

Céu: A Synchronous and Reactive Language for Constrained Embedded Systems

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Background

- LabLua:

- PUC-Rio
- Research in languages
- The home of *Lua*



LabLua
PUC-Rio

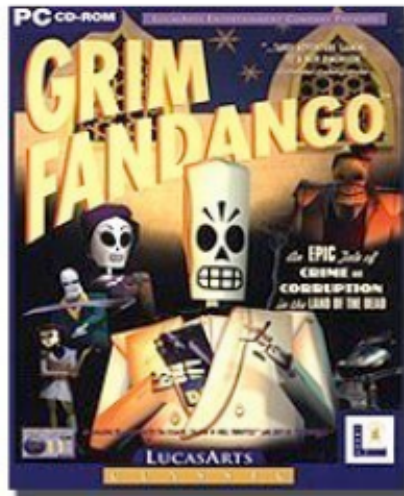
- My research:

- Reactive languages
- MSc.: *LuaGravity*
 - reactive extensions to Lua
- *(ongoing)* **PhD. : Céu**
 - a low-level reactive language “from scratch”

Lua

- Where is it used?
 - everywhere (ranked 22th)
 - *after* C, Java, Python, JavaScript, PHP, ...
 - *before* Fortran, Haskell, Erlang, Smalltalk, ...
 - niche in games
- Why?
 - it's an extension *scripting* language
 - “speaks” nicely with C

Some games...



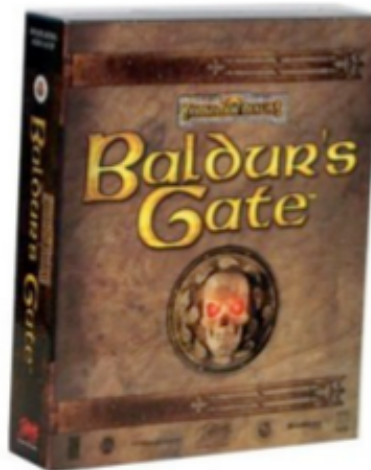
Some games...



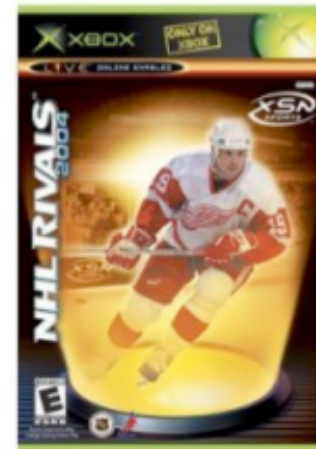
Some games...



Some games...



Some games...

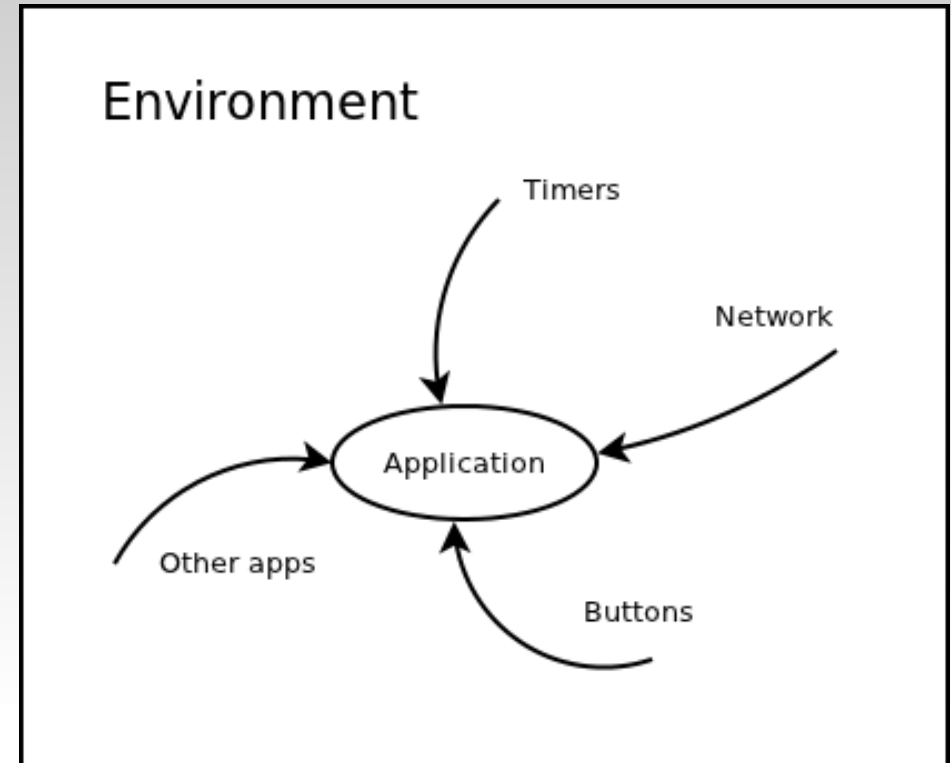


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www.ceu-lang.org

- Reactive?
 - environment in control
 - real-time requirements
- Synchronous?
 - one event at a time
 - safe concurrency
 - imposes some restrictions
- Constrained?
 - Sensor networks
 - 32 Kb ROM
 - 4 Kb RAM



Key features of Céu

- `await` statement

(vs callbacks)

- parallel compositions

(vs threads)

- safe shared-memory concurrency

(vs mutexes & locks)

- first-class timers

(vs callbacks)

- internal event-based communication

(vs global state)

How does Céu look like?

“Run forever: read sensor and broadcast readings every 10 min.
Force new read/broadcast on external request.”

```
loop do
  par/or do
    _sensorRequest();
    int v = await SENSOR_READ;
    par/and do
      _radioBroadcast(&v);
      await RADIO_SENT;
    with
      await 10min;
    end
  with
    await RESTART;
  end
end
```


Evaluation

- 20-70% reduction in code complexity
- no state variables
- less globals
- reasonable footprint

Application	Language	tokens	Céu / nesC	globals		ROM	Céu / nesC	RAM	Céu / nesC
				states	data				
Trickle	nesC	477	0.32	2	2	3894	1.31	114	2.07
	Céu	155		0	0	5100		236	
DRIP	nesC	342	0.77	2	1	13296	1.08	415	1.27
	Céu	264		0	0	14424		525	
SRP	nesC	418	0.70	2	8	12266	1.18	1252	1.01
	Céu	291		0	4	14492		1261	
CTP	nesC	383	0.79	4	5	27712	1.07	3281	1.01
	Céu	303		0	2	29624		3327	
CC2420	nesC	590	0.76	1	2	12062	1.02	379	1.02
	Céu	447		0	0	12360		387	