15-494/694: Cognitive Robotics

Dave Touretzky

Lecture 17:

Calypso (Kodu for Robots)

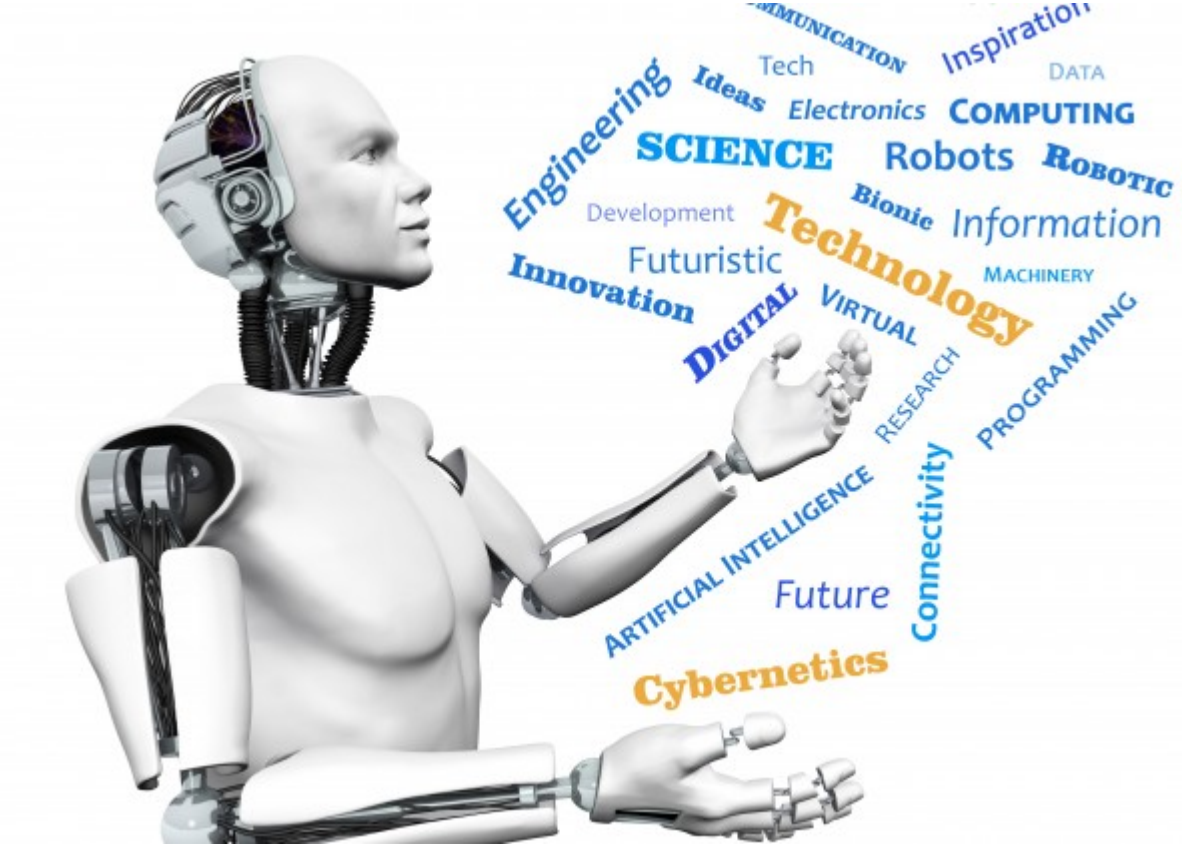
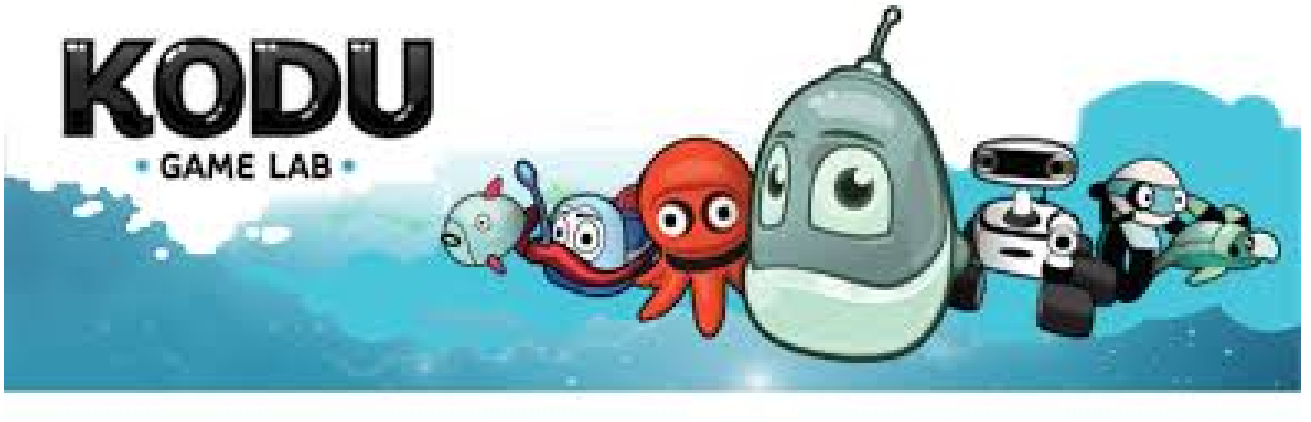


Image from http://www.futuristgerd.com/2015/09/10

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

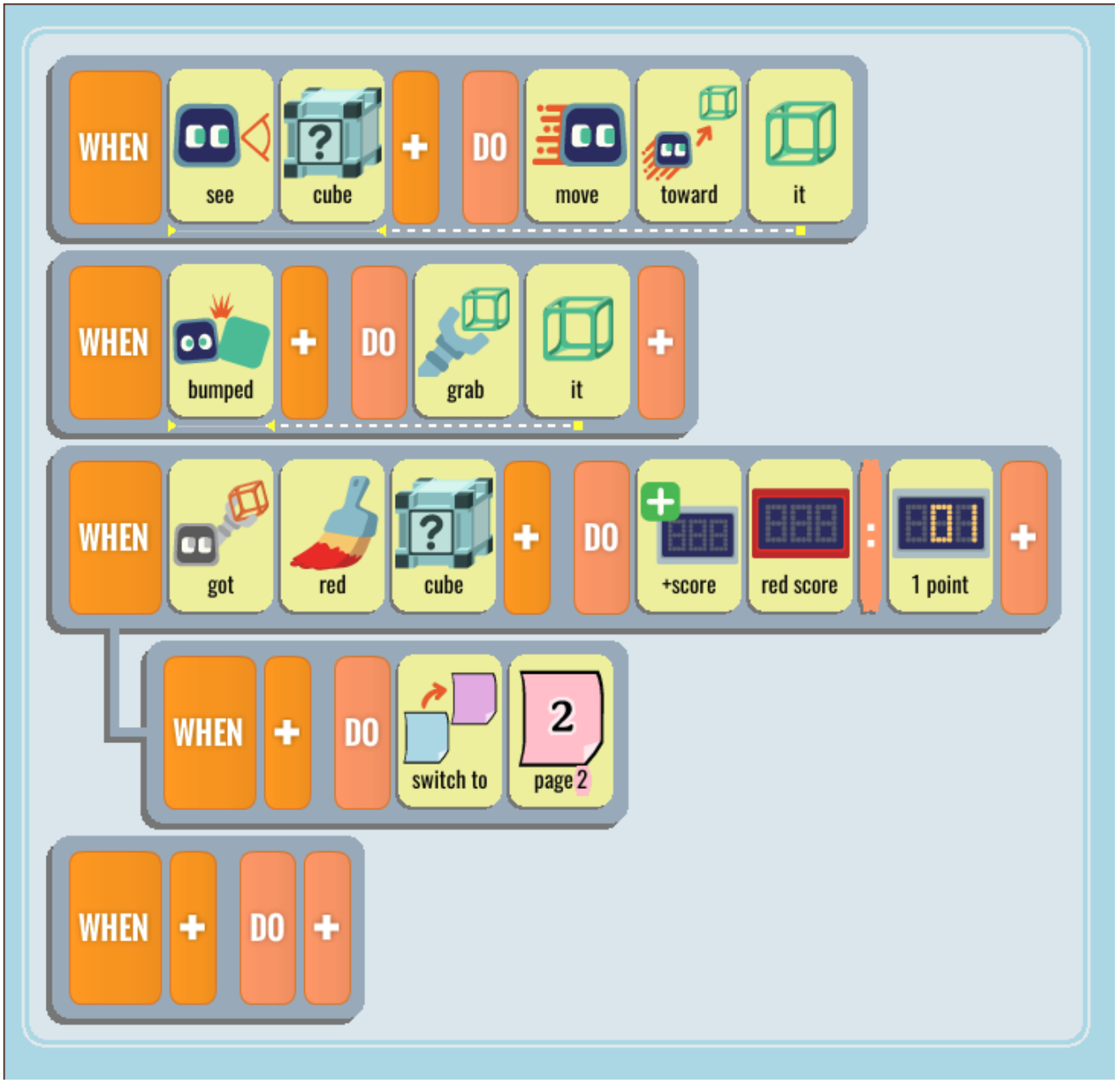
Full 3D, with physics and sound effects.

“Parallel” WHEN-DO Rules

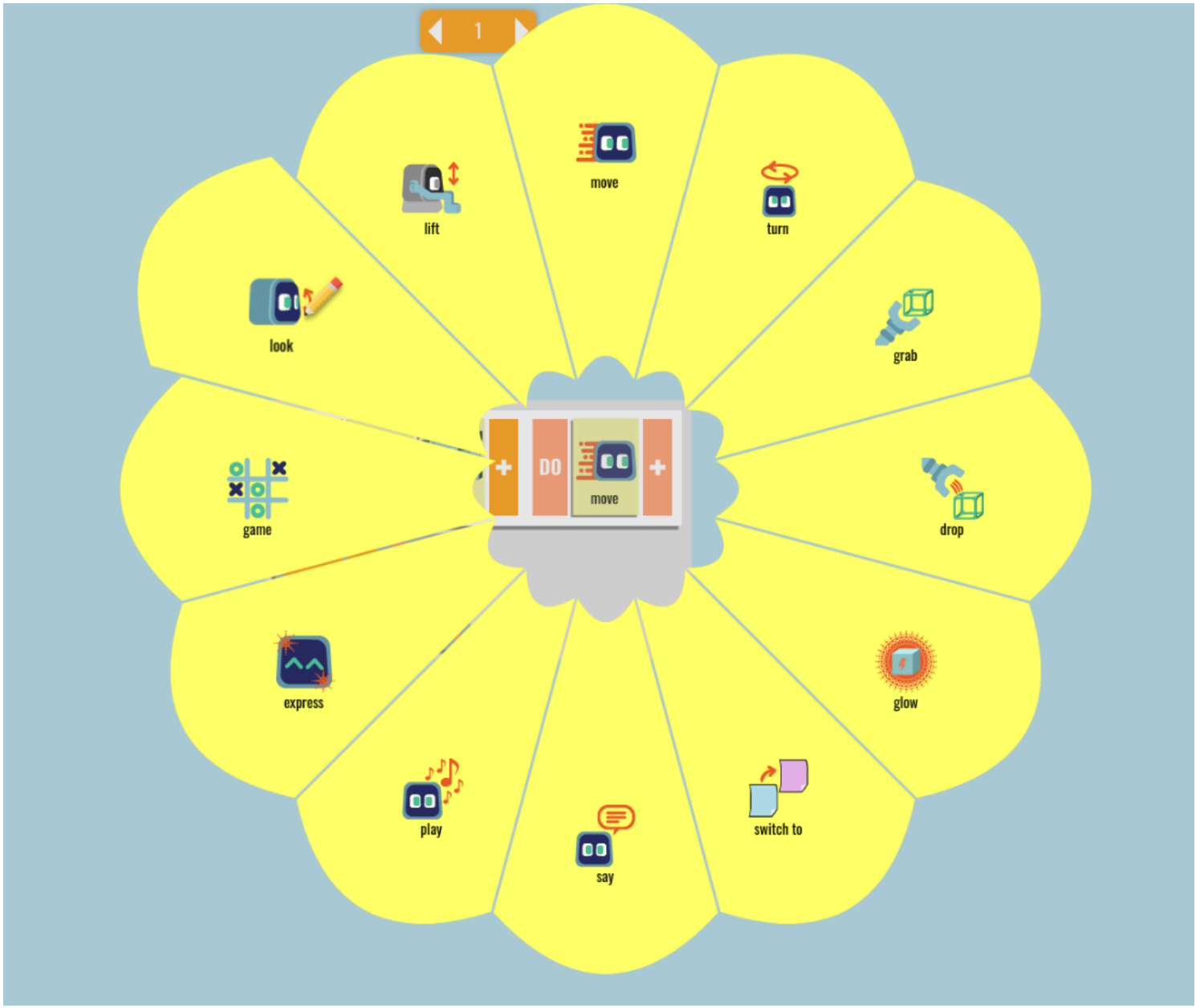
Menu Selection

Calypso: Kodu for Robots

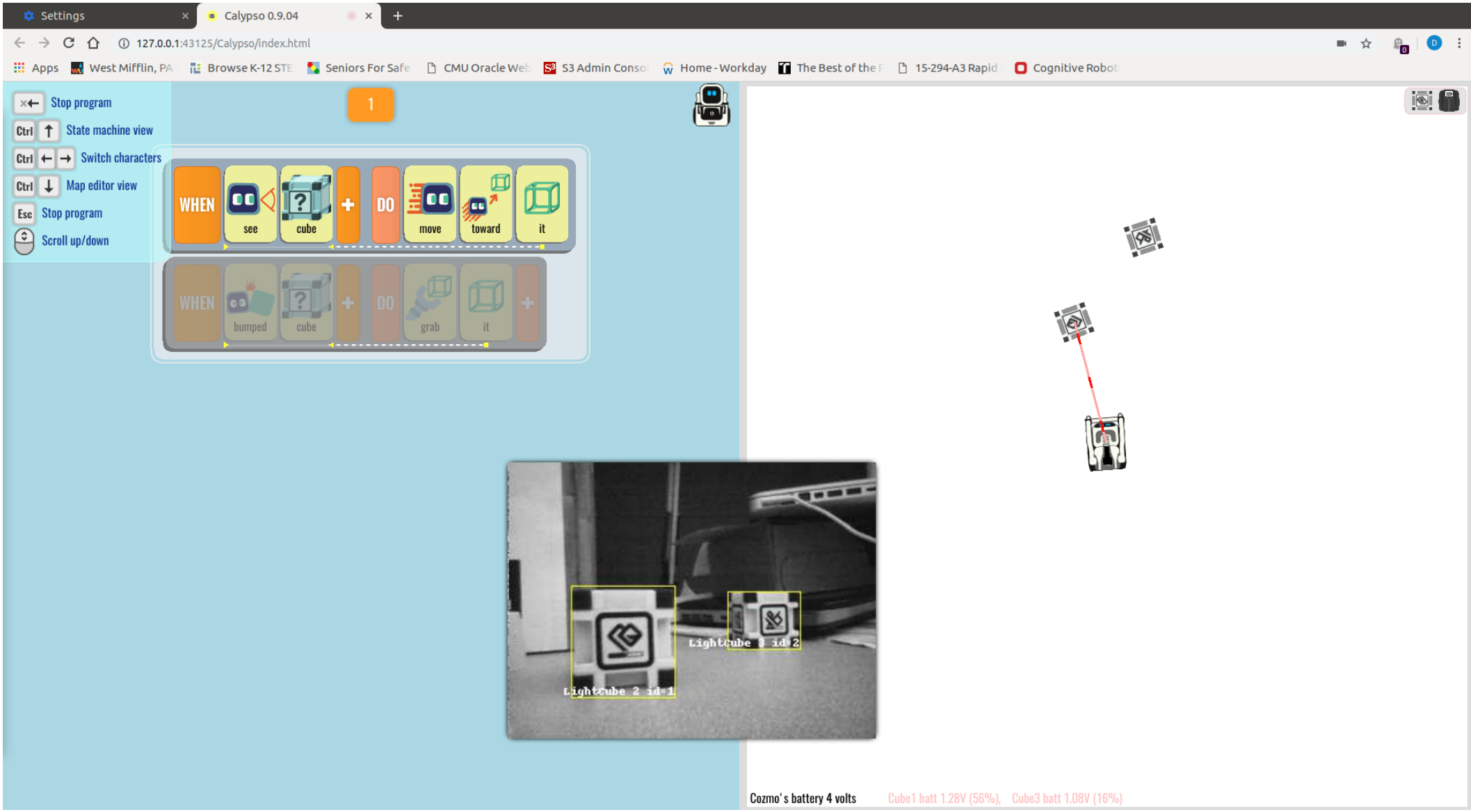
Sample Calypso Program



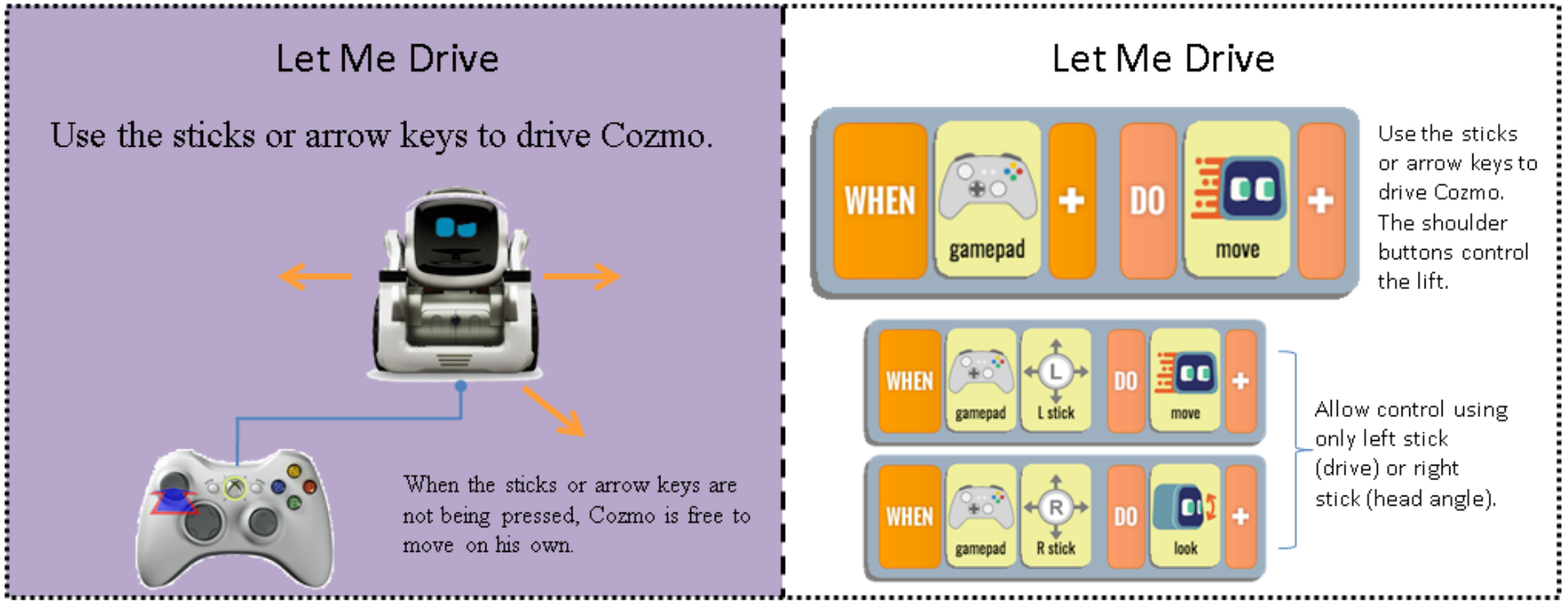
Context-Sensitive Petal Menus



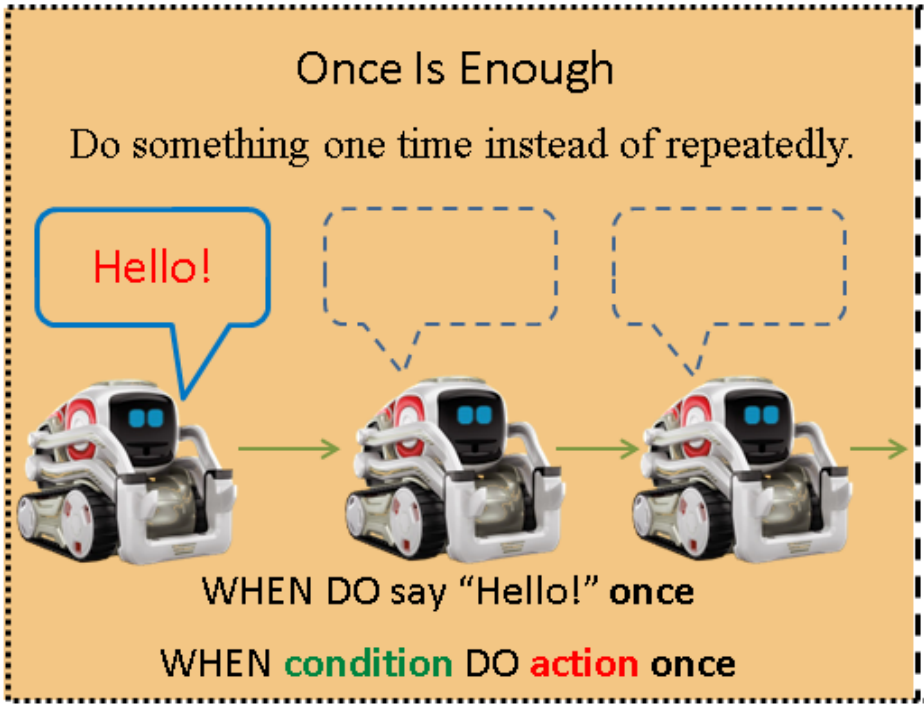
The Robot's World Map

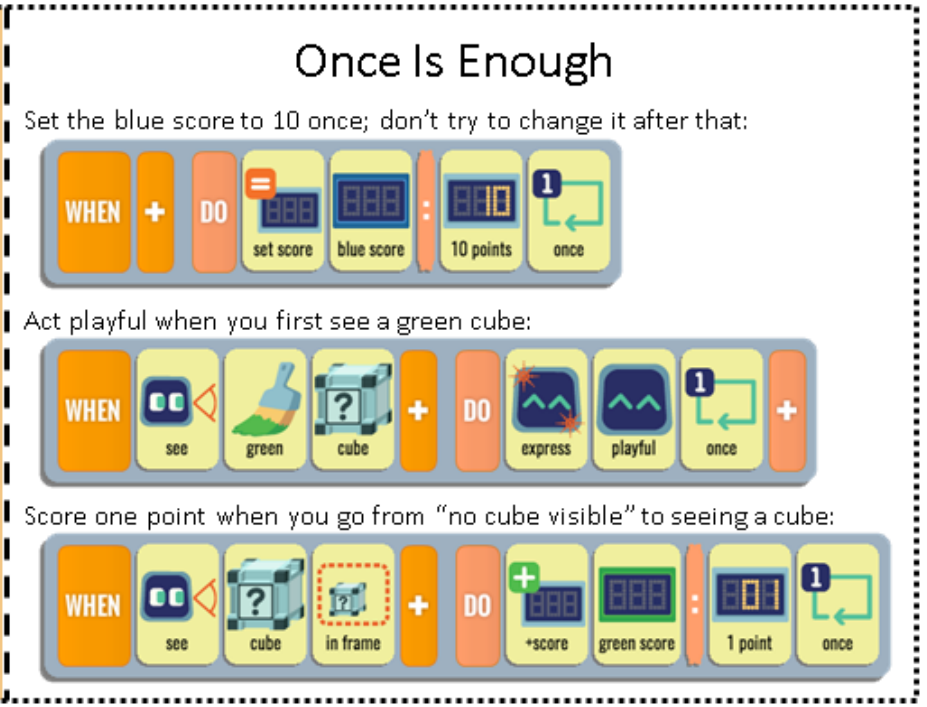


Calypso Idioms (Design Patterns)



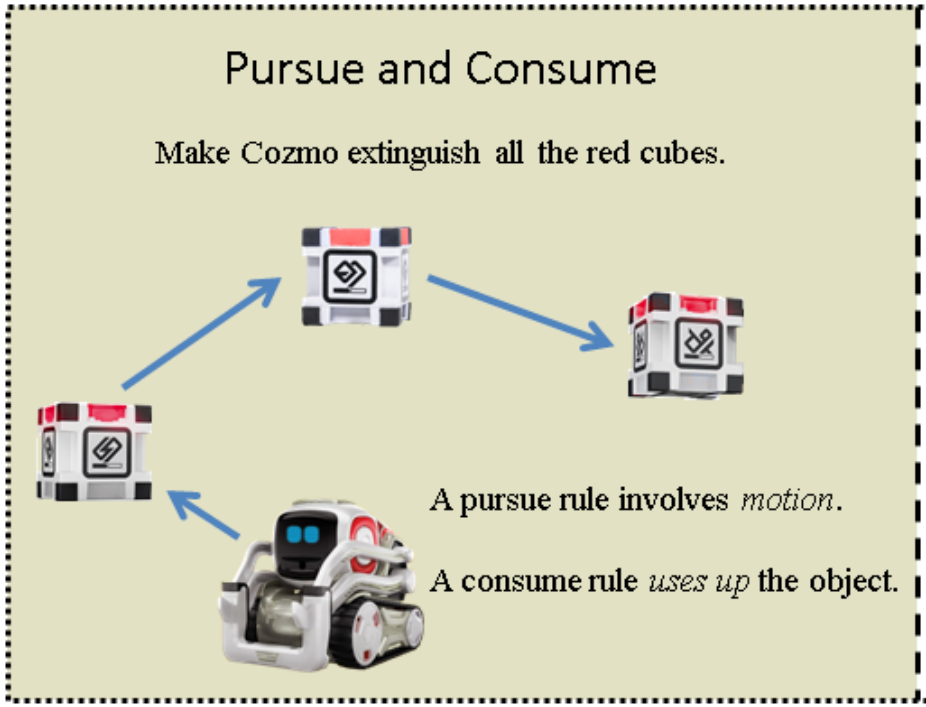
Calypso Idiom: Once Is Enough

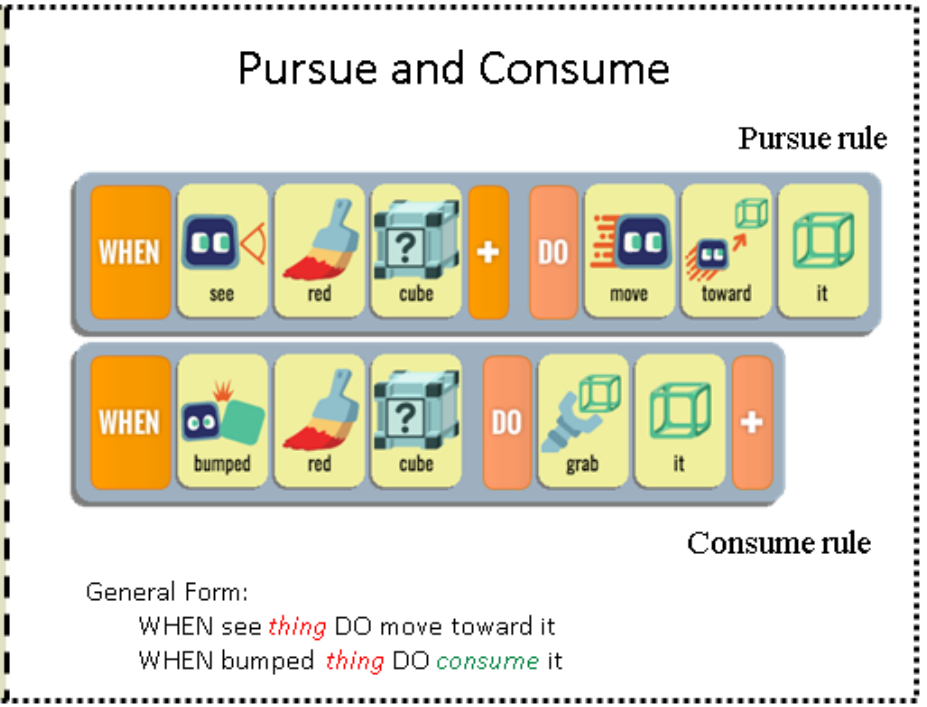




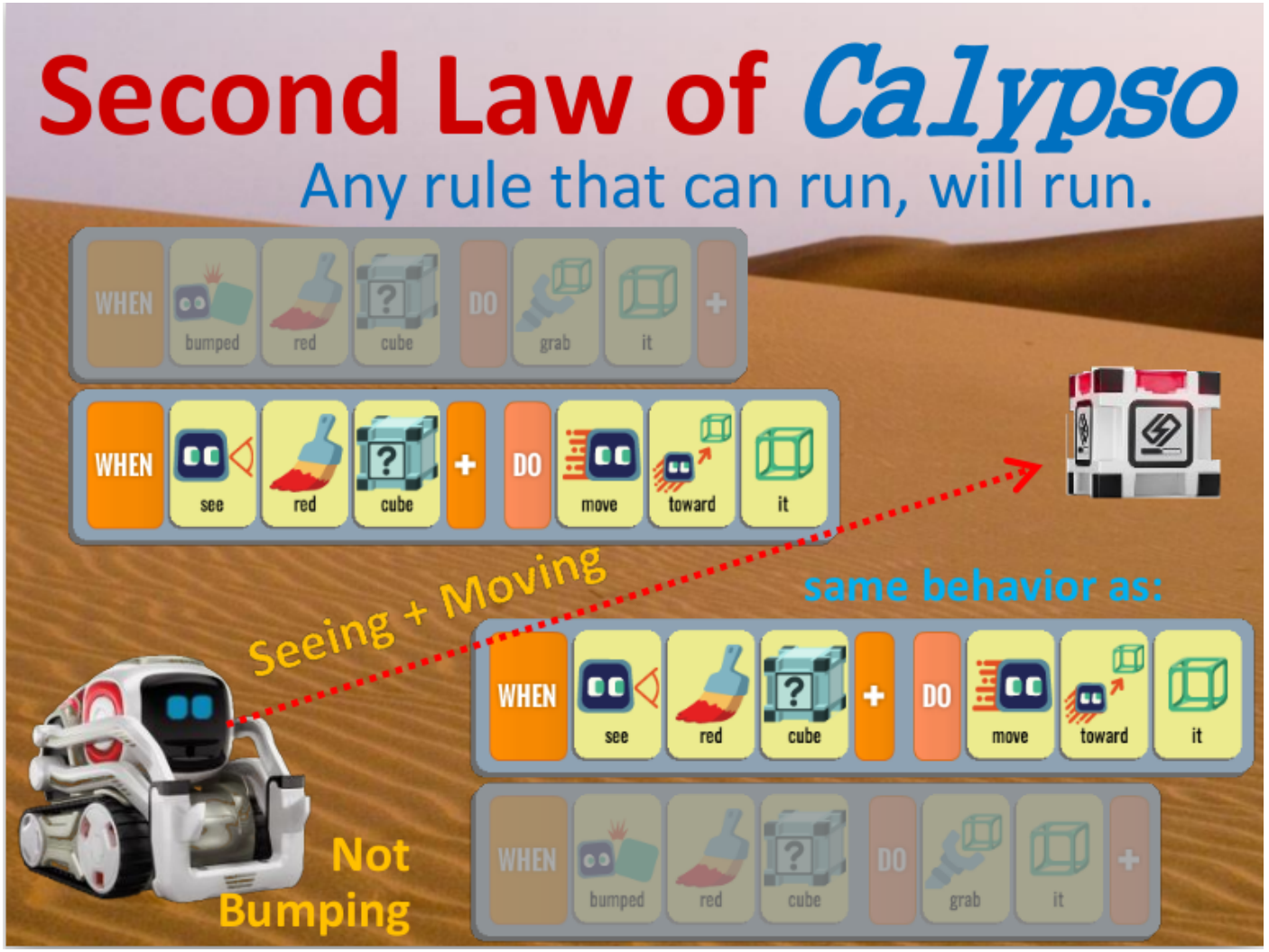
First Law of Calypso

Calypso Idiom: Pursue and Consume

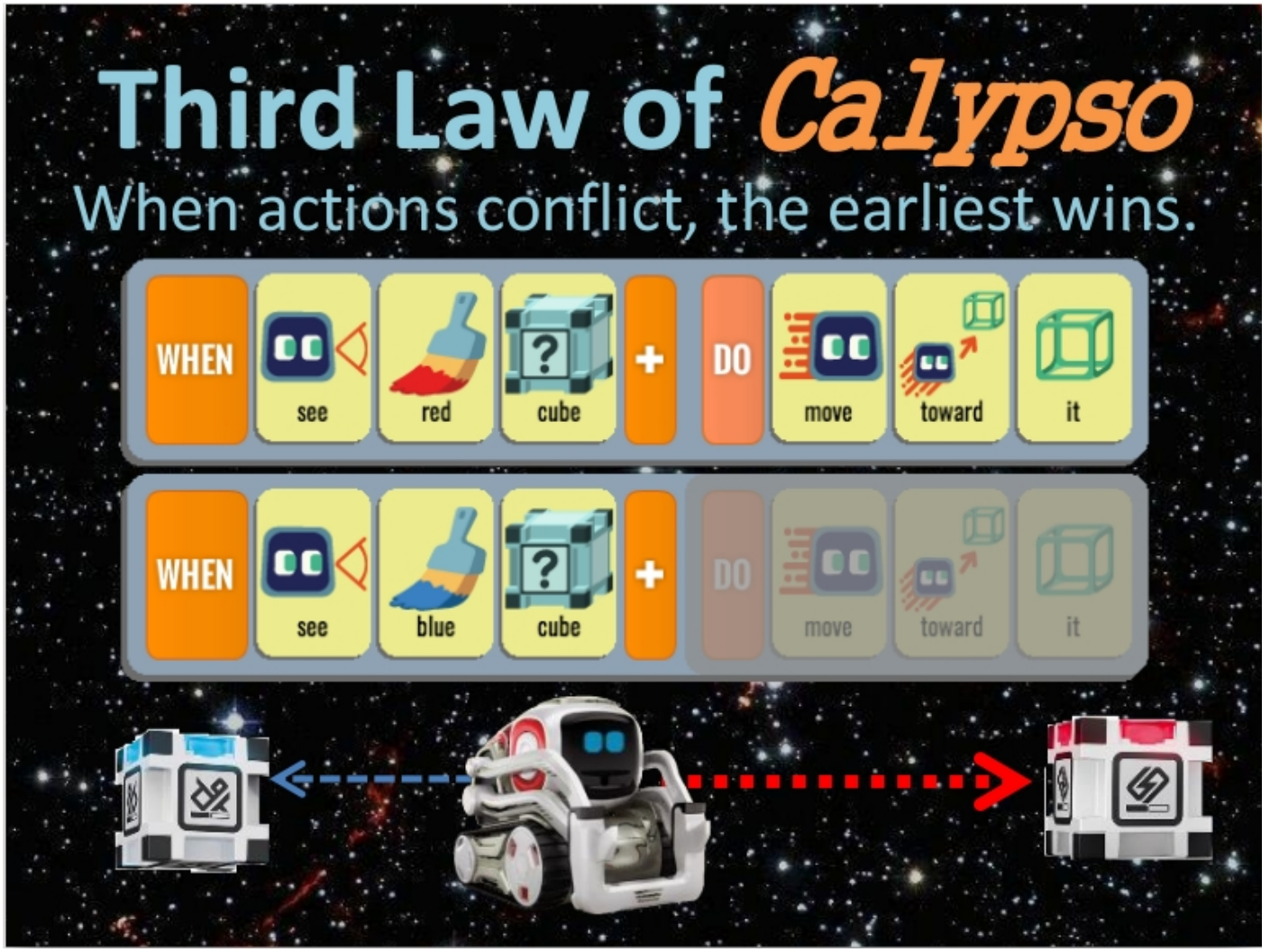




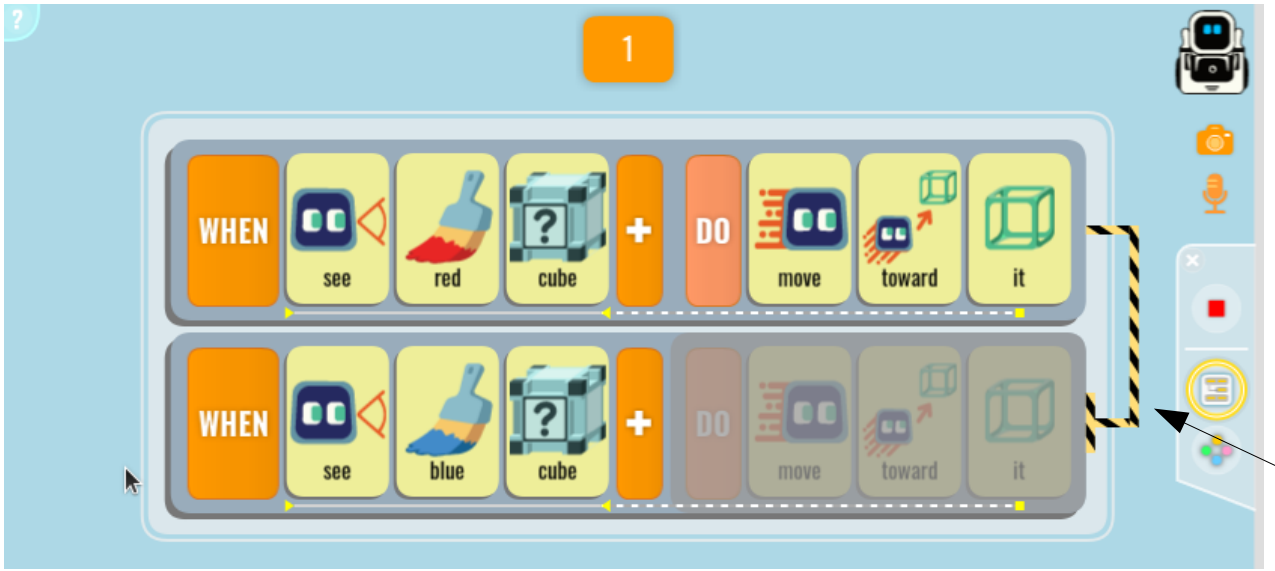
Second Law of Calypso

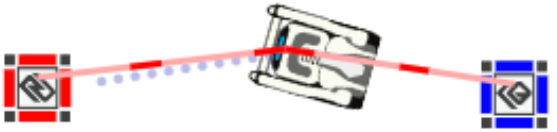


Third Law of Calypso



Third Law Visualization





Action suppression indicator

Calypso Idiom: Default Value

Default Value

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

situation → DO **action1** **value**

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

Default Value

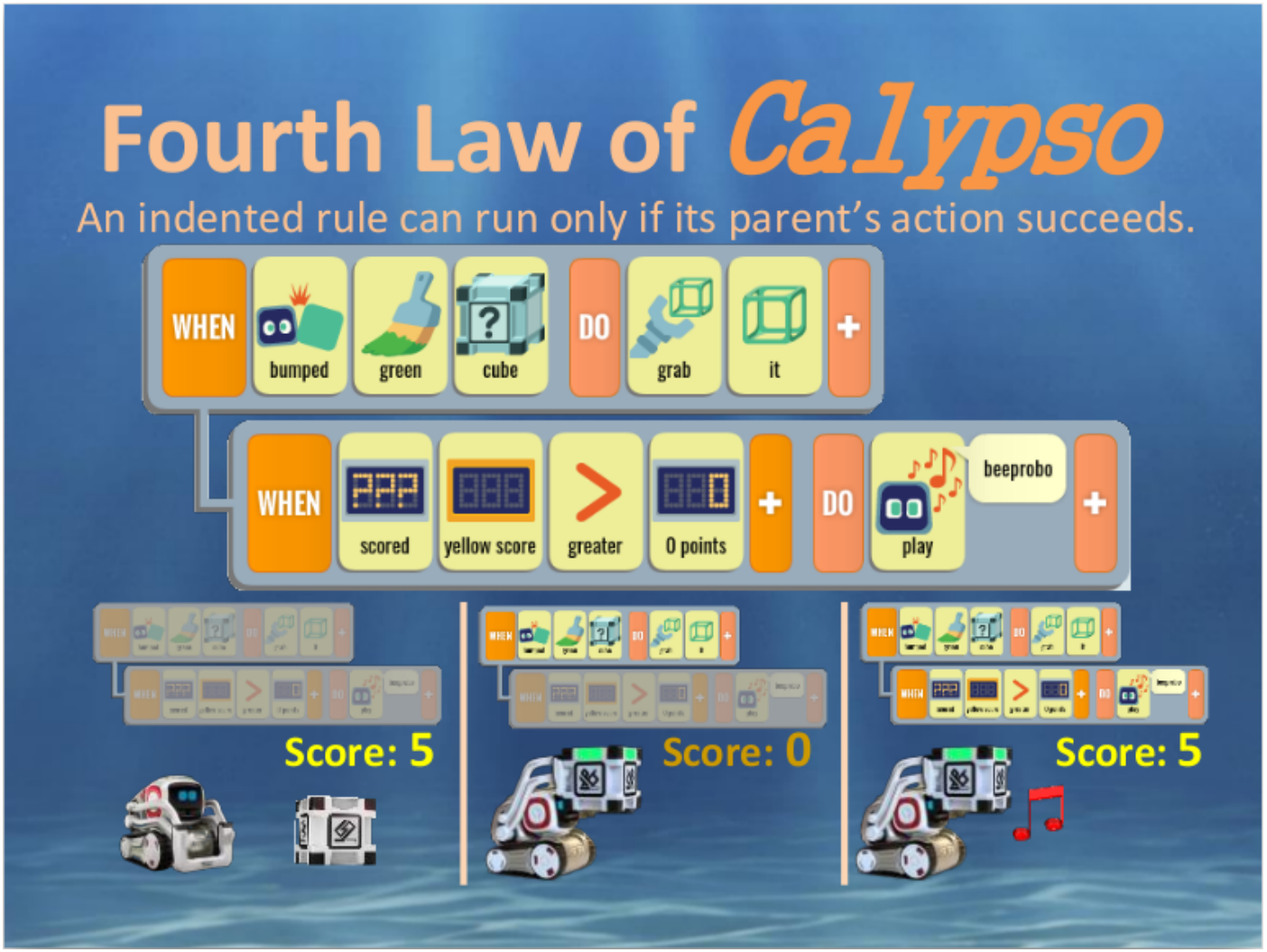
When the A button is pressed, glow red; otherwise glow blue.

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



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

Calypso Idiom: Do Two Things

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 Idiom: Count Actions

Count Actions

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

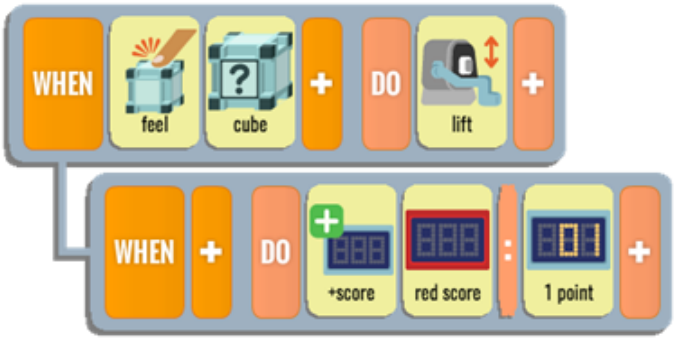
WHEN *something* DO **action**

and also

score **color** 1 point

Count Actions

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



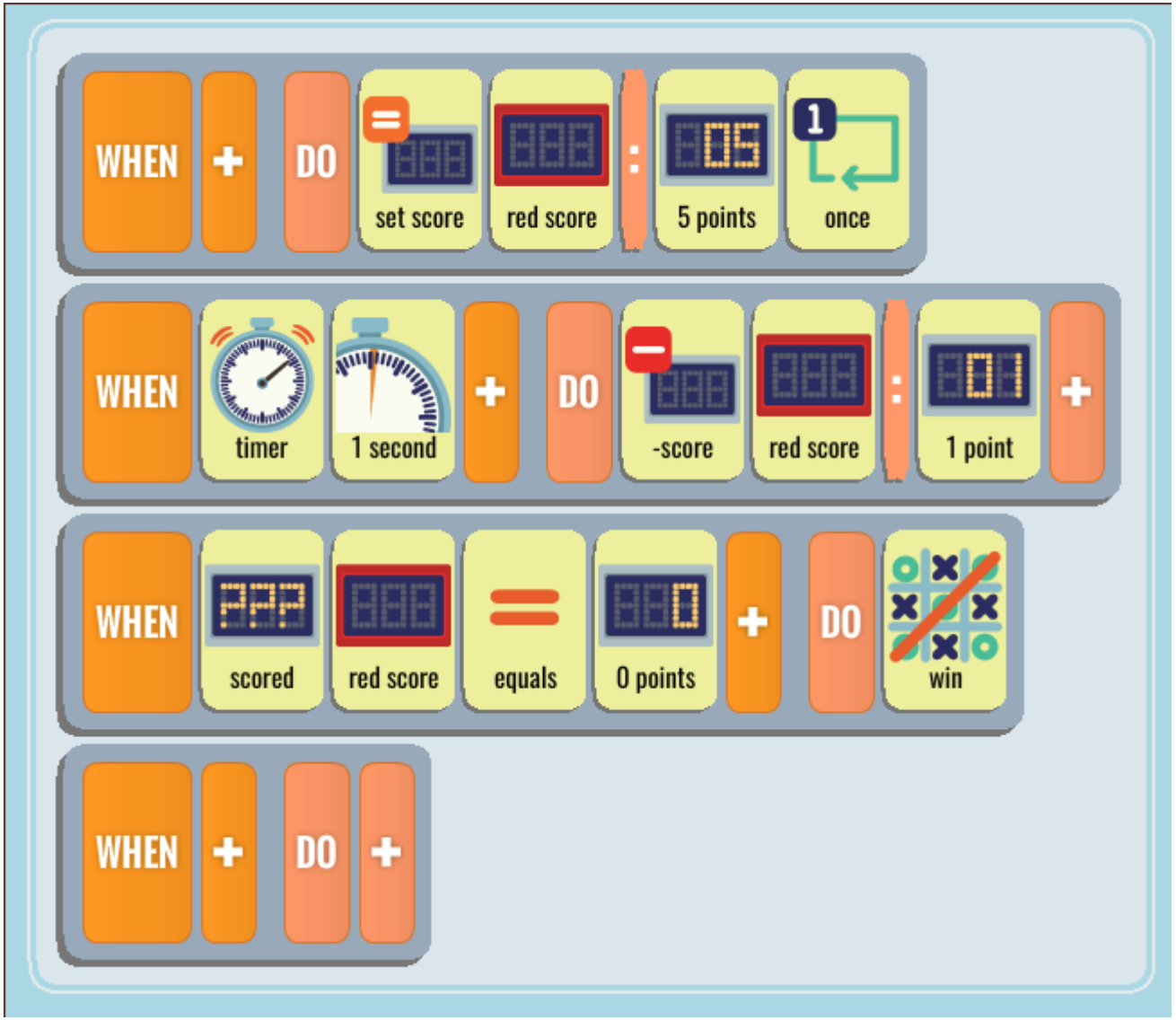
General Form:

WHEN *something* DO ***action***

↳WHEN DO score ***color*** 1 point

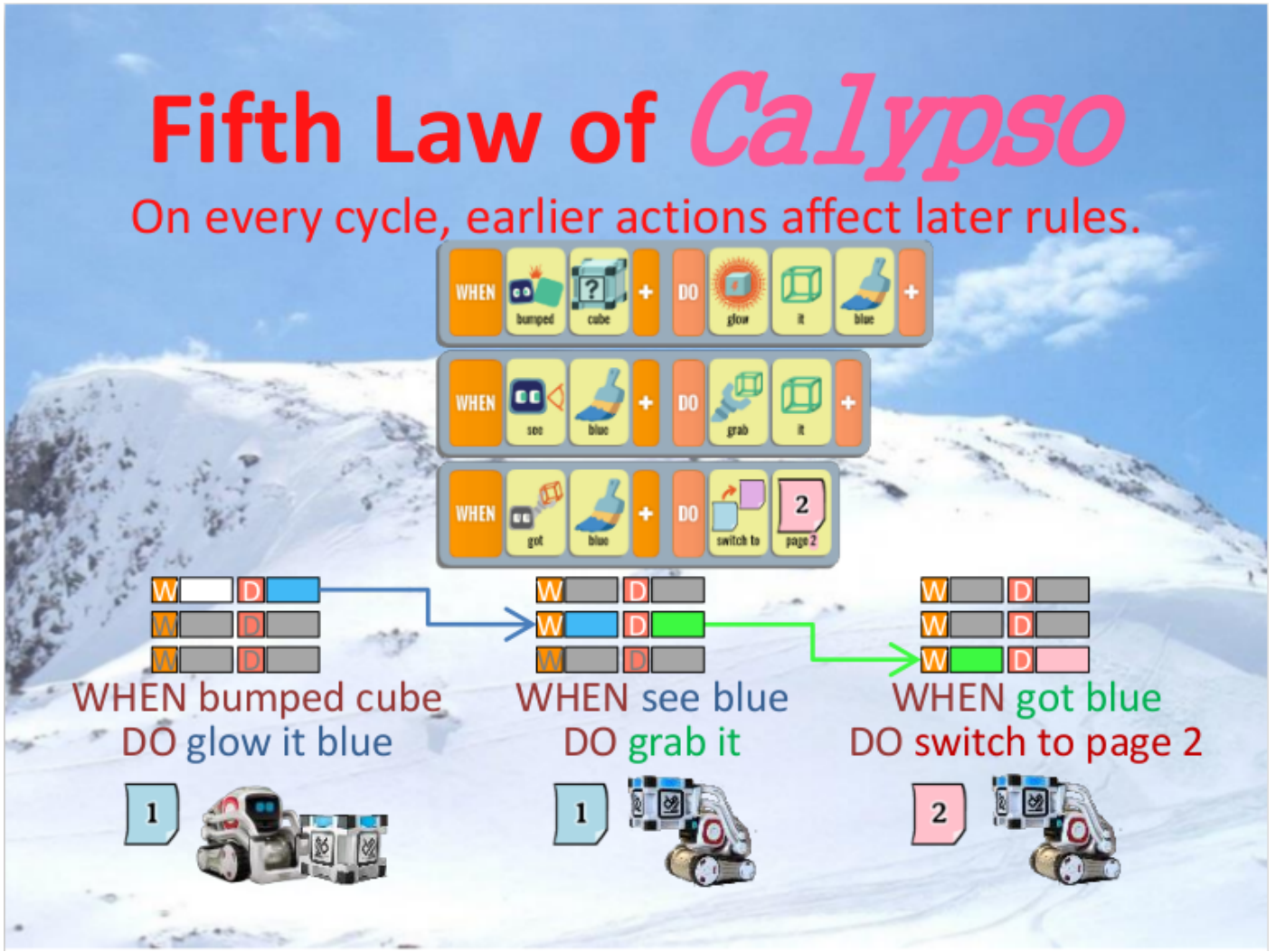
Scores are named by colors and displayed above the world map.

Parallel WHEN Evaluation?



In Kodu this would exit immediately.

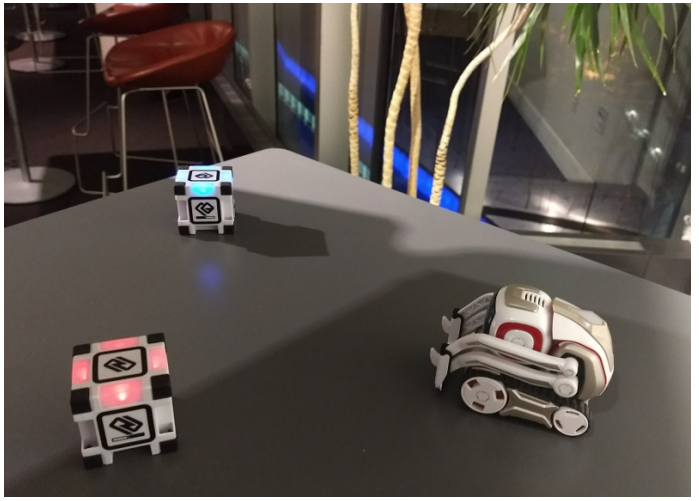
Fifth Law of Calypso



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

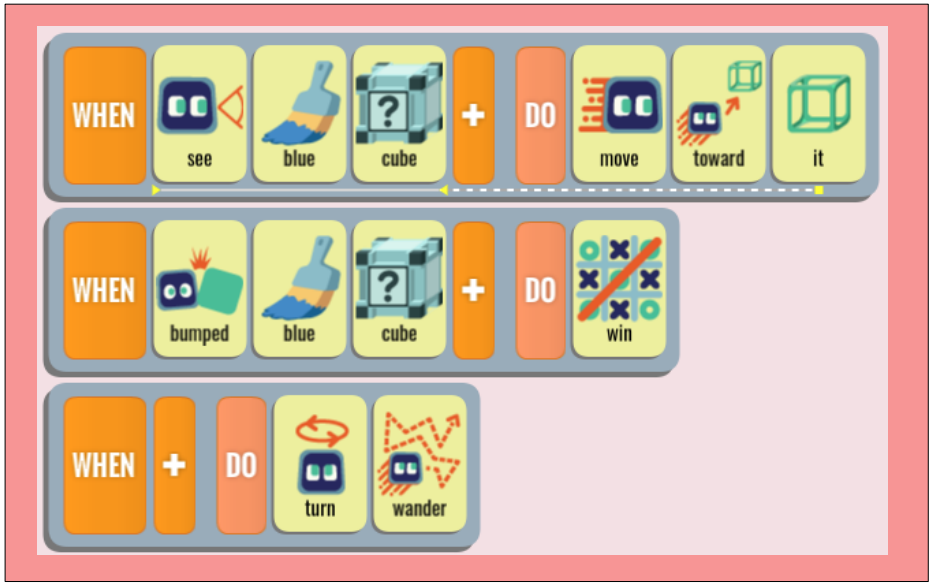
Visiting Cubes in Sequence

Visit red cube and
then blue cube.



PAGE 1:

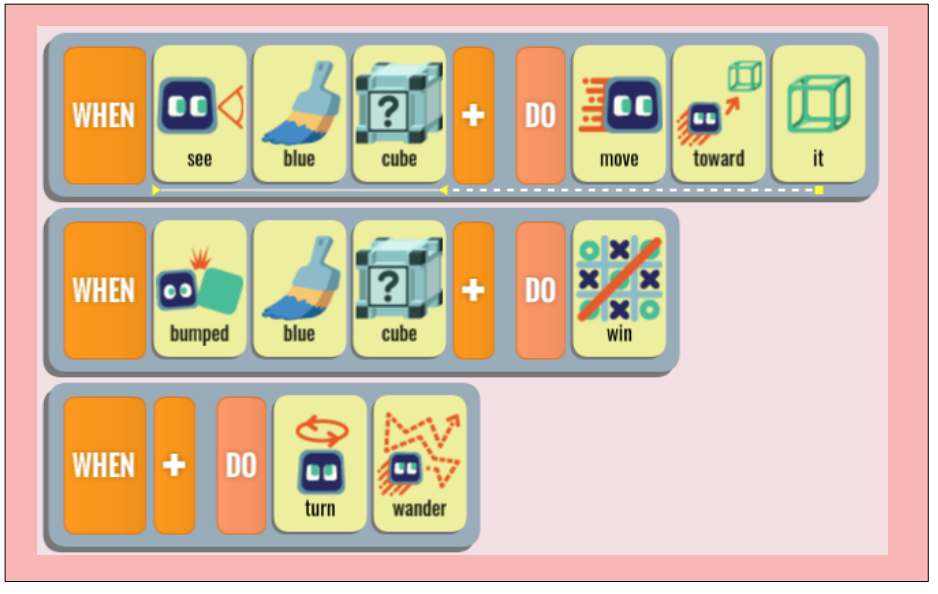
PAGE 2:



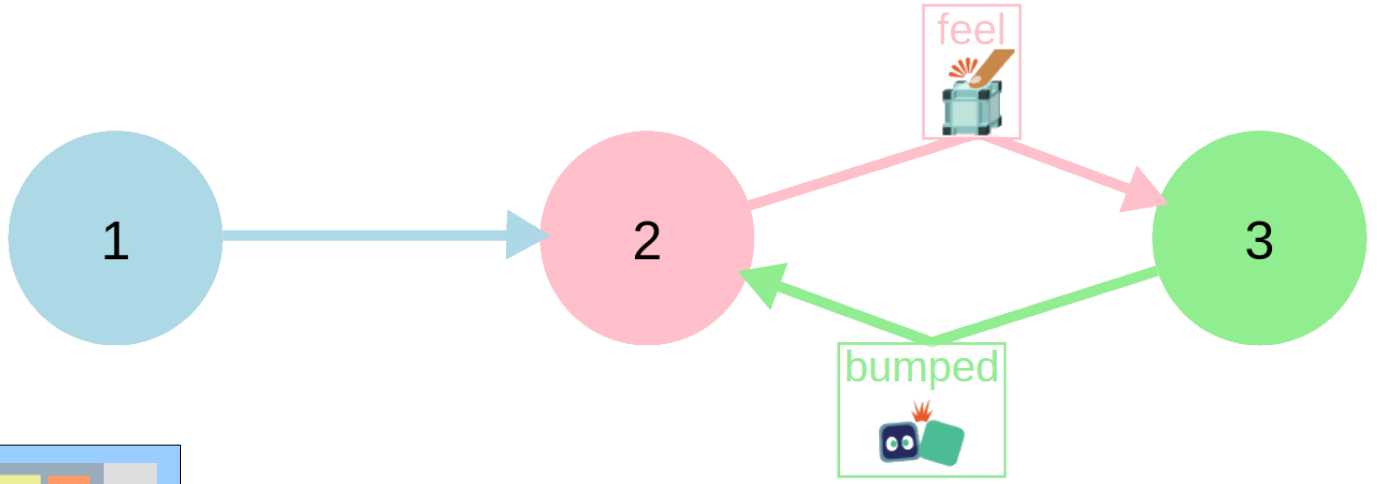
State Machine View

PAGE 1:

PAGE 2:



Loopy State Machine



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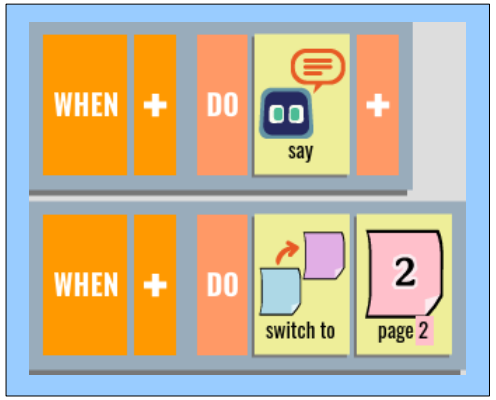

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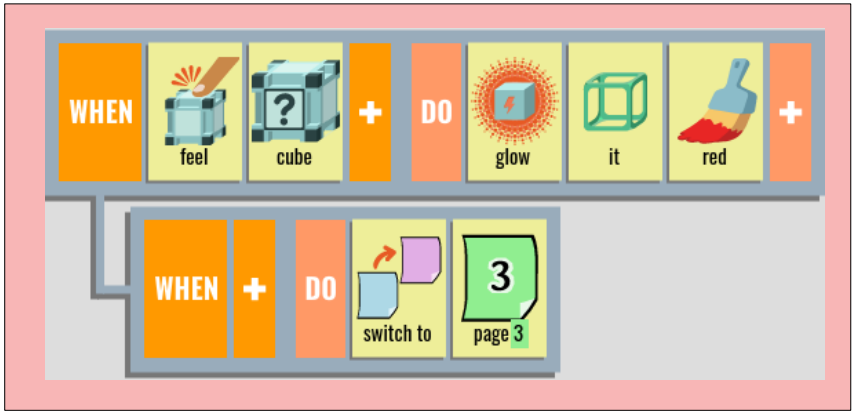
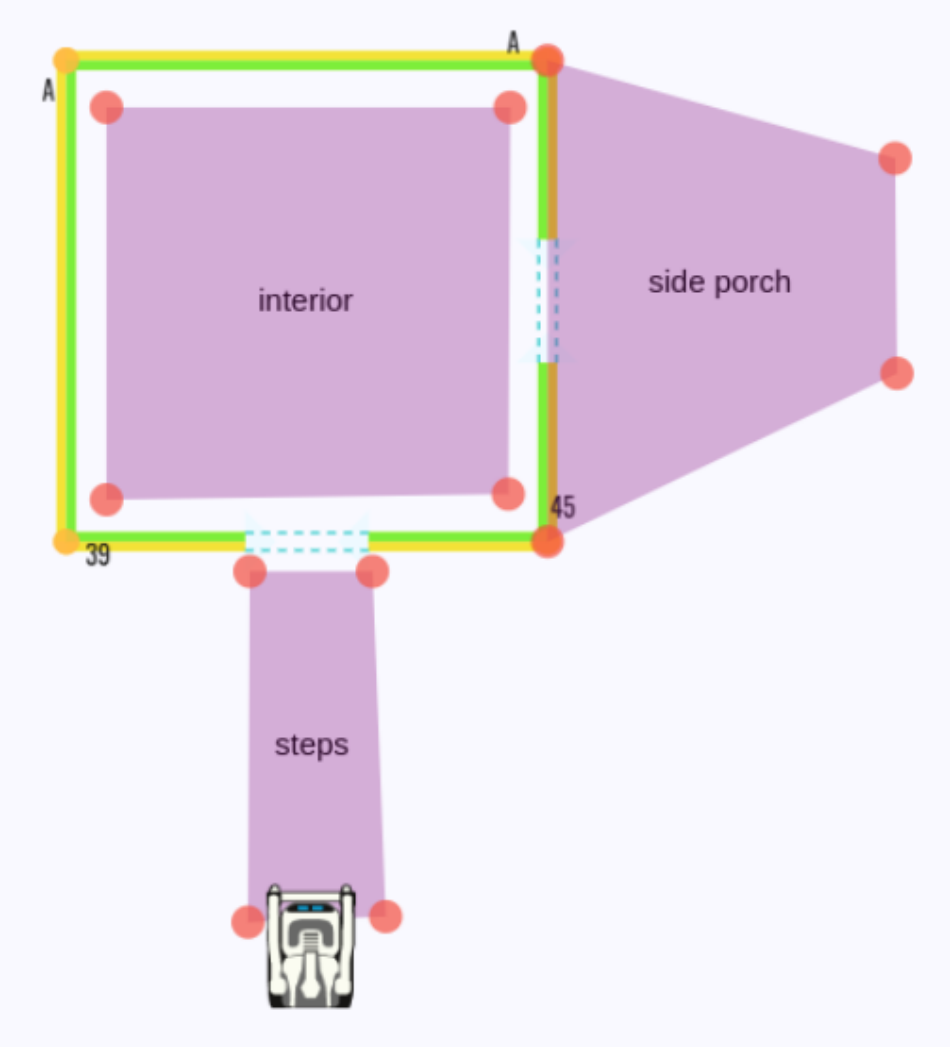
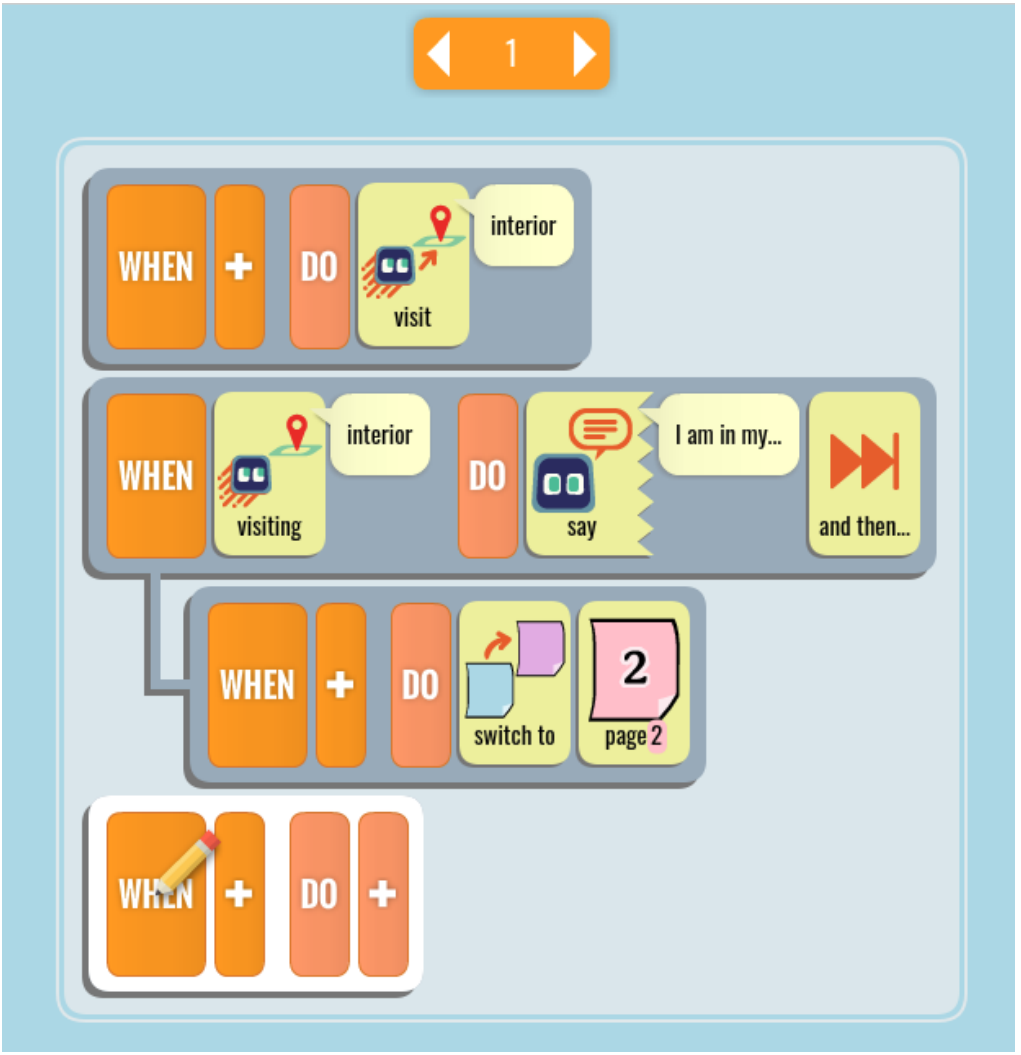


PAGE 3:

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
  - Drop
  - Roll
  - Express
- Some of these actions can fail. We won't know if they succeeded until they complete.

Four Types of Actions

1) Instantaneous: take effect immediately

- glow, +score, switch to page

2) Extended duration: take time to complete.

- say, play, move or turn by a fixed amount

3) Suspending: take control of the whole robot.

- grab, drop, roll, express

4) Incremental: take tiny steps. Must be repeat across multiple rule cycles to make progress.

- move toward, turn toward, visit

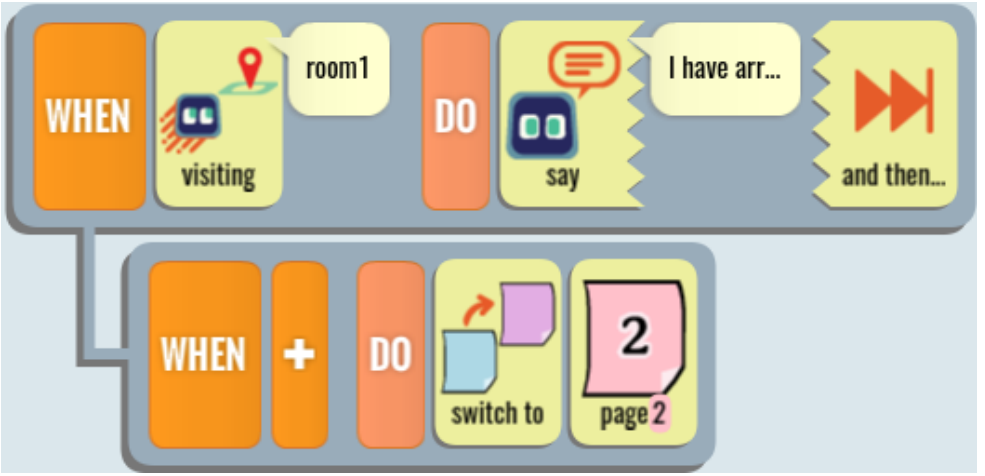
Extended Duration Actions

- Extended duration 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 of indented rules until these actions complete, we add an “and then...” tile.

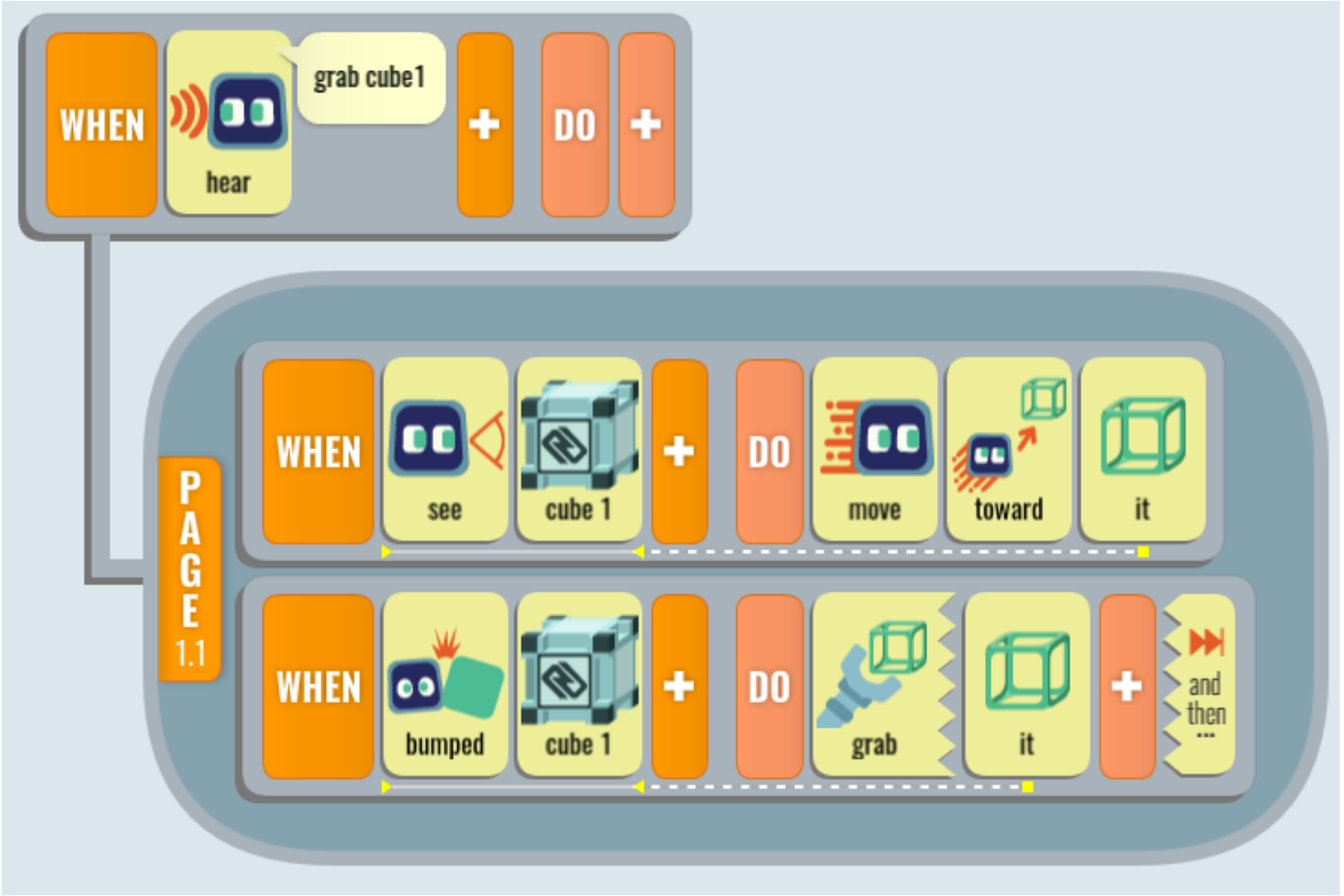
Use of “And Then...”

Switches pages as soon as the speech starts.

Switches pages after the speech completes.



Mini-Pages


WHEN
hear
grab cube1
+
DO
+
PAGE 1.1
WHEN
see
cube 1
+
DO
move
toward
it
WHEN
bumped
cube 1
+
DO
grab
it
+
and then ...

Cloud Calypso

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

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

- New primitives:
  - Trainable object recognition: done!
    (uses Google's Teachable Machine)
  - Visual search (in progress)
- Typed variables
- New object types:
  - Chips, Qubes, Containers
- Support for VEX AIM robot
- Multi-robot support