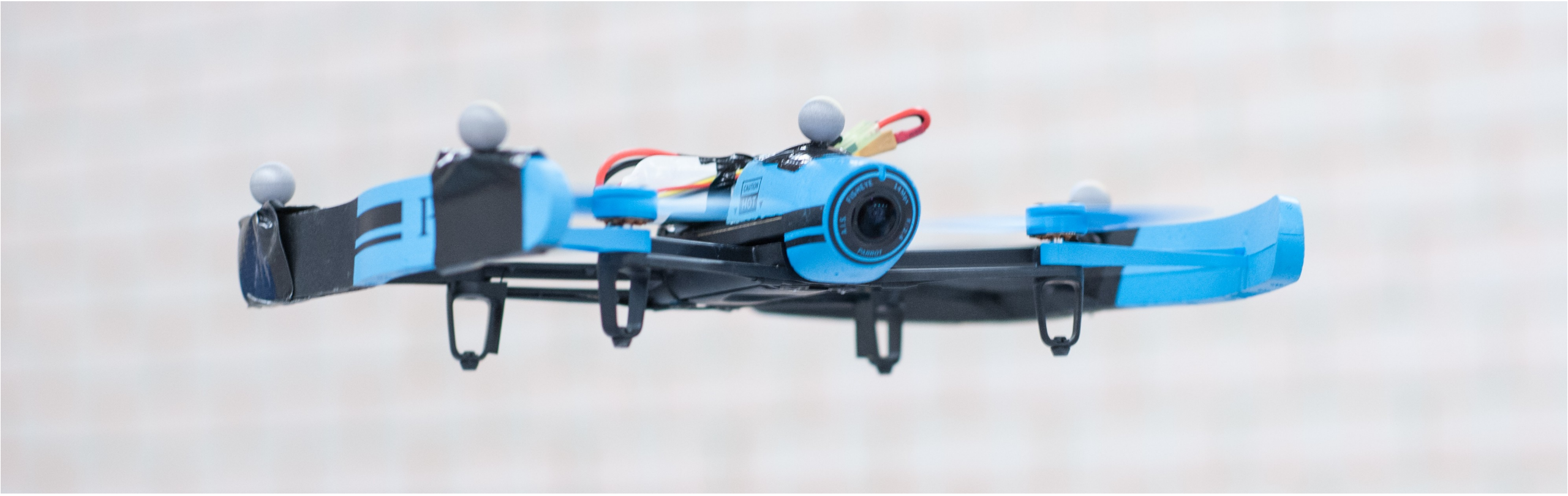


Code Manipulation through Interactive Markers in a Live Preview

Thomas Witte, Matthias Tichy | 31.10.2019

Some context

Quadcopter Lab as a demonstrator/student projects

Small Lua based Domain Specific Language (DSL) to define missions/waypoints

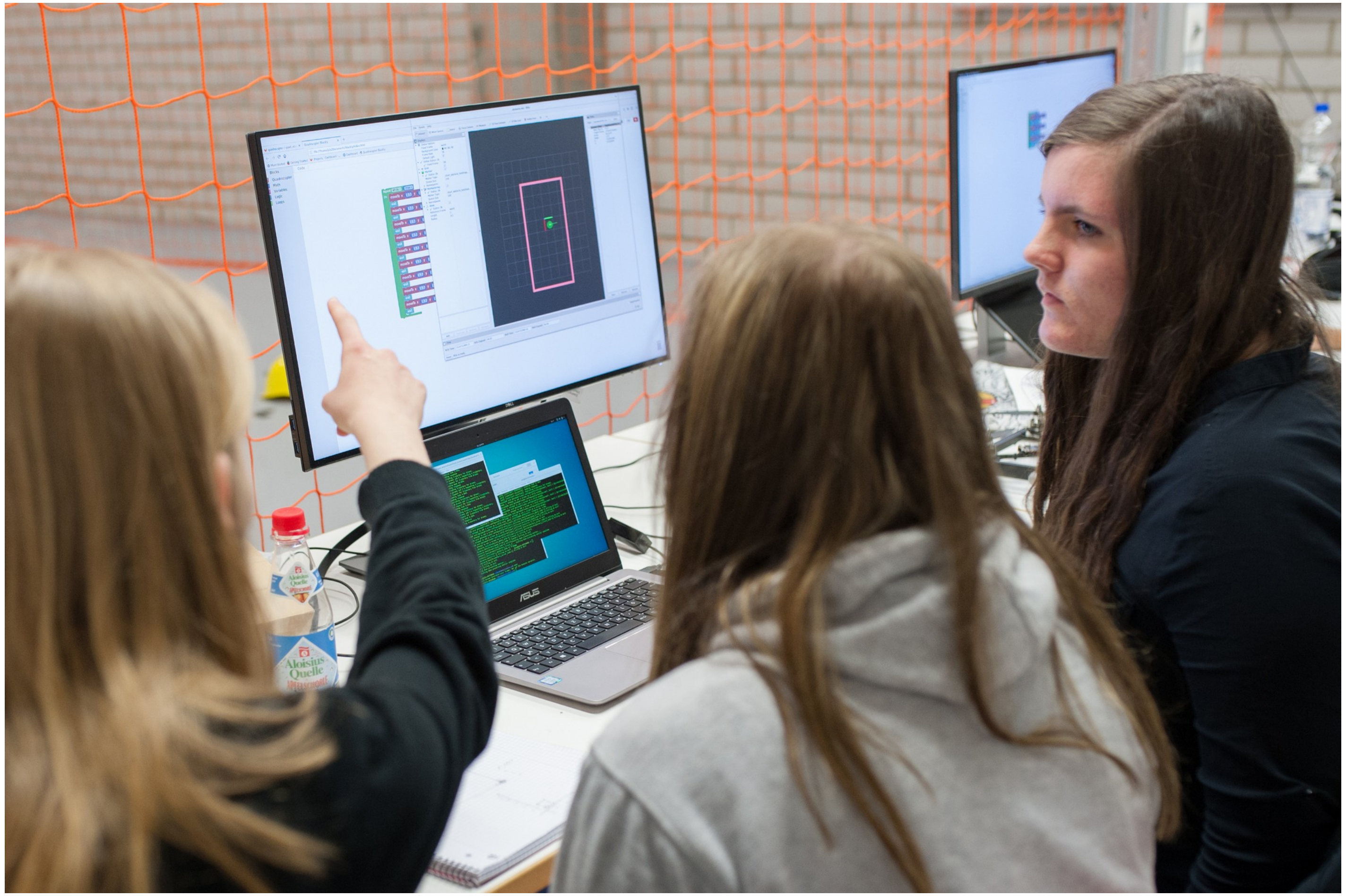
Programming novices often hesitant to experiment out of fear to break things

→ Simulation, easier understanding

Defining Quadcopter Missions

- Simplify the language, syntax
- Problems developing a strategy, estimating dimensions etc.

  → live coding / preview

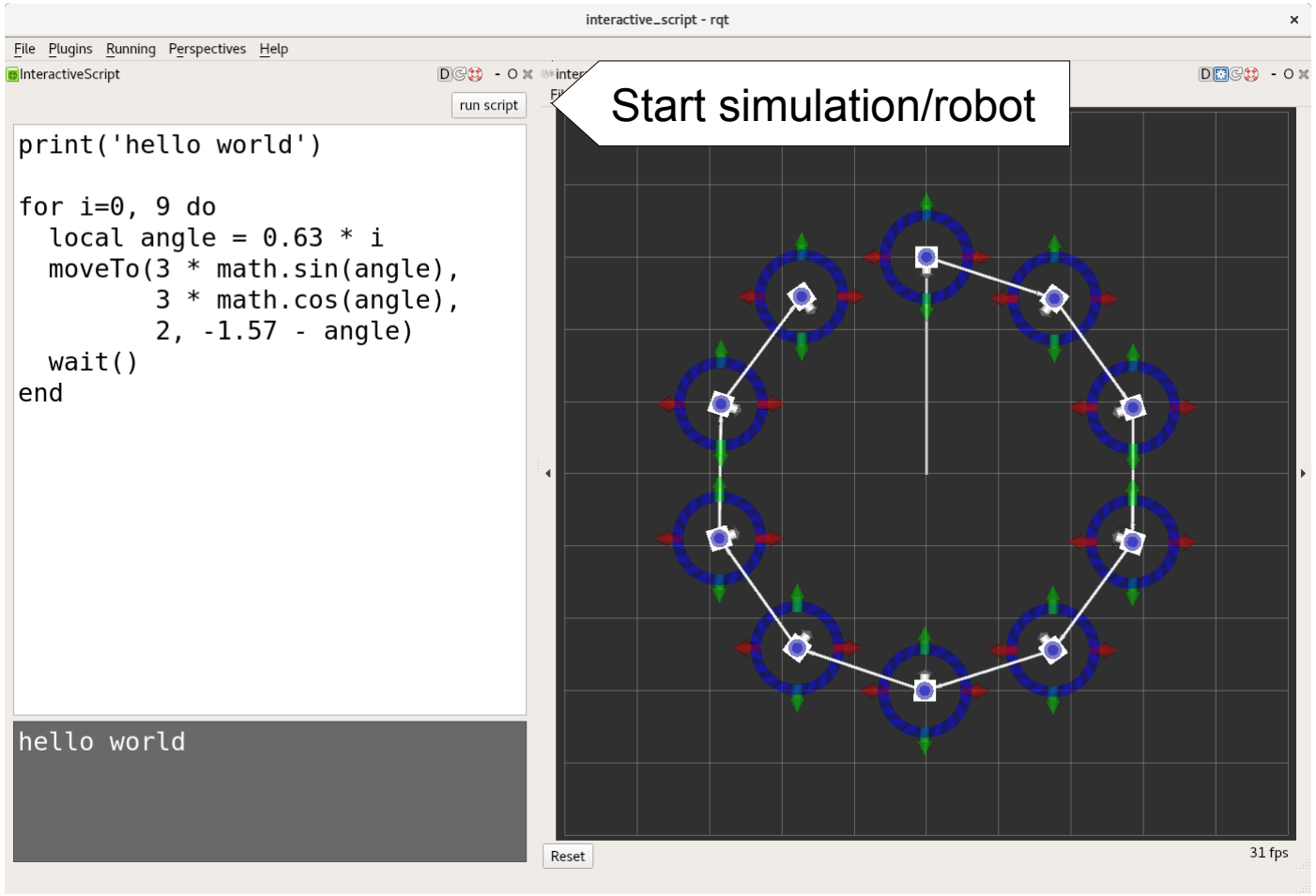


Overview

- 3 main concepts:
  - Live evaluation that previews runtime values and draws visualization
  - Source location tracking that allows to write changes back to the code
  - Mixing visualizations in RViz (integrates into existing visualizations, decoupled)

- Goal:
  - Helping novices exploring, experimenting, understanding code
  - Simplify debugging, remove barrier between development and runtime

Prototype



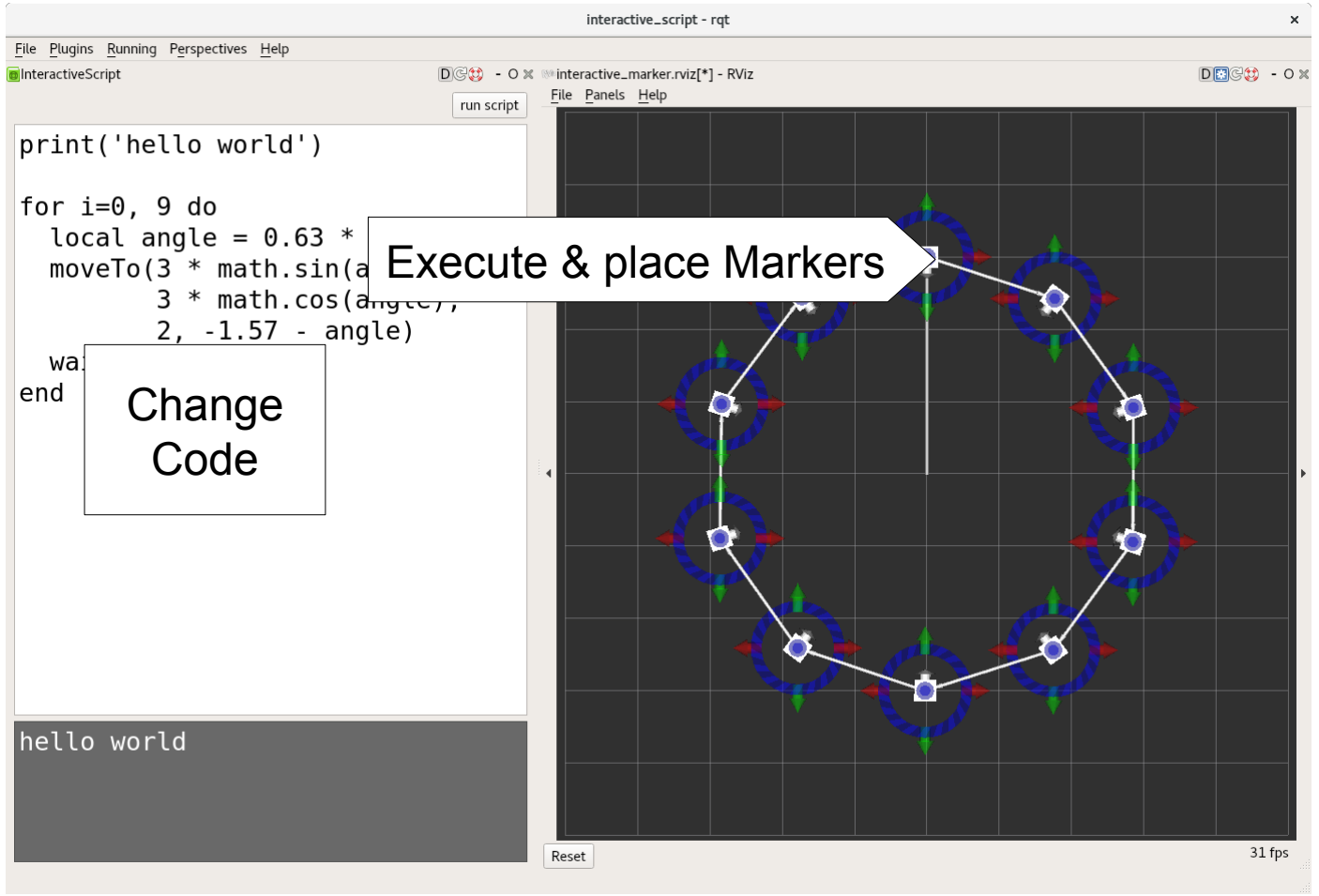
Code editor

Output console

Connected RViz

Live Preview

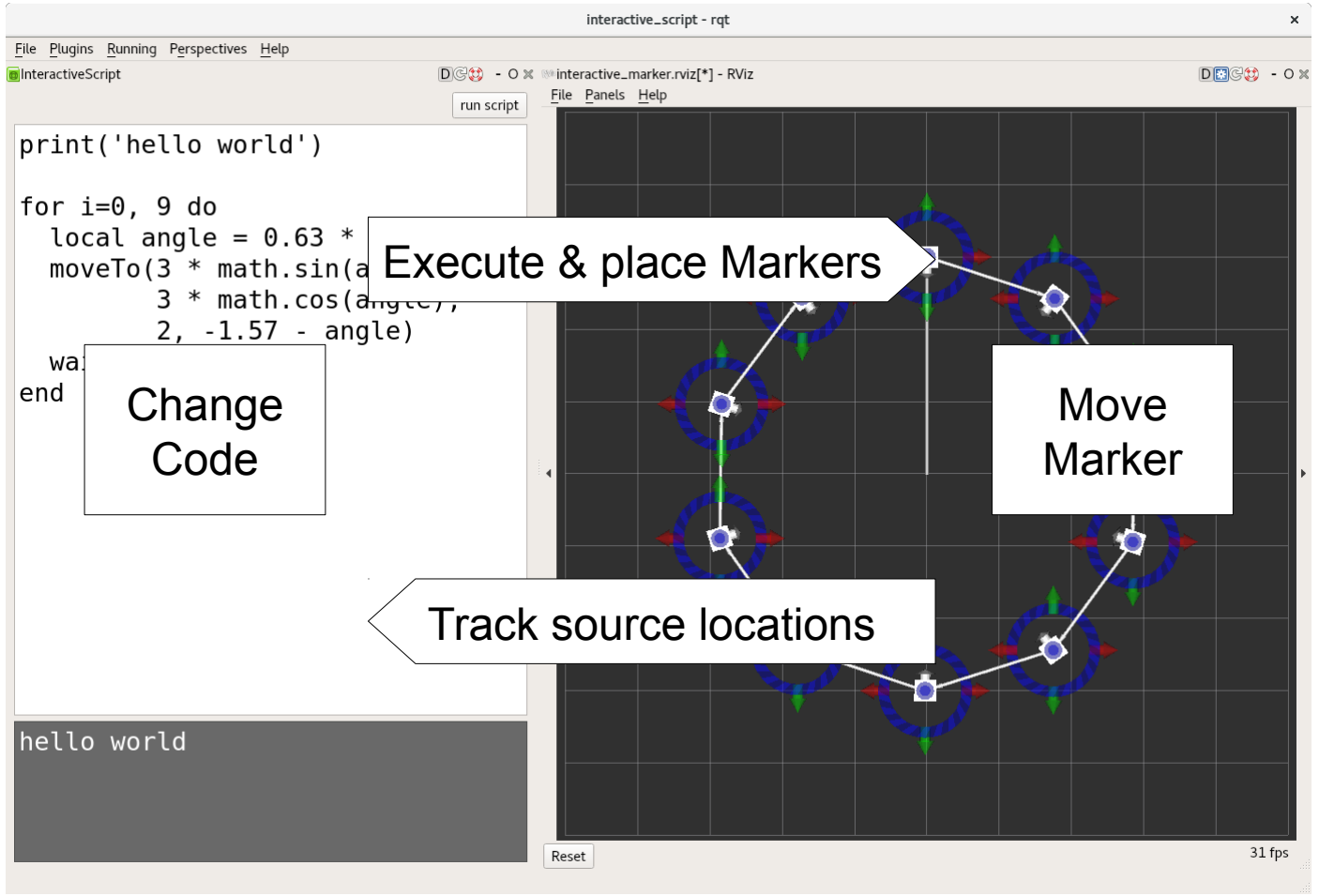
- The code is executed after each change and markers are placed



Live Preview

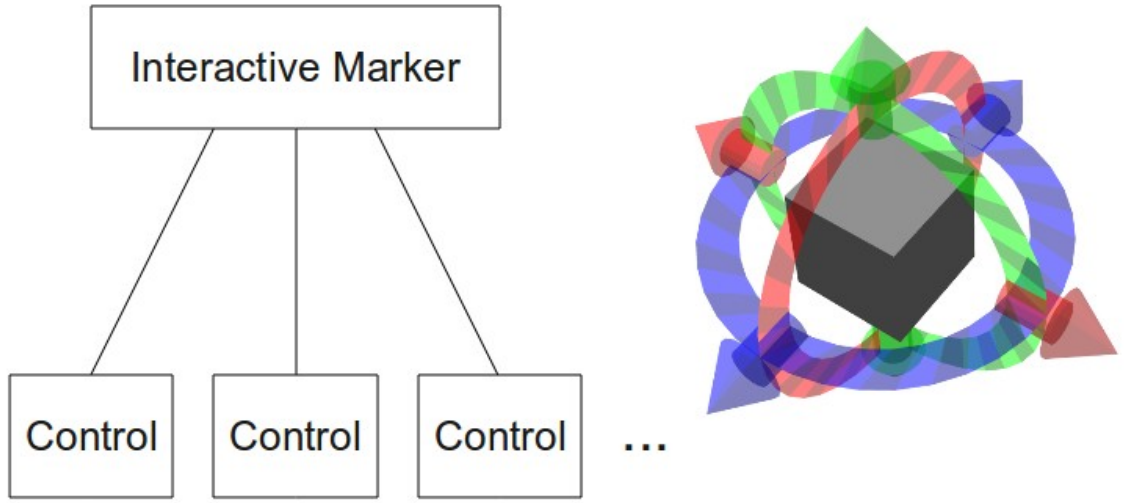
- The code is executed after each change and markers are placed
- Allow live modifications of both views

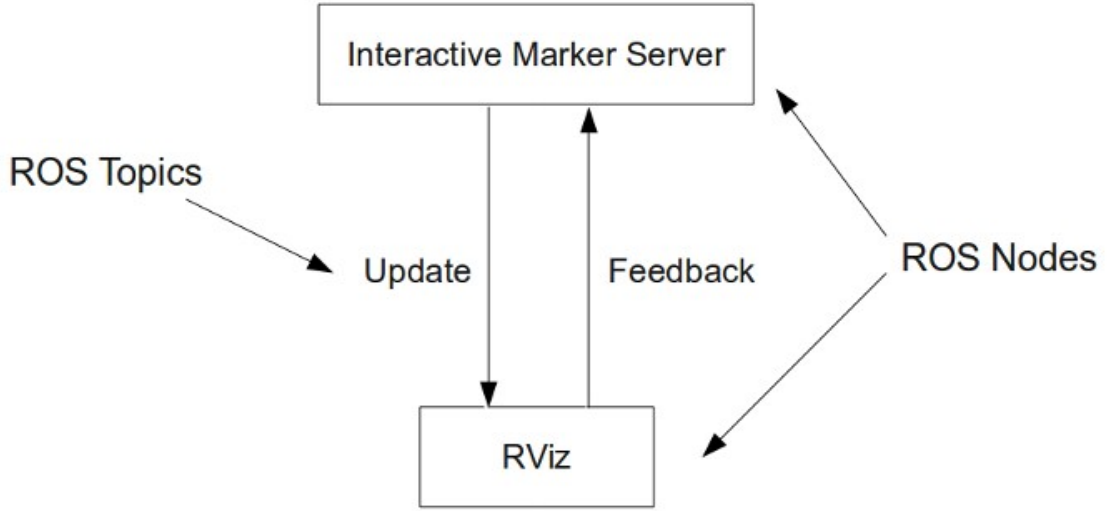
  Problem:
  imperative language, changing state



Interactive Markers

- Existing library, implemented in RViz
- Visualization integrates with other ROS nodes
- Can be implemented in other visualization tool (e.g. AR)
- Editor and live preview decoupled





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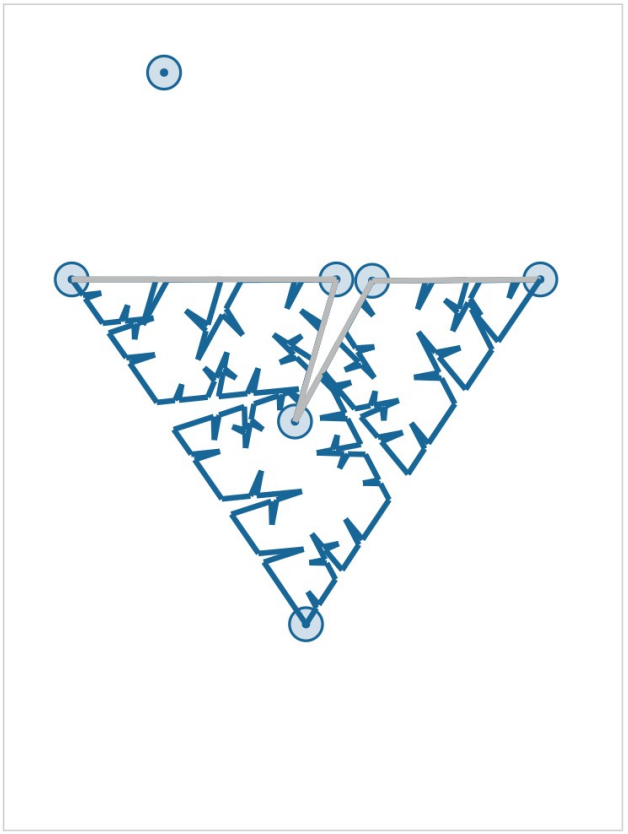
Source Location Tracking (SLT)

- My program returns 4 but I want it to be 6; what do I have to change?

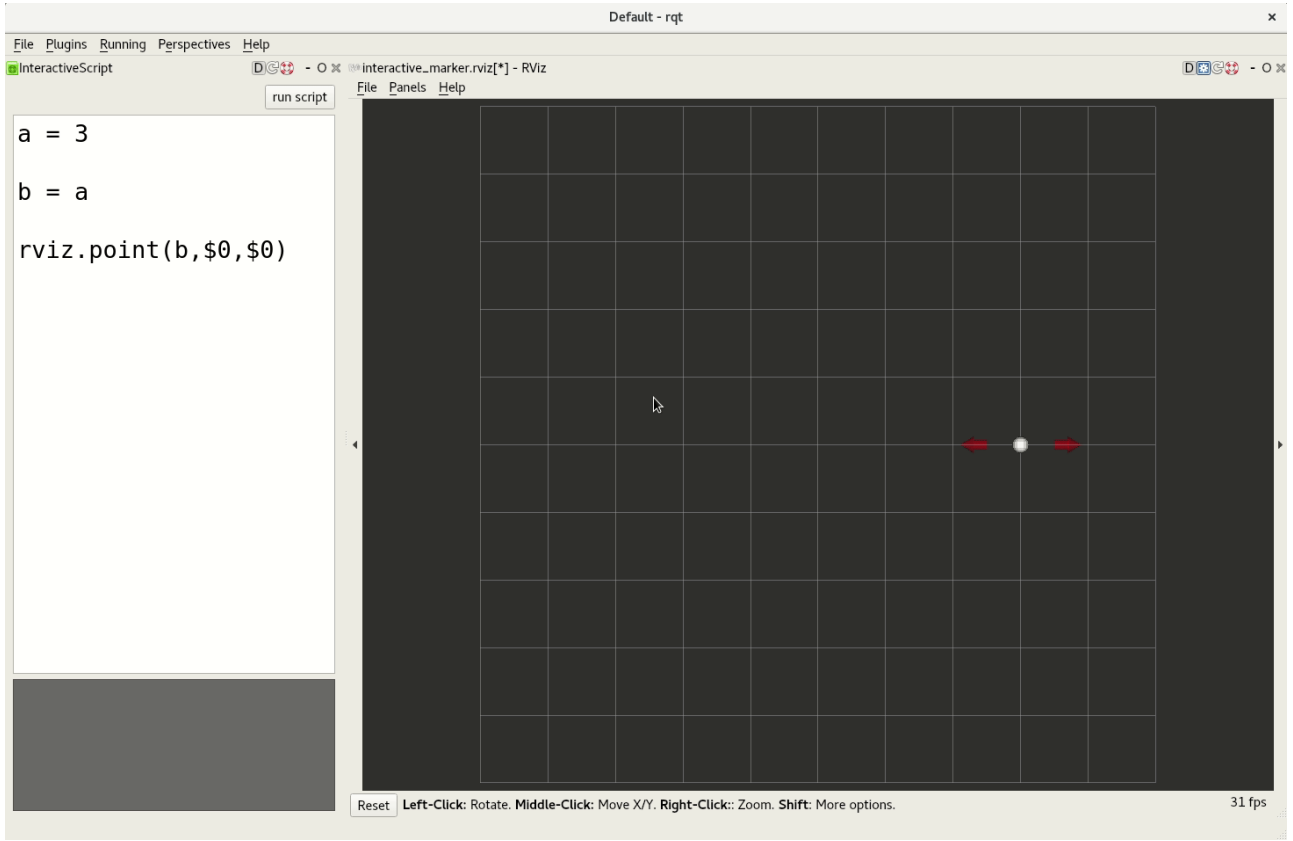
- **Values** can have a source location
- The source location for a literal is its location in the program code.
- The source location is propagated along with the value.

```
(include "prelude.qua")

(defun (path ps color)
  (if (< (length ps) 2) ()
      (begin (line (car ps) (cadr ps) color)
             (path (cdr ps) color))))

(defun (fractal a b n ps)
  (if
    (<= n 0)
    (line a b)
    (begin
      (define deg (- (angle180 (-- b a))))
      (define len (lengthv (-- b a)))
      (define ps' (rotatePath deg ps))
      (define ps'' (scalePath len ps'))
      (define ps''' (movePath a ps''))
      (map (lambda seg
             (fractal (car seg) (cdr seg) (- n 1) ps))
           (segments ps''')))))

(defun (koch a b n ps) ()
  (path ps #bbbbbb)
  (define ps' (movePath (* -1 (car ps)) ps))
  (define ps'' (scalePath (/ 1 (lengthv (last ps'))) ps'))
  (define axis (-- (last ps'') (car ps'')))
  (define ps''' (rotatePath (angle180 axis) ps''))
  (fractal a b n ps''')
)

(define anchors (list
(point 50 200)
(point 390 200)
(point 220 450)
))

(define ps (list
(car anchors)
(point 242 200)
(point 212 303)
(point 268 201)
(cadr anchors)
))
(define n (/ (car (point 117 (fix 50))) 50))

(map (lambda seg (koch (car seg) (cdr seg) n ps))
     (segments (cons (last anchors) anchors)))

```



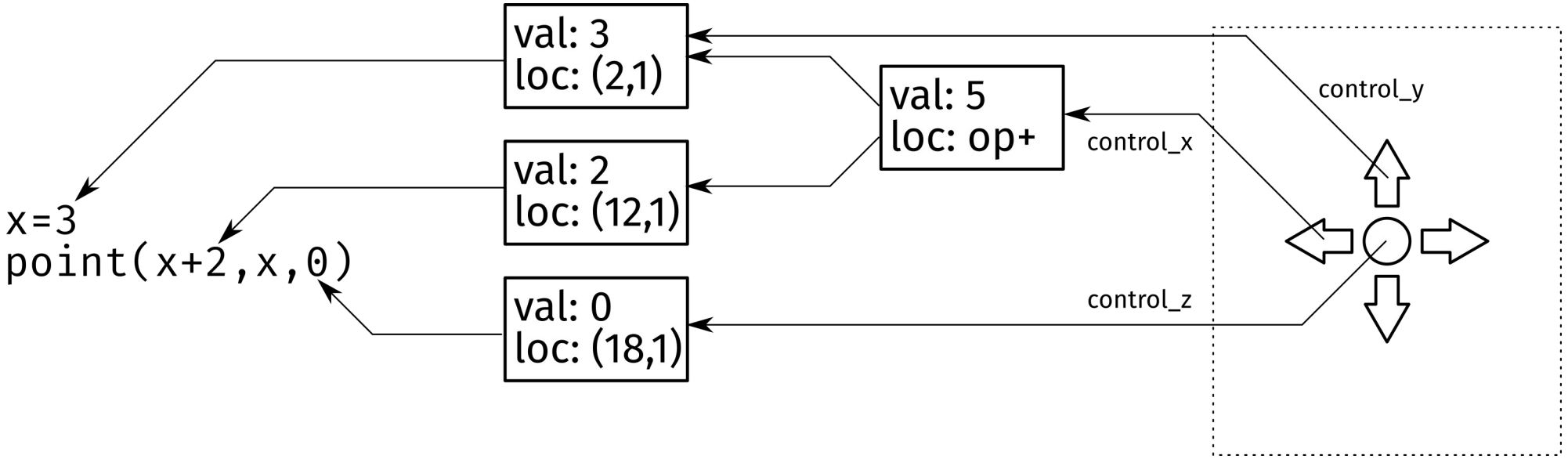
SLT – Simple Example

- Marker control is linked to the **value** that placed the marker
- Assignments etc. just copy the value
- The source is modified at the value‘s location and reexecuted → the marker is now at the desired position



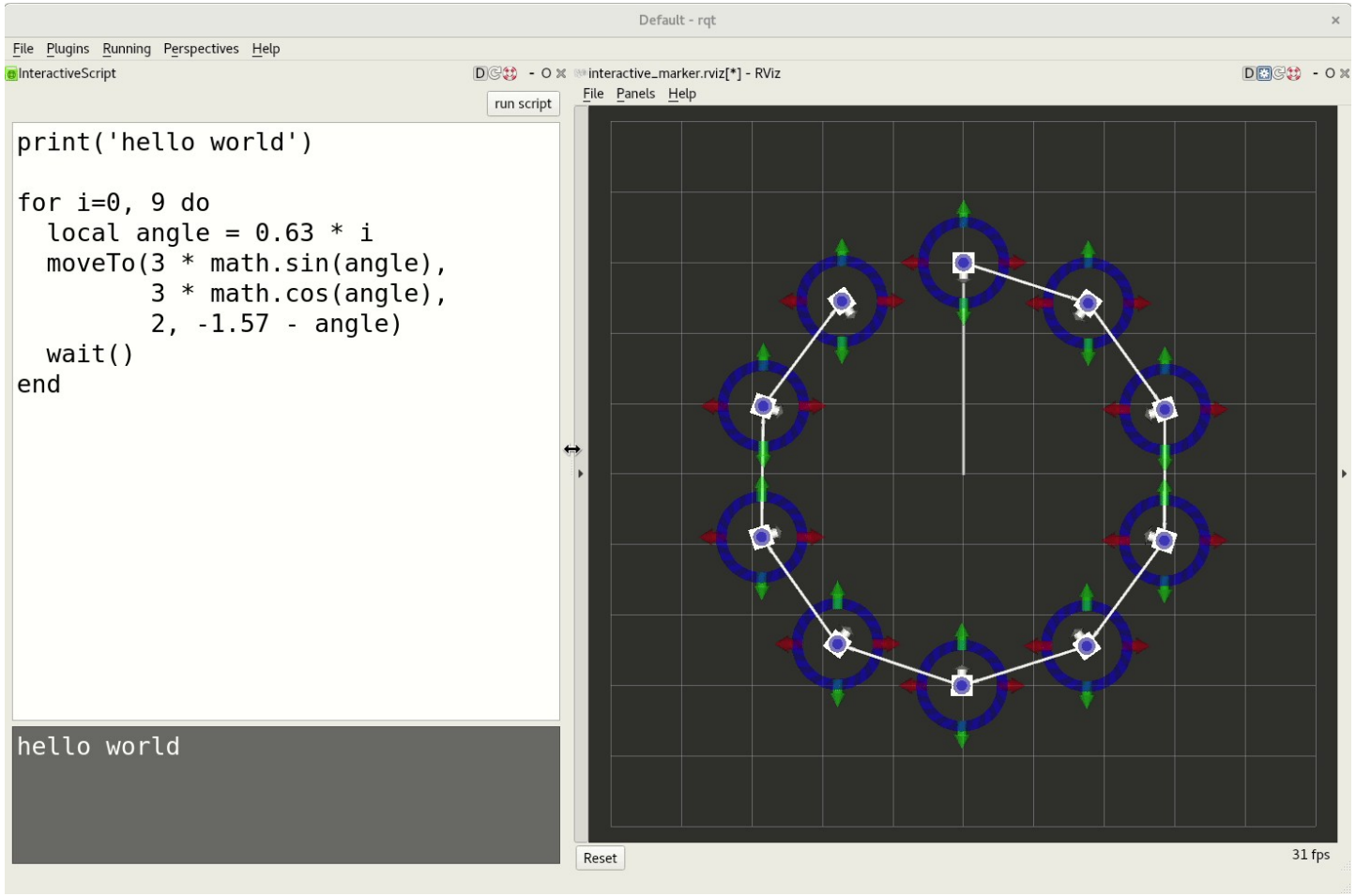
SLT – Expressions

- Forcing a desired value for an expression yields multiple results
- 5+4=7: 5 → 3 | 4 → 2 | (5 → 4.5, 4 → 2.5) | …
- Left bias implemented: first operand that has a source attached is changed



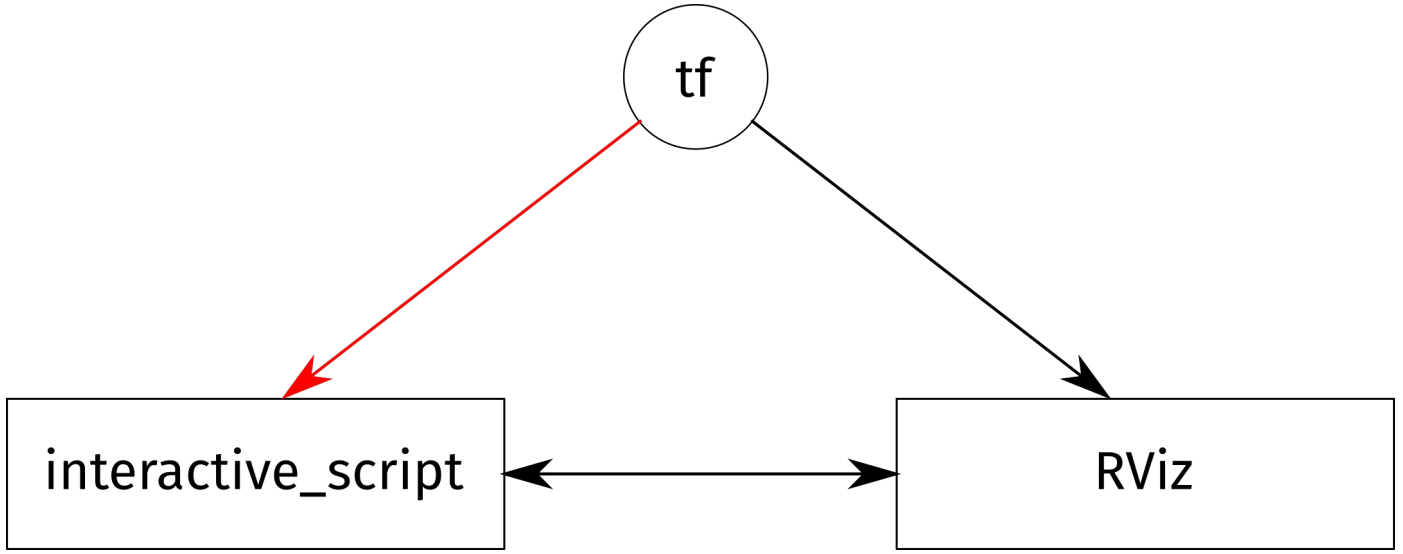
SLT – Examples, Generalizing effects

- Incomplete heuristic, but it works in many cases
- Nice generalizing effect: Moving a marker keeps the shape elliptical
- Language and Domain agnostic



tf Integration

- Interaction with physical objects should be visible in the preview
- Capturing a pose: placing an object and using live evaluation
- Experimentation to explore corner cases

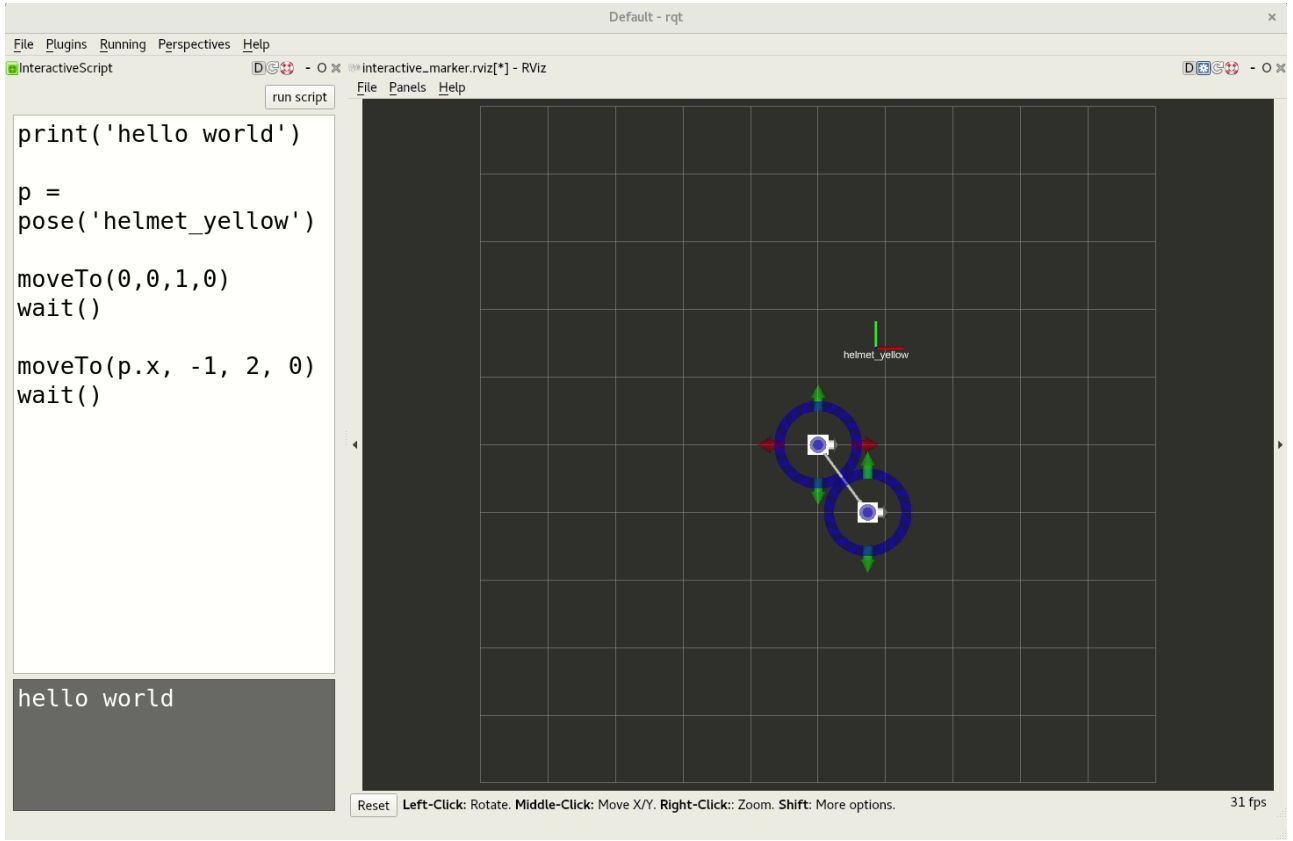


Live Evaluation, \ operator

- Simple script:
  fly to x-coordinate of
  the yellow helmet

- pose command uses tf
  → preview changes when
  helmet is moved

- Show the live coordinates
  in the code



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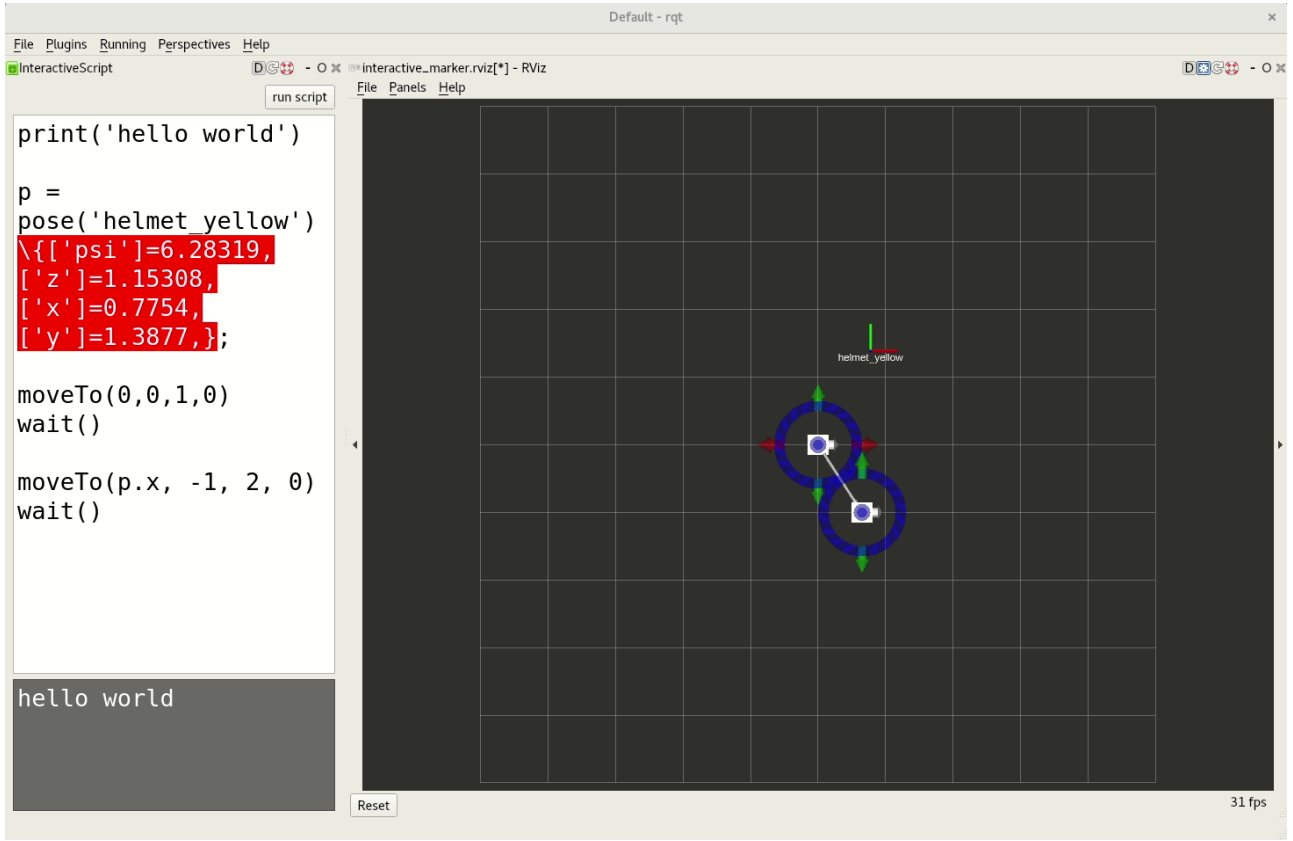
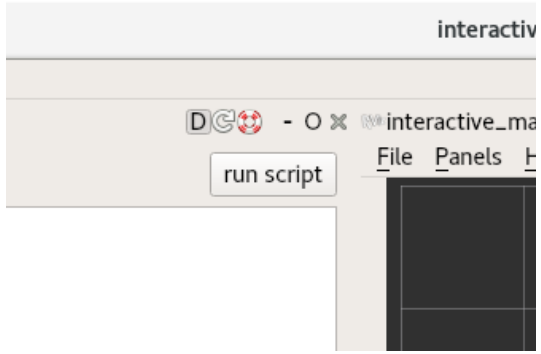
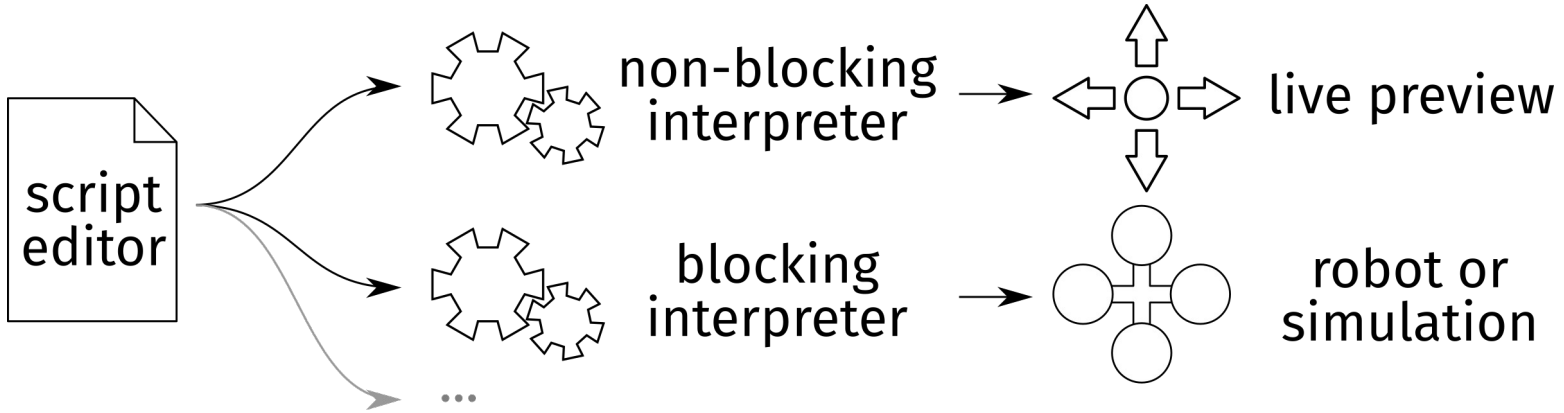


Start simulation

- Directly start script on a connected system (simulation/robot)
- Separate interpreter, implementation of functions
- write structure → move markers → see preview → run simulation (→ start robot)





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Overview

- Prototype implementation:
  - Not yet released
  - Code available at **github.com/sp-uulm/interactive_script**

- Future Work:
  - Evaluate prototype and DSL
  - Integrate block-based language frontend
  - Integrate Augmented Reality visualization