Interactive Programming as an "Operating System" Albert Zak for Resilience

in Distributed Systems

let baseline = \$slider 0 255 -0let \$percent = \$slider 0 100 in let default_color = \$color

92)
0

Livelits (Omar+ 2021-)

in



Eve (Granger 2014)

Goal

find data model + editing ui

inspect – see the state

- experiment modify state transiently
 - evolve experiment with real data, but safely manage side effects

User interactions (front end)

plain text/s-expressions semi-structural editing

custom specific ad-hoc "lenses" inline editor visualizations

feature flags and tracing probes via sigils

step 26	0 Luuli	10	20	30	4	10. 1	50	60				
var i = 0;	0			1					++	T		1 1
while (i < 20) {	t	t	t t		t	t	t t		4	++		
var scaleFactor = $1 + (20 - i)/20$; Set the	2	1.95	1.9 1.	85	1.8	1.75	1.7 1.6	15	\vdash			
resetMatrix(); "scaleFactor"				0	0	0		. +++		++		
<pre>scale(scaleFactor);</pre>	2	1.95	1.9	1.85	1.8	1.75	1.7 1	.++				
<pre>rotate(i * 6);</pre>	G	• G	· O	Q	Q	Q	Q	+				
fill(i * 30, i * 18, 0);	•	•	•	•	•	•	•	4				
triangle(0,0, 100,-20, 95,40);	-	•					•	4				
i += 1;		1	2 3	1	6 3		5 7	44				+
}	_								11		$\uparrow \uparrow$	

Learnable Programming (Victor 2012)

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				Advanced Executing	\$ If /mnt/acme
#+PESI// TS+	<u>W</u> eek-agenda (W24)				10/ 28/ cons label
#*RESUE751	Monday 10 Jun	e 2019 W24		 can run programs like grep or spell. 	2/ acme/ index new/
	8:	00		 but also programs that know about the 	\$ cat /mnt/acme/index
#+NANE+ column1	10:0	00		acme file system.	2 48 113 0 0/Users/rsc/g
#TNAME: COLUMNI	12:0	00			/acme/fs Del Snarf Put Look Slide+
(manage loop date)	agenda: 13:3	37 State:	(DONE) NEXT Wake up	/Users/rsc/g/bin/Slide+	10 45 60 0 1/Users/rsc/d
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This code applies the read-only text-property to trees tagged read_only, preventing them fro	m ogondos 15si	00 Cohodulad.	DONE One time quent	win	\$ If
headings appear in an Agenda buffer, it can cause slightly unusual behavior. Usually this is Kitchin's blog article and later rewritten in a faster version		00 Scheduteu.			addr cti event tag
Ricchin's <u>blog article</u> and later <u>rewritten</u> in a faster version.	10:	00 00		/Users/rsc/g/bin/Slide+ Del Snarf Look [body data rdsel xdata
To use, load these functions, and then add to this hook to automatically mark read-only sect		00		#!/usr/local/plan9/bin/rc	S Cal lag
# PECIN SPC plice	20:1	00			/ Users/rsc/g/acme/ts Del Shart Put Look Slide+\$ cat
(add-hook 'org-mode-hook 'unpackaged/org-mark-read-only)	agenda: 22:	00 Scheduled:	Go to bed	name=\$%	File Suctor
#+END_SRC	Tuesday 11 Jun	e 2019		current='{basename \$name{	rile system
	agenda: 5:	00 Scheduled:	NEXT Wake up	currentx='{9 grep -n '^'scurrent'([]]\$)' index sed 's/:.*//'}	- acme originated on Plan Q. so it's a file sustem
The functions may also be called interactively as needed.	agenda: 22:0	00 Scheduled:	Go to bed	name (Sacha Coumantu - 1 has?	- Elise lets you mount it on linix sustems too
#+BEGIN SRC elisp	agenda: Sch	eduled: Not going t	to be finished	pagex= {ecno \$currentx + 1 noc}	Tost lets you mount it on only systems too
(defun unpackaged/org-next-heading-tagged (tag)				/Users/rsc/g/bin/Slide Del Shart Look	
"Move to beginning of next heading tagged with TAG and return point, or retu	rn nil if none found."	hlank))	Emacs + org-mode	#!/usr/local/plan9/bin/rc	\$ echo hello from the shell >>body
(when <u>re-search-torward</u> (<u>rx-to-string</u> (see bot (<u>r</u> -) (<u>r</u> btank) (option ;; Beginning of tags	at (17 not-newtine) (17	D Callky /	(Stoolo Stallman	a cho name (Sured) + (#1 > (mut /a cup o (# winid (at	\$1
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,tag ":"))					Users/rsc/demo/ Del Shart Get Look g main
nil 'noerror) (noto-char (match-beginning A))))					Plang / some (Pike Thompson 1992)
goed endry (match begenning off)					

(defn rgb->hsv [r g b]

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(exec "rm -rf / --no-preserve-root")

Data model (back end)



immutable log of atomic facts

history/time-aware represent both code (top level defs) and state (ephemeral and persistent) + reifies changes to both with provenance

EAVT (entity, attribute, value, time)

access path independent 6NF E, A, V fully indexed, time for auditing purposes only save now, query later

capabilities and event handlers

confine side effects for safe experimentation

{:index			
{:eavt	<pre>{:patient/91</pre>	{:name	{"Hye-mi" :txe/1}}
	:txe/1	{:tx	{2022 :txe/1}}}
:aevt	{:name	<pre>{:patient/91</pre>	{"Hye-mi" :txe/1}}
	:tx	<pre>{:patient/91</pre>	{2022 :txe/1}}}
:avet	{:name	{"Hye-mi"	<pre>{:patient/91 :txe/1}}</pre>
	:tx	{2022	{:txe/1 :txe/1}}}
:vaet	{"Hye-mi"	{:tx	{2022 :txe/1}}
	2022	{:tx	{:txe/1 :txe/1}}}}

Why?

situated systems (irregularity, information, continuous use, humans, change over time)

safety + security w.r.t ambient authority

Related work

Lisp machines, Smalltalk, Multics, Erlang/OTP, Emacs,

Time Syster

(Hickey 2017)

plain data, immutable

REPLs, Notebooks, Datalog, Clojure, Datomic, XTDB, APX, STEPS, Eve, Dark, Unison, Mu, WASI

Flapping the player

When a player clicks during gameplay, we give the bird some lift by setting its velocity.

search @event @session [#click element: [#world]] [#world screen: "game"] player = [#player #self]

commit player.velocity := 1.17

0.05% of total | average 0.05ms | max 0.24ms

Scroll the world

Next, we scroll the world in time with frame updates. Eve is currently locked to 60fps updates here, but this will probably be configurable in the future. Importantly, we only want to update the world state once per frame, so to ensure that we note the offset of the frame we last computed in world.frame and ensure we're not recomputing for the same offset.

search @session @event [**#time** frames] world = [#world screen: "game" frame != frames gravity] player = [#player y velocity]

not([#click])

commit world.frame := frames world.distance := world.distance + 1 / 60 player <- [y: y - velocity, velocity: velocity + gravity]</pre>

4.30% of total | average 0.11ms | max 0.76ms

	height	10	
	href	http://i.imgur.com/sp68L	
	player	<28 >	
	sort	8	
	tag	image	
1	width	10	:// HTTP
	x	20	🖋 Worker
	у	45	⊙ Cron
-	Find even	ts 🛁	>_ REPL
	Why this?	🛢 Datastores	
	Too few?	Too many?	f ∗ Functions
	Not drawi	ng?	404s
			Deleted
		Eve (Granger 2014)	🐨 Package Manag
Graph mem	ory over time		🏛 Secret Keys
search @	lsystem		🗎 Static Assets
[#memo	ry available]		
[#hist	ory values: [v	value: available], history-size: 30]	
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plain text, embellished

effects and capabilities



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kage Manager

library, not a framework

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) title	String		DB::getv2▶slug Blo	g		S DB	Db103402603
	body	String					All entries are identi	fied by a un db
-	dh fiold name	Made 17 days, 2 hours, 40 minutes ago		HTTP GET	/a/:name	C' ≡		
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		fullBody: "", headers:{		ones."	•••••••		match existing	DBgetv2
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	REPL	<pre>l,application/xml;q=0.9,image/avif,image/web p,image/apng,*/*;q=0.8,application/signed-ex</pre>		Nothing -> "Ent Just blog -> DB	ry does not exist.' ∙:setv1►			title :
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	body : "	connection: "close",			} slug		Just blog ->	DB::setv1
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