a green block), 'green' (green block), 'cube' (cube with question mark), 'DO' (orange), 'grab' (hand holding cube), 'it' (cube), and a '+' sign.

A Kodu block with a yellow background. It starts with a 'WHEN' block (orange), followed by 'scored' (digital display '222'), 'yellow score' (digital display '000'), 'greater' (red >), '0 points' (digital display '000'), a '+' sign, 'DO' (orange), 'play' (robot playing music), 'beeprobo' (speech bubble), and a '+' sign.

A smaller Kodu block with a yellow background, identical to the first block: 'WHEN' (orange), 'bumped' (robot bumping green block), 'green' (green block), 'cube' (cube with question mark), 'DO' (orange), 'grab' (hand holding cube), 'it' (cube), and a '+' sign.

Score: 5



A smaller Kodu block with a yellow background, identical to the second block: 'WHEN' (orange), 'scored' (digital display '222'), 'yellow score' (digital display '000'), 'greater' (red >), '0 points' (digital display '000'), a '+' sign, 'DO' (orange), 'play' (robot playing music), 'beeprobo' (speech bubble), and a '+' sign.

Score: 0



A smaller Kodu block with a yellow background, identical to the first block: 'WHEN' (orange), 'bumped' (robot bumping green block), 'green' (green block), 'cube' (cube with question mark), 'DO' (orange), 'grab' (hand holding cube), 'it' (cube), and a '+' sign.

Score: 5



Actions don't fail in Kodu, but they do on real robots.


Calypso Idioms (Design Patterns)

Do Two Things

Make Cozmo take two actions with one WHEN condition.

WHEN *something* ... DO **this** 

and also →

DO **that** 

Do Two Things

When you feel a cube being tapped, move the lift *and also* play a sound.



General Form:

WHEN *something* DO *action1*

↳ WHEN DO *action2*

Indenting the second rule makes it dependent on the success of the action of the parent rule.

Calypso Idioms (Design Patterns)

Count Actions

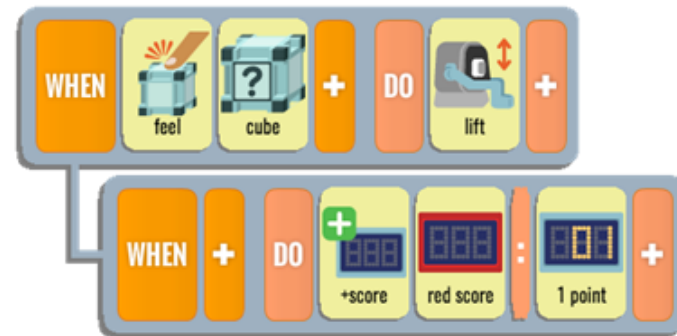
Make Cozmo keep a count of an action he takes.
This is a special case of Do Two Things.



WHEN *something* DO **action**
↳ *and also* → score **color** 1 point

Count Actions

When you move the lift, add one to the red score.



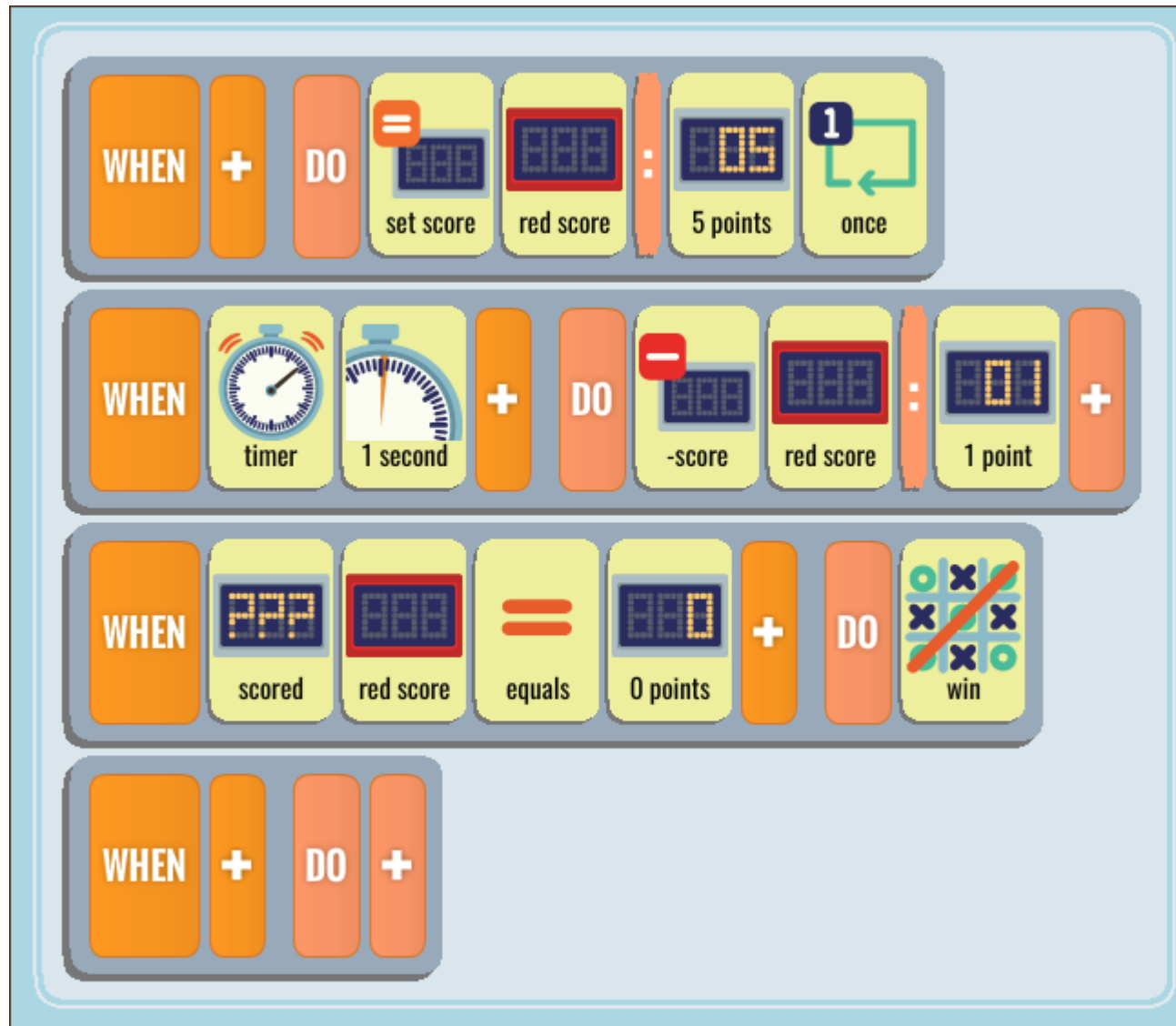
General Form:

WHEN *something* DO **action**

↳ WHEN DO score **color** 1 point

Scores are named by colors and displayed above the world map.

Parallel WHEN Evaluation?



In Kodu this would exit immediately.

Fifth Law of Calypso

Fifth Law of *Calypso*
On every cycle, earlier actions affect later rules.

WHEN bumped cube DO glow it blue

WHEN see blue DO grab it

WHEN got blue DO switch to page 2

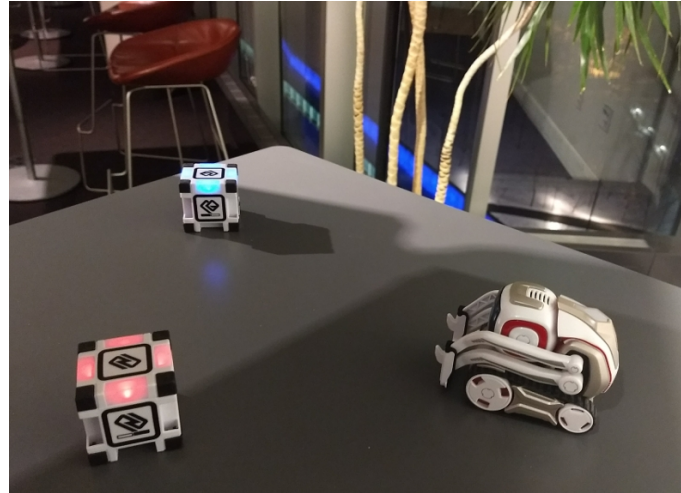
1

1

2

Differs from Kodu, where all WHEN parts are evaluated simultaneously.

Visiting Cubes in Sequence



PAGE 1:

WHEN				+	DO			
WHEN	+	DO						
WHEN				DO				

PAGE 2:

WHEN				+	DO			
WHEN	+	DO						
WHEN				DO				

State Machine View



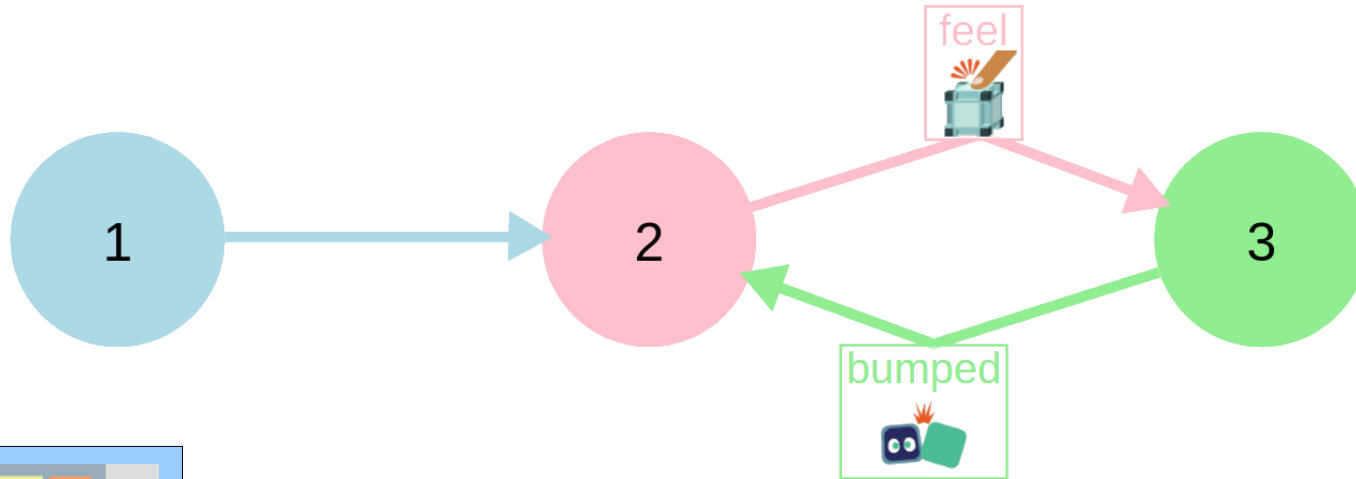
PAGE 1:

WHEN				+	DO			
WHEN	+	DO						
WHEN				DO				

PAGE 2:

WHEN				+	DO			
WHEN	+	DO						
WHEN				DO				

Loopy State Machine



PAGE 1:

WHEN	+	DO	say	+
WHEN	+	DO	switch to	page 2

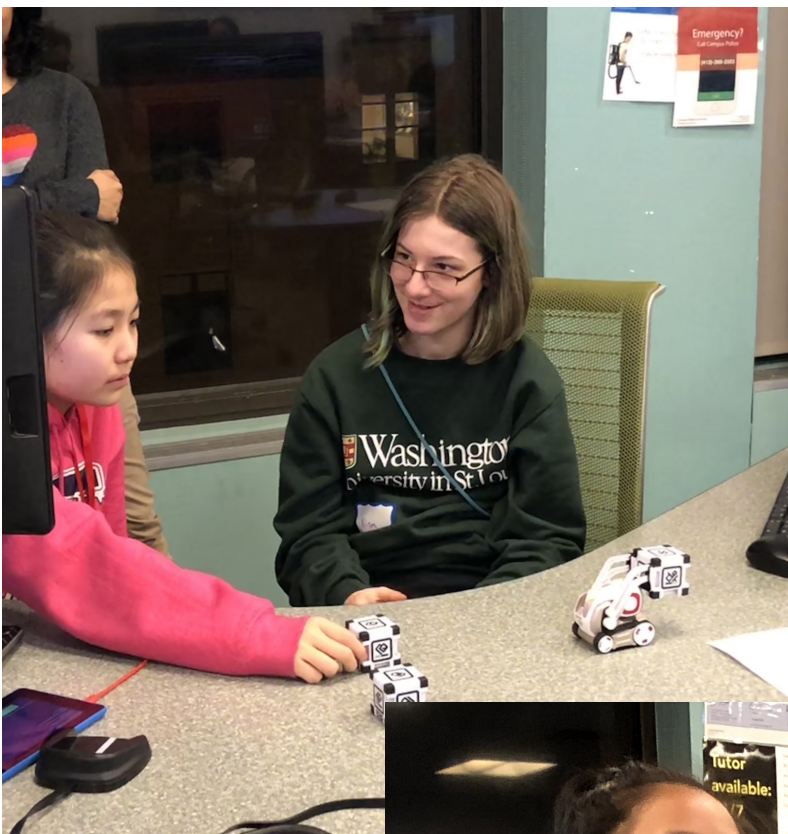
PAGE 2:

WHEN	feel	cube	+	DO	glow	it	red	+
WHEN	+	DO	switch to	page 3				

PAGE 3:

WHEN	see	red	cube	+	DO	move	toward	it
WHEN	bumped	red	cube	DO	glow	it	none	+
WHEN	+	DO	say	+				
WHEN	+	DO	switch to	page 2				

tap on another one



Testing
With
Real
Kids

Code Lab vs. Calypso (1/2)

Feature	Code Lab	Calypso for Cozmo
Free	✓	✗
Familiar to anyone who knows...	Scratch	Kodu Game Lab
Built in to the Cozmo app	✓	✗
Large display; runs on laptop or desktop	✗	✓
Camera viewer shows you what Cozmo is seeing	✗	✓
User-visible world map	✗	✓
Interpreter highlights rules that are running	✗	✓
Xbox game controller, mouse, or keyboard input	✗	✓

Code Lab vs. Calypso (2/2)

Feature	Code Lab	Calypso for Cozmo
Voice commands	✗	✓
Simulator mode	✗	✓
Support for state machines	✗	✓
Detects failed actions	✗	✓
Free online curriculum	✗	✓

Calypso Development Plans

- Add support for walls and places.
 - Cozmo's clubhouse.
 - Cozmo's Magic Dreamhouse
- New object types:
 - Chips
 - Qubes
 - Containers
- Multi-robot support