

15-494/694: Cognitive Robotics

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Lecture 16:

Calypso (Kodu for Robots)

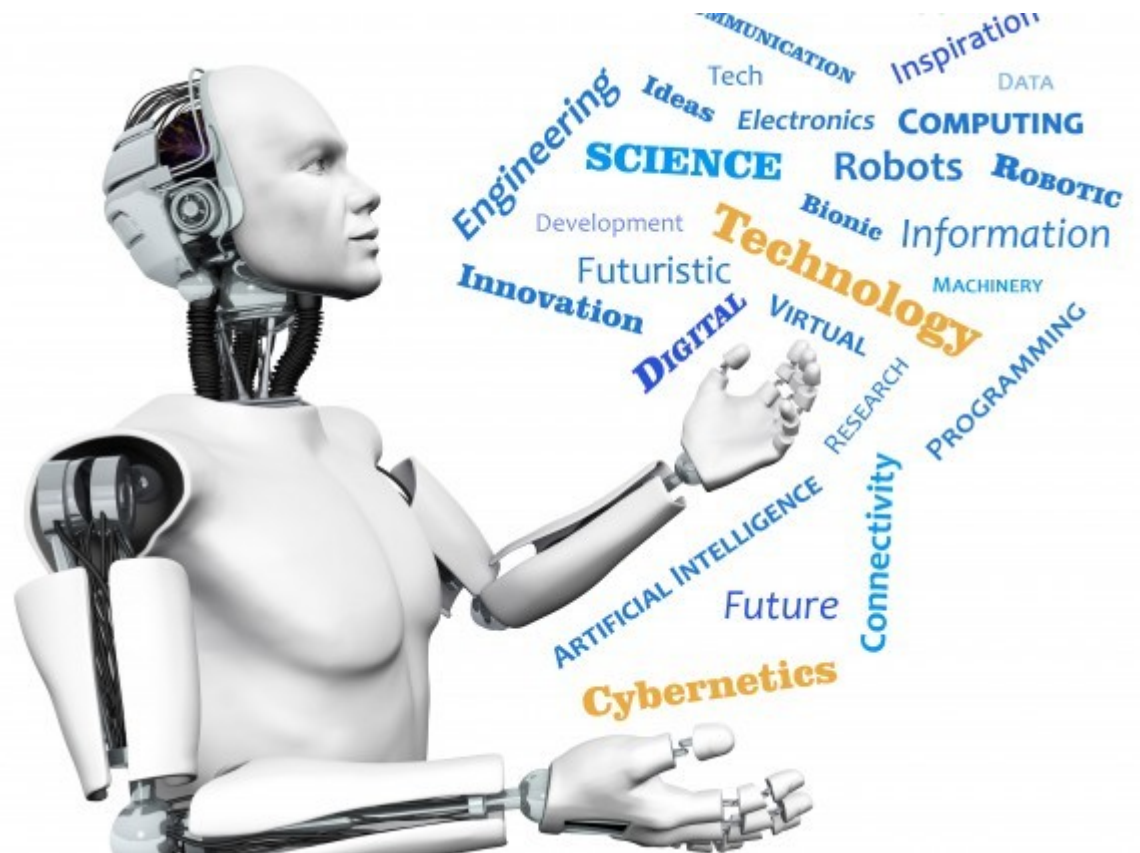
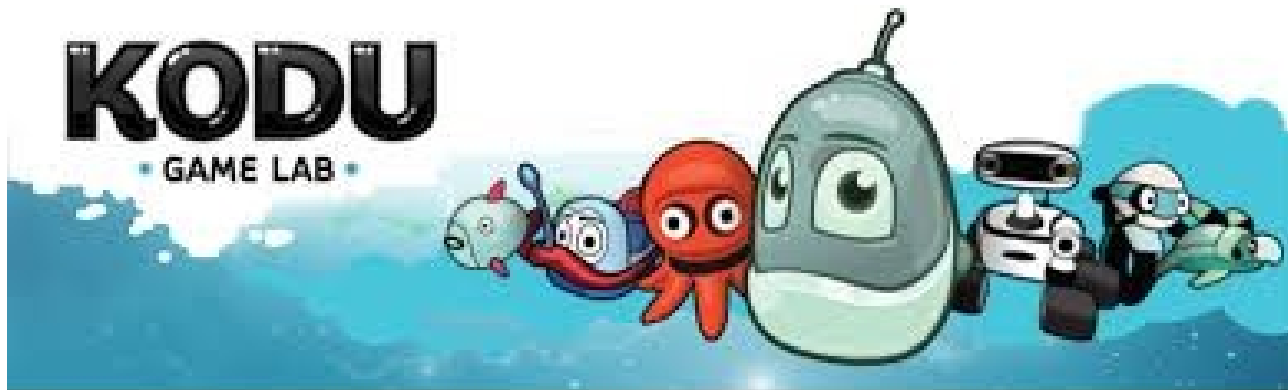


Image from <http://www.futuristgerd.com/2015/09/10>

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



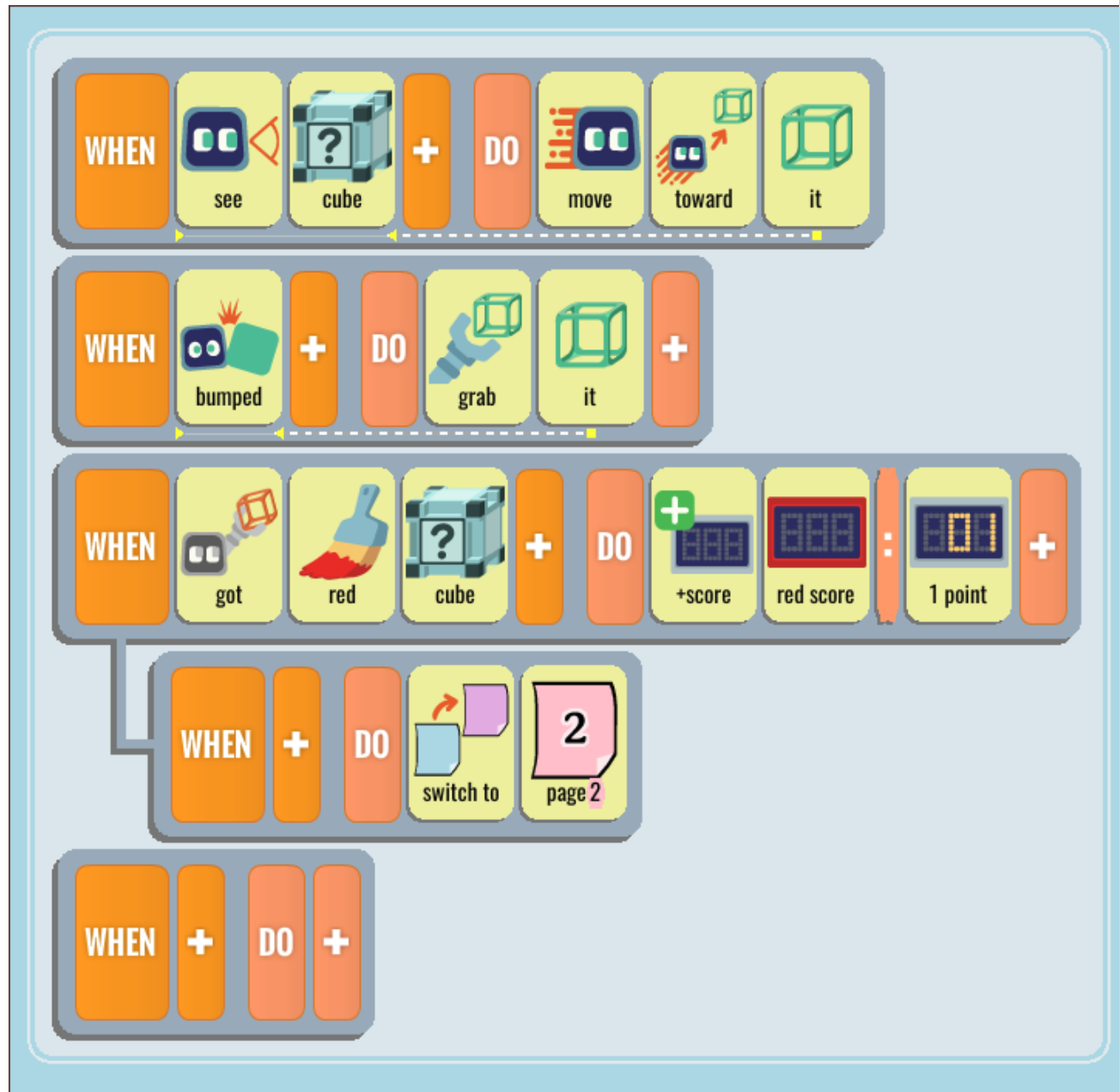
Menu Selection



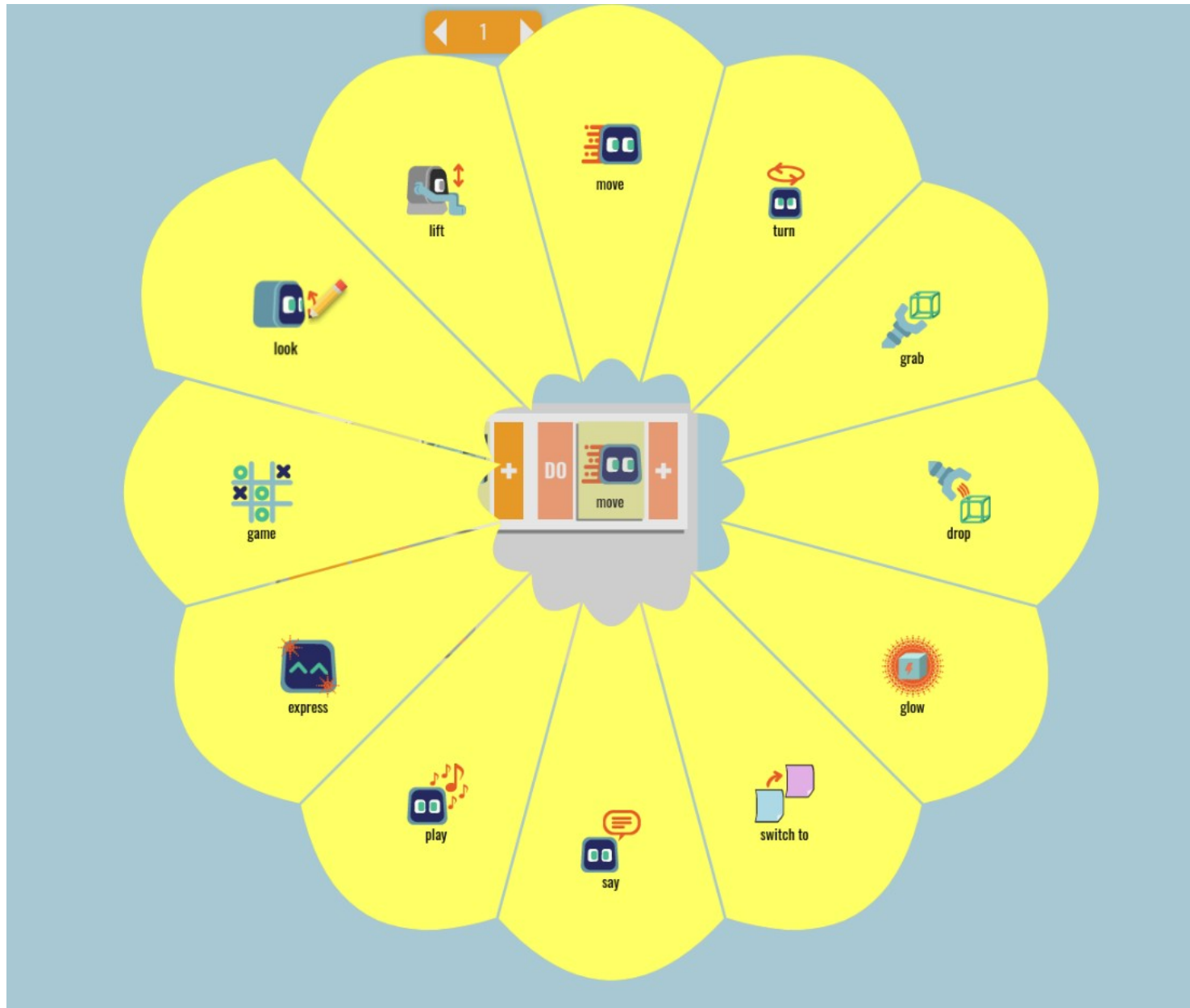
Calypso: Kodu for Robots



Sample Calypso Program



Context-Sensitive Petal Menus



The Robot's World Map

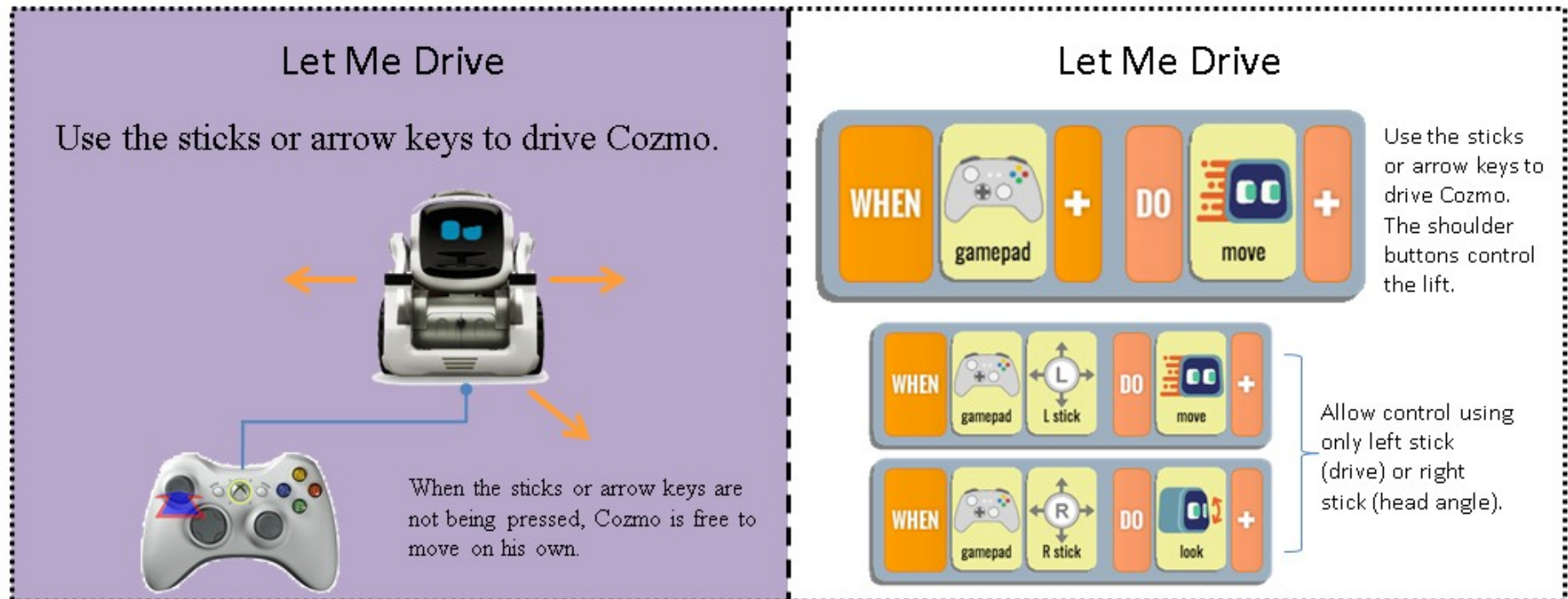
The screenshot displays the Calypso 0.9.04 web interface. The top navigation bar includes a 'Settings' link and a browser tab for 'Calypso 0.9.04'. The address bar shows the URL '127.0.0.1:43125/Calypso/index.html'. Below the navigation bar, there are several tabs for different applications: 'Apps', 'West Mifflin, PA', 'Browse K-12 STE', 'Seniors For Safe', 'CMU Oracle Web', 'S3 Admin Console', 'Home - Workday', 'The Best of the F', '15-294-A3 Rapid', and 'Cognitive Robot'.

The main interface is divided into two main sections. On the left, there is a control panel with a 'Stop program' button and a 'State machine view' button. Below these, there are two rows of buttons for controlling the robot's actions. The first row contains a 'WHEN' button, a 'see' button, a 'cube' button, a '+' button, a 'DO' button, a 'move' button, a 'toward' button, and an 'it' button. The second row contains a 'WHEN' button, a 'bumped' button, a 'cube' button, a '+' button, a 'DO' button, a 'grab' button, an 'it' button, and a '+' button. A small robot icon is visible in the top right corner of the control panel.

On the right, there is a large white area representing the robot's world map. It shows a top-down view of the robot's environment, with a red line indicating the robot's current position and orientation. The map includes several small icons representing objects in the environment, such as a cube and a lightcube.

At the bottom of the interface, there is a video feed showing a close-up view of the robot's camera. The video feed shows two lightcubes on a table, labeled 'Lightcube 2 id=1' and 'Lightcube 2 id=2'. The robot's battery status is displayed at the bottom right: 'Cozmo's battery 4 volts', 'Cube1 batt 1.28V (56%)', and 'Cube3 batt 1.08V (16%)'.

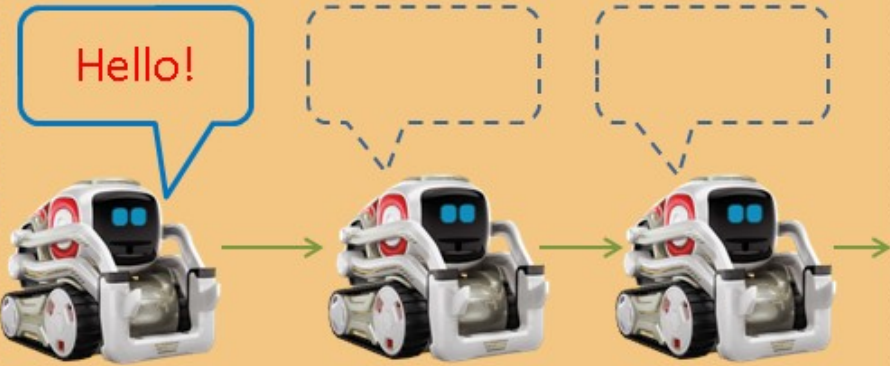
Calypso Idioms (Design Patterns)



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:



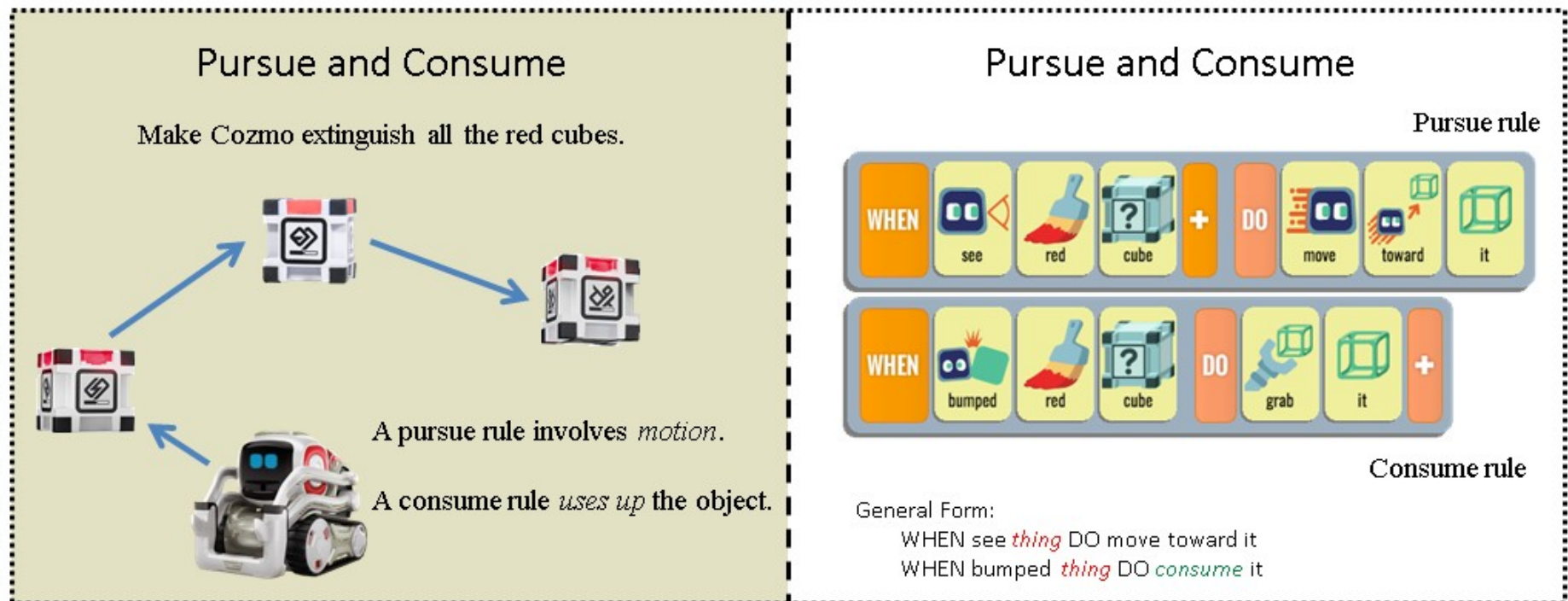
Score one point when you go from "no cube visible" to seeing a cube:



First Law of Calypso

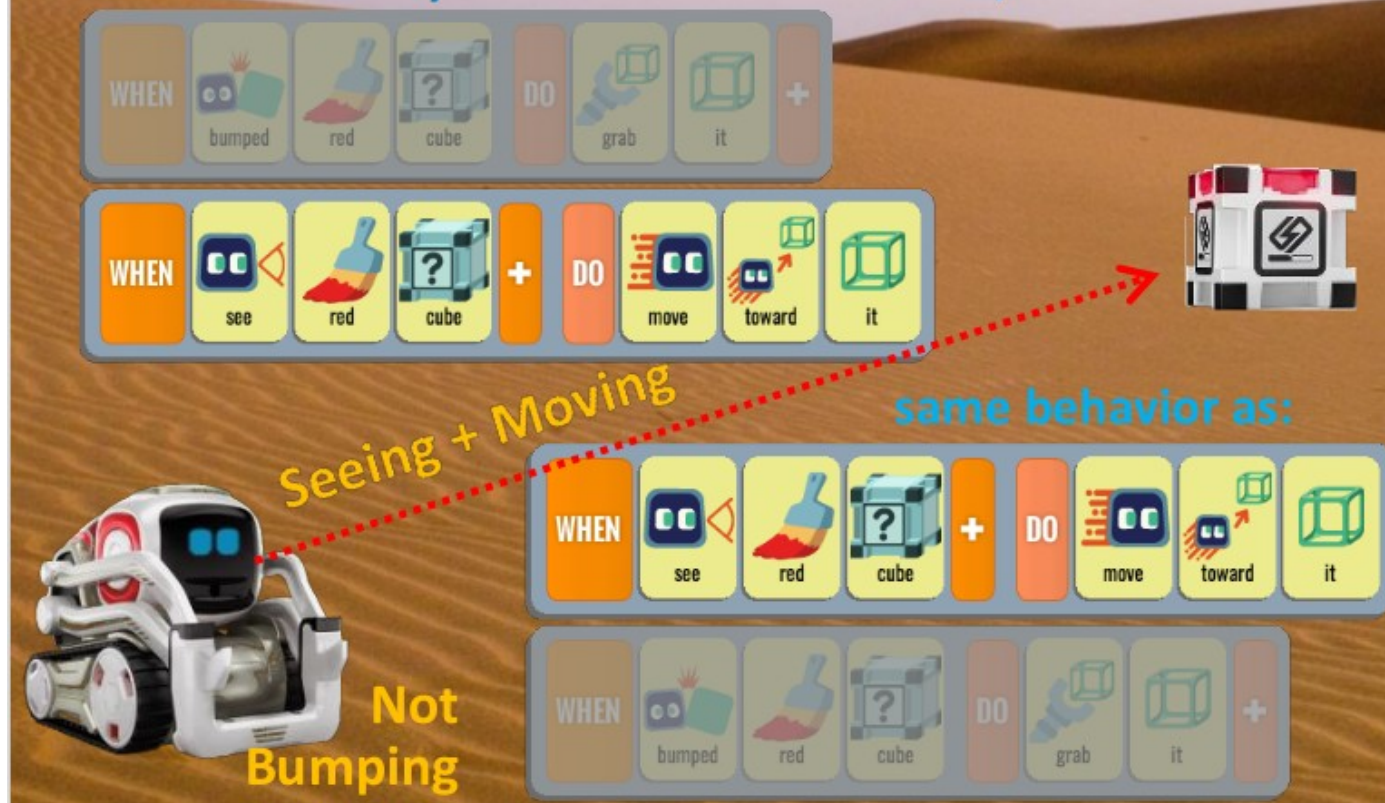


Calypso Idioms (Design Patterns)



Second Law of Calypso

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



Third Law of Calypso

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

The diagram illustrates the Third Law of Calypso, which states that when actions conflict, the earliest one wins. It shows two sequences of actions in a game environment:


- Sequence 1 (Top):** WHEN see red cube + DO move toward it. This sequence is highlighted in orange and yellow, indicating it is the earliest and thus wins.
- Sequence 2 (Bottom):** WHEN see blue cube + DO move toward it. This sequence is faded, indicating it is later and thus loses.

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

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.

The diagram illustrates the Fourth Law of Calypso, which states: "An indented rule can run only if its parent's action succeeds." It shows three scenarios of a robot's actions and their outcomes:



- Scenario 1 (Left):** The robot bumps a green cube. The parent action (bumped) succeeds, so the indented action (grab it) runs. The robot then plays a beeprobe, resulting in a **Score: 5**.
- Scenario 2 (Middle):** The robot bumps a green cube. The parent action (bumped) fails (the cube is not green), so the indented action (grab it) does not run. The robot then plays a beeprobe, resulting in a **Score: 0**.
- Scenario 3 (Right):** The robot bumps a green cube. The parent action (bumped) succeeds, so the indented action (grab it) runs. The robot then plays a beeprobe, resulting in a **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)

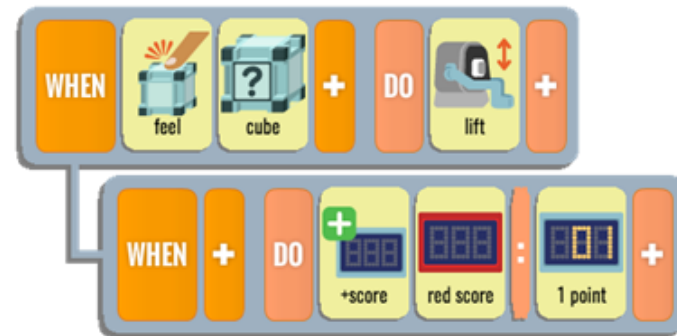
Count Actions

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

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

Count Actions

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

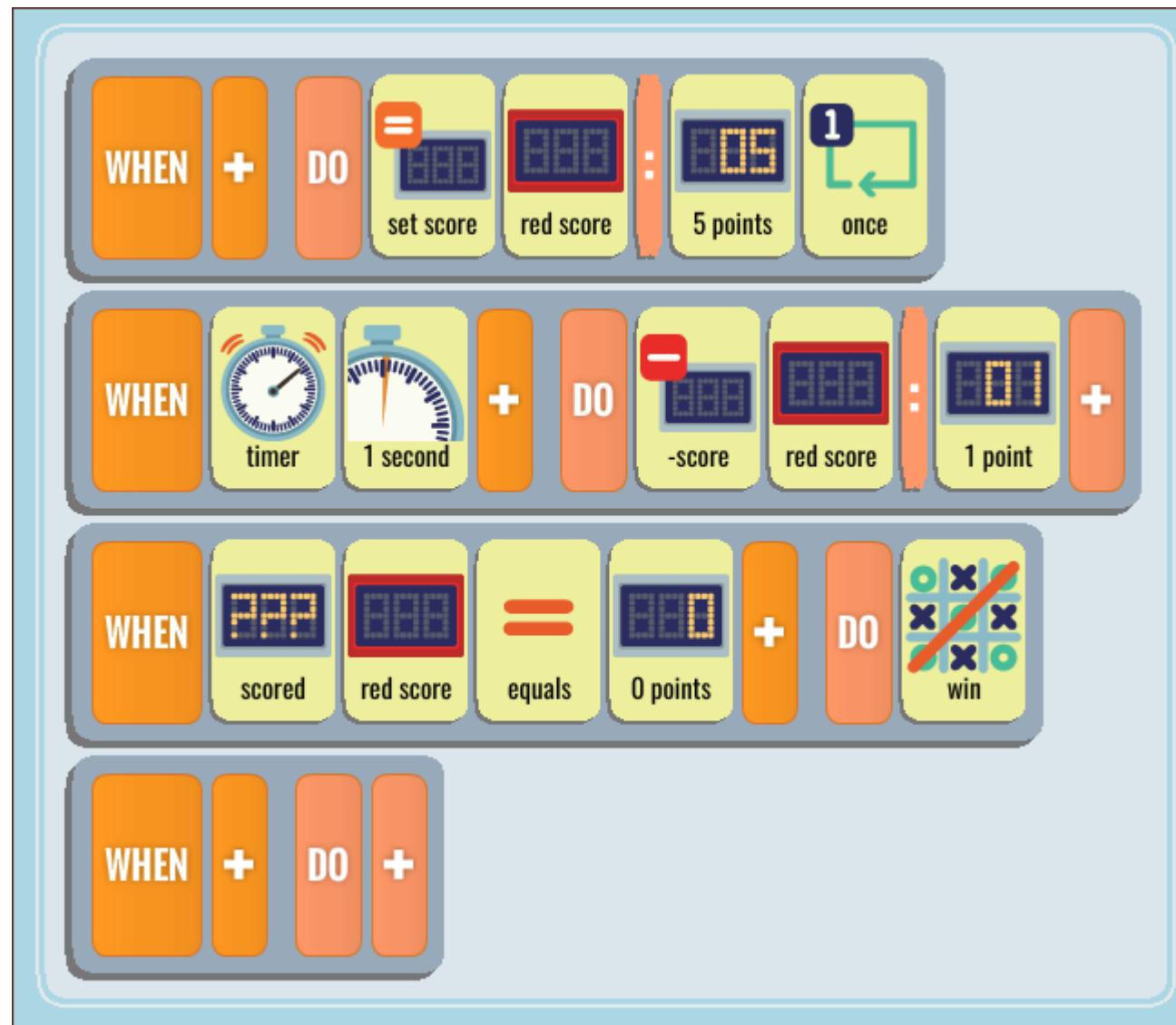


General Form:

WHEN *something* DO **action**
↳ WHEN DO score **color** 1 point

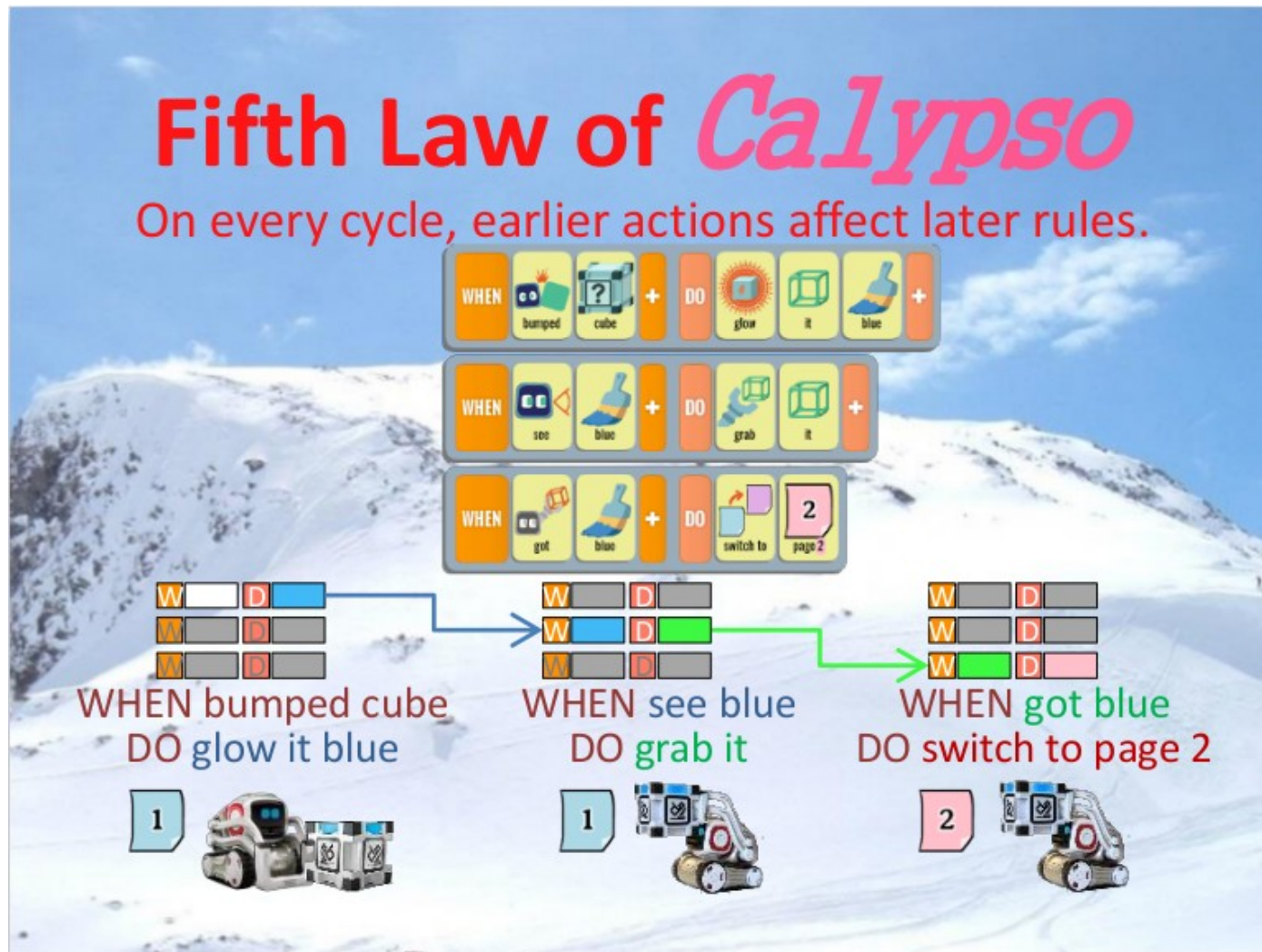
Scores are named by colors and displayed above the world map.

Parallel WHEN Evaluation?



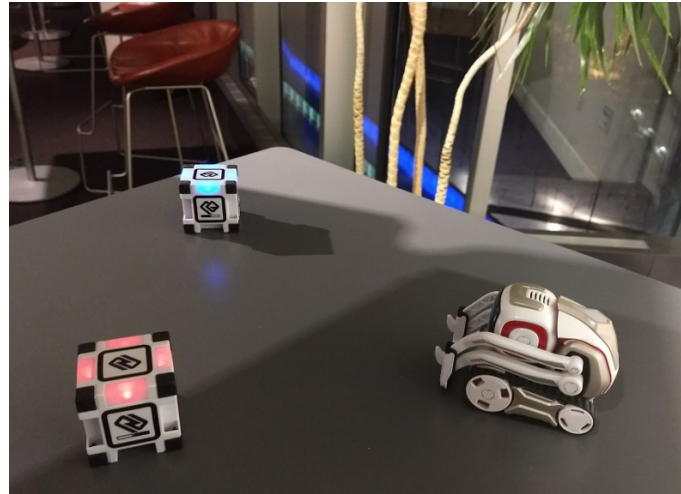
In Kodu this would exit immediately.

Fifth Law of Calypso



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

Visiting Cubes in Sequence



PAGE 1:

WHEN	see	red	cube	+	DO	move	toward	it
WHEN	+	DO	turn	wander				
WHEN	bumped	red	cube	DO	switch to	page 2		

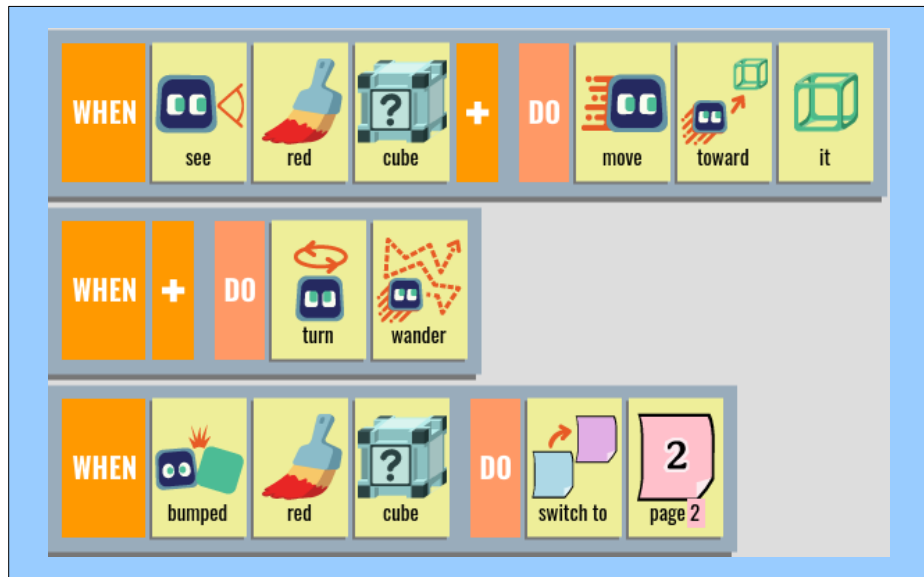
PAGE 2:

WHEN	see	blue	cube	+	DO	move	toward	it
WHEN	+	DO	turn	wander				
WHEN	bumped	blue	cube	DO	win			

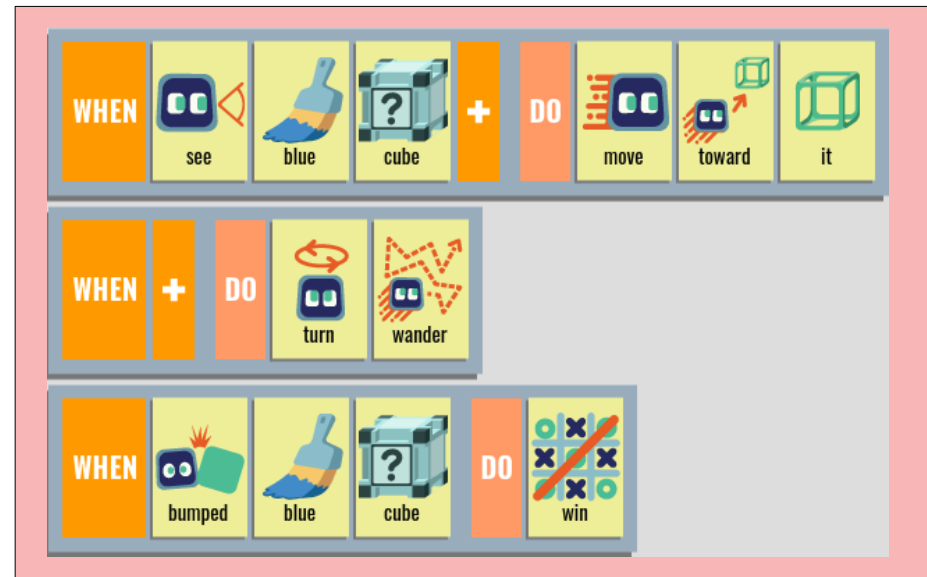
State Machine View



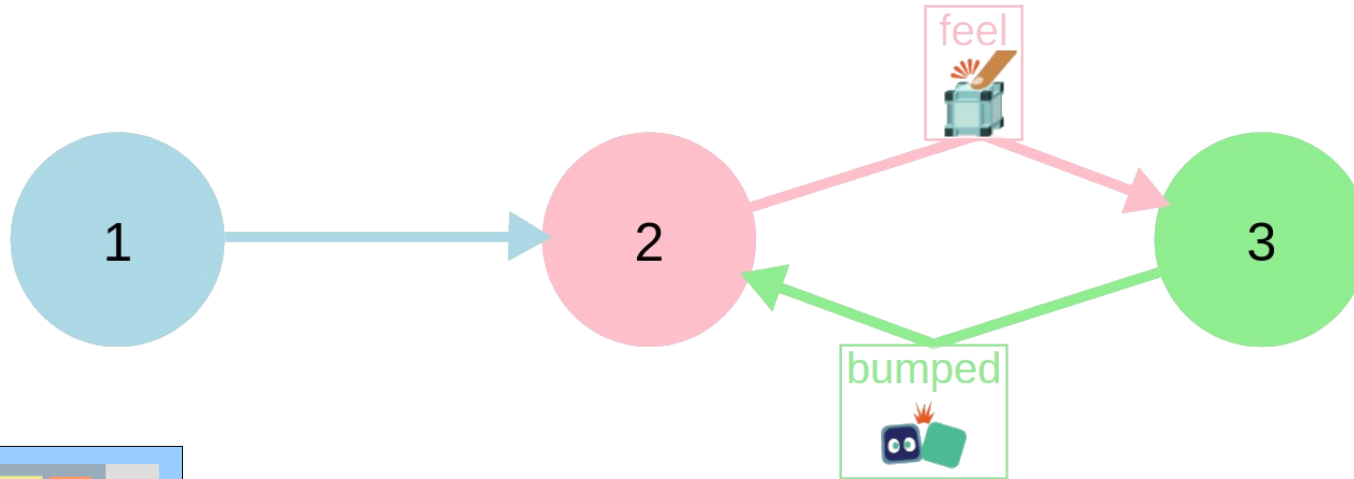
PAGE 1:



PAGE 2:



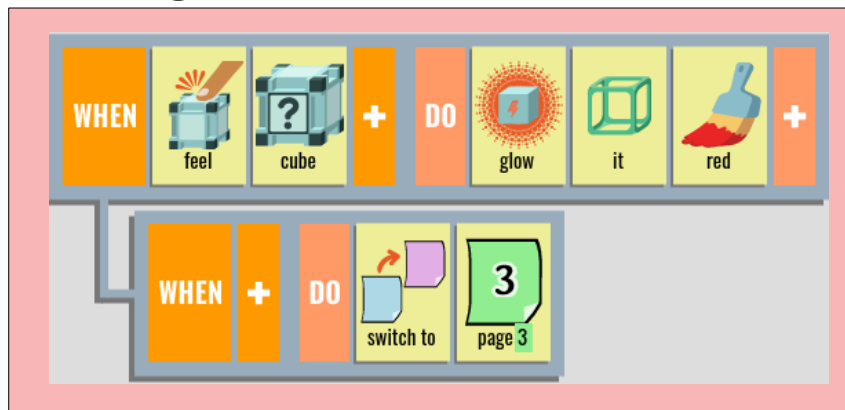
Loopy State Machine



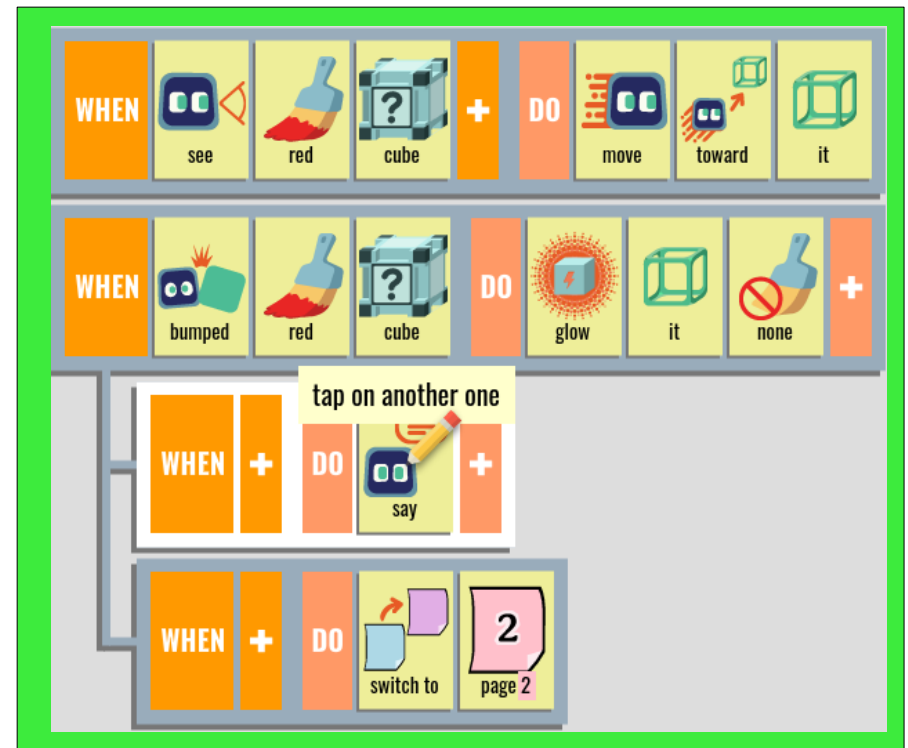
PAGE 1:



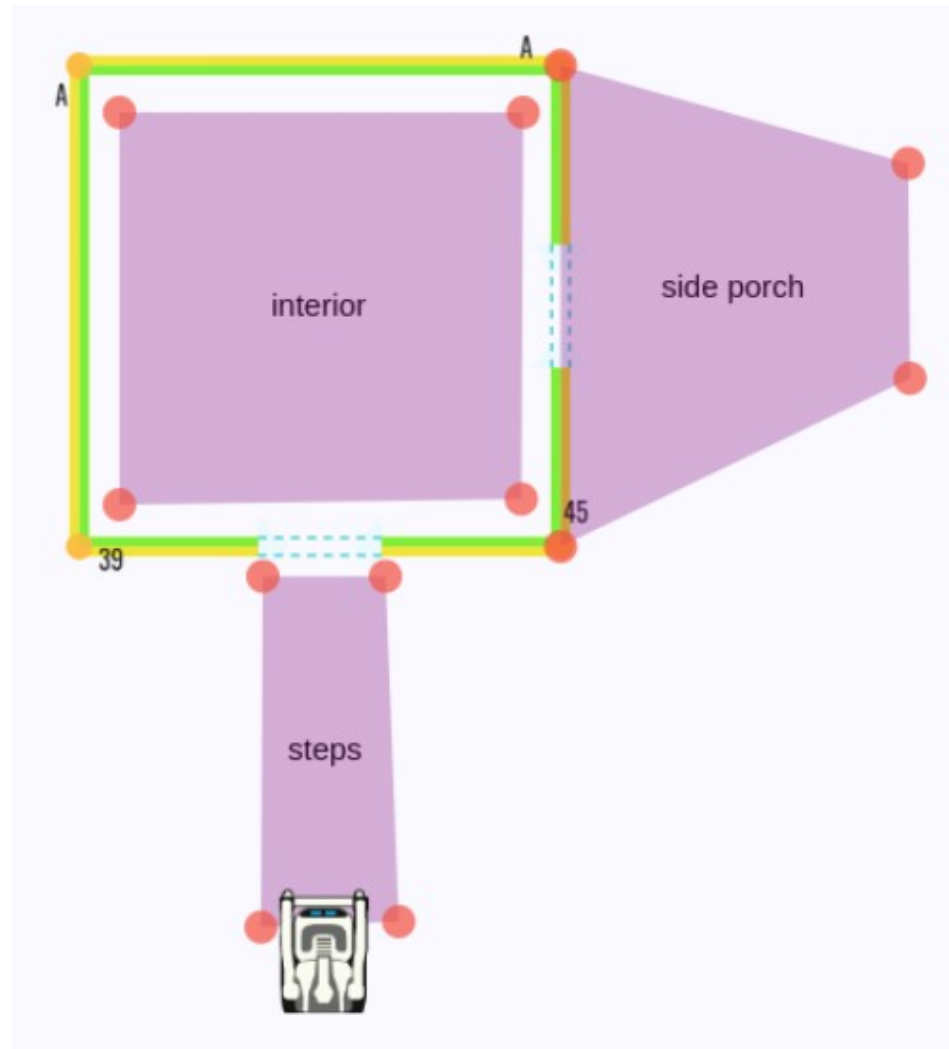
PAGE 2:



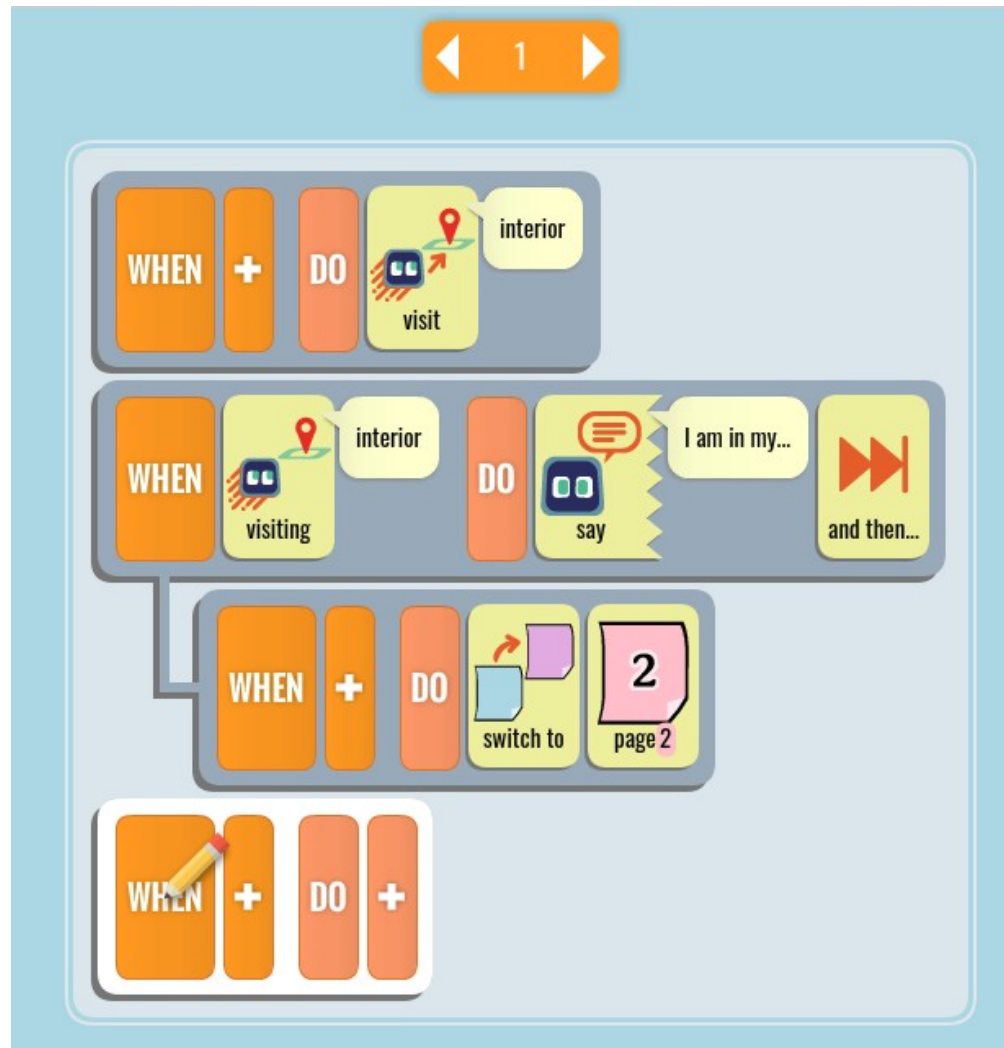
PAGE 3:



Walls and Rooms



Visit Action and Visiting Predicate



Suspending the Rule Interpreter

- Some actions require full control of the robot and take time to complete. They must suspend the rule interpreter until they succeed or fail:
 - Grab, Roll, Drop, Express
- Some actions complete immediately and never fail:
 - Glow, score manipulation, switch to page

Suspending (cont.)

- A third class of actions take time to complete but can run in parallel with other actions, so they don't suspend:
 - Say, Play, Look, Lift
- If we want to suspend execution until these actions complete, we add an “and then...” tile.





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	✗	✓

Cloud Calypso

- Runs in the browser.
- Uses AWS for authentication and storage.
- Simulated robot and world.
- Try it free at <https://calypso-robotics.com>

Calypso Development Plans

- New primitives:
 - Visual search
 - Line following
 - Trainable object recognition
- New object types:
 - Chips
 - Qubes
 - Containers
- Multi-robot support