ITU FRP 2010

Lecture 3: YFrob: Functional Reactive Robotics

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Outline

- Introduction to YFrob
- The Task monad

YFrob (1)

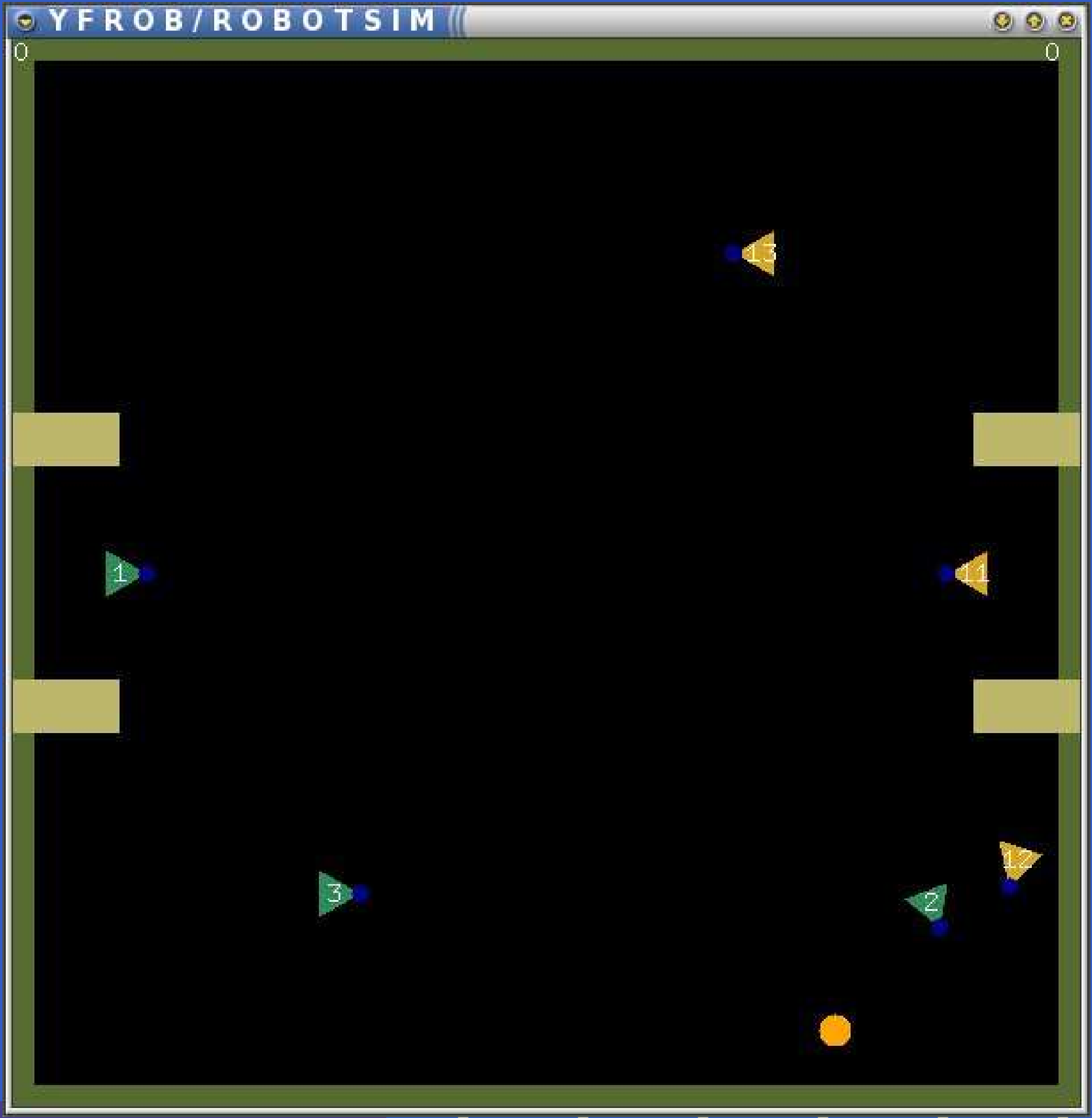
YFrob, Yampa version of Frob: Functional Robotics.

- Framework for robot programming on top of Yampa.
- Intended to be generic:
  - Programs written in terms of specific ***features***: specific kinds of sensors and actuators.
  - A program will (in principle) run on any specific platform that provides the assumed features.

YFrob (2)

- Platforms:
  - Pioneer (historical)
  - RobotSim: a simulated environment providing the Simbot platform.

YFrob (3)



Robot Controller

```
type SimbotController =
       SimbotProperties
       -> SF SimbotInput SimbotOutput
```

Input Features (1)

```
class HasRobotStatus i where
    rsBattStat :: i -> BatteryStatus
    rsIsStuck  :: i -> Bool

data BatteryStatus = BSHigh | BSLow | BSCritical
     deriving (Eq, Show)
```

Input Features (2)

```
-- derived event sources:
rsBattStatChanged   :: HasRobotStatus i =>
                       SF i (Event BatteryStatus)
rsBattStatLow       :: HasRobotStatus i =>
                       SF i (Event ())
rsBattStatCritical :: HasRobotStatus i =>
                       SF i (Event ())
rsStuck             :: HasRobotStatus i =>
                       SF i (Event ())
```

Input Features (3)

```
class HasOdometry i where
    odometryPosition :: i -> Position2
    odometryHeading  :: i -> Heading
```

Input Features (4)

```
class HasRangeFinder i where
    rfRange    :: i -> Angle -> Distance
    rfMaxRange :: i -> Distance

-- derived range finders:
rfFront :: HasRangeFinder i => i -> Distance
rfBack  :: HasRangeFinder i => i -> Distance
rfLeft  :: HasRangeFinder i => i -> Distance
rfRight :: HasRangeFinder i => i -> Distance
```

Input Features (5)

```
class HasAnimateObjectTracker i where
    aotOtherRobots :: i -> [(RobotType, RobotId,
                             Angle, Distance)]
    aotBalls       :: i -> [(Angle, Distance)]
```

Input Features (6)

```
class HasTextualConsoleInput i where
    tciKey :: i -> Maybe Char

tciNewKeyDown :: HasTextualConsoleInput i =>
                 Maybe Char -> SF i (Event Char)
tciKeyDown    :: HasTextualConsoleInput i =>
                 SF i (Event Char)
```

Output Features

```
class MergeableRecord o => HasDiffDrive o where
  ddBrake   :: MR o
  ddVelDiff :: Velocity -> Velocity -> MR o
  ddVelTR   :: Velocity -> RotVel   -> MR o

class MergeableRecord o => HasTextConsoleOutput
  tcoPrintMessage :: Event String -> MR o
```

Mergable Records

```
mrMerge    :: MergeableRecord a => MR a
mrFinalize :: MergeableRecord a => MR a
```

For example, the expression:

```
sbo :: SimbotOutput
sbo = mrFinalize
       (ddVelDiff vel1 vel2 ‘mrMerge‘ tc
```

merges the velocity output with a console message.

The Task Monad

You might have noticed that the type of switch looks a lot like monadic bind:

```
switch :: SF a (b, Event c)
          -> (c -> SF a b)
          -> SF a b
```

A task is a signal function along with a terminating event. Instance of monad. Useful for sequencing.

YFrob Installation (1)

- Download `YFrob-0.4.tar.gz` from the course web page.
- Unpack it.
- Go to the top directory: `cd YFrob`.
- Compile and install (Linux/Unix):
  - `cabal configure`
  - `cabal build`
  - `sudo cabal install --global`

YFrob Installation (2)

- Try one of the applications, e.g. `afp-soccer` (Linux/Unix):
  - `cd afp-soccer`
  - `make`
  - `./afp-soccer`

YRSC 2010 “Protocol” (1)

To make it easy to set up games for the Yampa Robot Soccer Cup (YRSC) 2010, follow this “protocol”:

- Each player writes a single module with a distinct module name (e.g. using his or her own name).
- This module exports all the robot controllers the player wants to use for controlling the robots of his or her team.

YRSC 2010 “Protocol” (2)

- If a controller needs to know what team the robot it controls belong to (likely), it should have an extra parameter to allow this information to be passed in from the code that sets up an initial game configuration. For example:

  ```
  attacker :: Int -> SimbotController
  ```

  For simplicity, let us say the convention is that 1 stands for the left team, and 2 for the right team.

YRSC 2010 “Protocol” (3)

- For identifying team mates, use the animate object tracker. The left team have IDs 1, 2, 3, the right team 11, 12, 13.

Reading

- Paul Hudak, Antony Courtney, Henrik Nilsson, John Peterson. Arrows, Robots, and Functional Reactive Programming. In *Summer School on Advanced Functional Programming 2002, Oxford University*, volume 2638 of Lecture Notes in Computer Science, pages 159–187, Springer-Verlag, 2003.