Parallel Client
Programmable by Everyone

today’s slice: declarative language for designers

Ras Bodik
University of California, Berkeley
What’s behind 200 new iPhone features?
New features = new APIs + visualizations
Modern interface = visualization with interaction

This involves mostly the **layout** of three kinds:

- **data visualizations**: charts, ...
- **user interface**: the modern scrollbar, ...
- **documents**: pages in HTML, ...
HTML + CSS + JavaScript + future data formats and languages

Grammar

Parallel CSS
Selector Matcher

Leo

DOM
CSS rules

Parallel layout engine

Leo

Parallel parser

Leo

Parallel evaluation strategies
Leo

Serial evaluation strategies
Adam

Formalize CSS spec
Leo

Layout language
James, Thibaud

Synthesizer/compiler
Ali, Thibaud

Live tiles/widgets

Infer layout from a demonstration
Ali

Parser generator
Seth

Attribute grammar evaluator generator
Adam, Justin, Leo

Rendering
John

Hand-drawn mockup

Infer layout from a demonstration
Ali
Layouts Designs (today)

Harry Potter and the Deathly Hallows - Part 1
Reviews - Trailer - Photos - IMDb
2hr 30min - Rated PG-13 - SciFi/Fantasy/Action/Adventure/Drama
Director: David Yates - Cast: Daniel Radcliffe, Rupert Grint, Emma Watson, Ralph Fiennes, Bill Nighy - : ★★★★★

"Harry Potter and the Deathly Hallows" is a much-anticipated motion picture event to be told in two full-length parts. The long-feared war has begun and Voldemort's Death Eaters seize control of the Ministry of Magic and even Hogwarts, terrorizing and arresting anyone who might more »

UA Berkeley 7
2274 Shattuck Avenue, Berkeley, CA
12:10 12:40 1:10 3:20 3:50 4:20 6:30 7:00 7:30 9:40 10:10 10:40pm

AMC Bay Street 16
5614 Shellmound Street, Emeryville, CA
12:30 2:15 4:00 6:30 7:30 10:00pm

Rialto Cinemas Cerrito
10070 San Pablo Ave., El Cerrito, CA
3:10 6:30 9:50pm

Grand Lake Theater
3200 Grand Avenue, Oakland, CA
4:15 7:30pm

Regal Cinemas Jack London Stadium 9
100 Washington Street, Oakland, CA
11:45am 12:30 3:00 3:45 6:30 7:00 9:40 10:10pm

Orinda Theater
2 Orinda Theater Square, Orinda, CA
4:00 7:15pm

Show more theaters »

Burlesque
Reviews - Trailer - Photos - IMDb
1hr 40min - Rated PG-13 - Drama
Director: Steve Antin - Cast: Cher, Christina Aguilera, Eric Dane, Cam Gigandet, Julianne Hough - : ★★★★★

Ali is a small-town girl with a big voice who escapes hardship and an uncertain future to follow her dreams to LA. After stumbling upon The Burlesque Lounge, a majestic but ailing theater that is home to an inspired musical revue, Ali lands a job as a cocktail waitress. Burlesque's outrageous more »

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# Readable Layouts (tomorrow)

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**Rainman Forever**

*Action:* An autistic man fights crime on the streets of Gotham. Uwe Boll, Dustin Hoffman, Jim Carrey, Jet Li

*“137 interminable minutes. I counted them.”* (Ebert)

*“He's an excellent driver in a terrible movie.”* (Boston Sun)

*“A flop. Definitely a flop.”* (SF Chronicle)

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**Die Hard With More Intensity**

*Drama:* A streetwise cop confronts loneliness in Tokyo. Sofia Coppola, Bill Murray, Bruce Willis, Jet Li

*“Extrordinarily powerful ... A masterpiece of cinema.”* (Ebert)

*“Beautiful and haunting.”* (filmscritic.com)

*“Moves slow but packs a punch.”* (Boston Sun)

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**Hairy Plumber and the Goomba of Doom**

*Fantasy:* Mario and Luigi attend a school of wizardry. Steven Spielberg, Daniel Radcliffe, Emma Watson, Jet Li

*“Not as good as the others, but still a visual treat.”* (Ebert)

*“The boys are back and better than ever.”* (filmscritic.com)

*“Fans of the series won't be disappointed.”* (Boston Sun)

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**Rent and Rentability**

*Romance:* Dissimilar sisters seek husbands in the East Village. Ang Lee, Emma Thompson, Kate Winslet, Jet Li

*“A poor adaptation of the Broadway hit.”* (Ebert)

*“A real tear-jerker. Keep your hanky handy!”* (filmscritic.com)

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**The Little Schemer**

*Adventure:* An elephant journeys to find Lambda the Ultimate. Friedman & Felleisen, Car, Cdr, Cons, Cond

*“Cons is magnificent! ... Add this movie to your list!”* (Ebert)

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Bret Victor, *Magic Ink*
Can we avoid designer frustrations?
Data visualization = layout + animation


How Data Layouts Are Created Today

Pick a **canned layout**, eg from ProtoViz DSL limited to layouts in the library non-programmers cannot define their own

Programmers could write **own layout engine** may take days => can’t quickly try layout ideas.

~10x more code if using Python/JavaScript
Mud: our layout language

We choose **declarative programming** because
- for designers, who know “what” but not “how”
- seeks to naturally maps to designer’s thought process
- believe that it supports programming by demonstration

Our compiler does **synthesis**. Why not use off-the-shelf solver?
- Performance
- We compile down to tree passes. Linear Time. In parallel.
- No search and backtrack.
TreeView of Financial Industry

NY Times
TreeMap on the Drawing Board

Designer’s Intention:

Area ~ market capitalization

Companies stacked vertically (or horizontally)

Parent exactly encompasses children
Specification of $V$

Let’s first write the spec in English. Then translate it into Mud.

English Specification:
1. $V$ is a rectangle with some style.
2. $V$ area is divided vertically among its children.
3. $V$’s children are stacked on top of each other.
4. $V$ area is proportional the sum its children’s capitalization.
The Three Constraints

```
trait VDiv(h, w) {
  // vertical division
  h = children[0].h + children[1].h
  w = children[0].w = children[1].w
}
trait VStack() {
  // vertical stacking
  children.left = 0
  children[0].top = 0
  children[0].h = children[1].top
}
trait TreeMap(h, w, cap) {
  // area =~ cap
  SCALE * cap = h * w
  cap = children[0].cap + children[1].cap
}
```
V, H are compositions of traits

Now we declare our two building blocks:

```haskell
let V with RelCoord, BasicBoxStyle,
    VDiv, VStack, TreeMap
let H with RelCoord, BasicBoxStyle,
    HDiv, HStack, TreeMap
```

“Trait”: Composable unit of behaviour
Are we done?

**Compiler to designer:** “Your treemap is under-constrained. There are distinct ways to lay it out:”

A fix: Root.h = 640  

**An alternative fix:** set the aspect ratio.

**Benefits of our semantics:**

– Show possible solutions ==> Designer-friendly debugging
– Unique solution ==> predictable layout.
Demo of a Mud program

http://www.cs.berkeley.edu/~tbh/treemap/treemapDemo.html
Radial Layout: just define polar coords

trait Polar (x, y, ω, radius) {
    x = parent.x + radius * cos(ω)
    y = parent.y + radius * sin(ω)
}
Summary

Declarative programming for designers
  – data visualization, GUIs, documents

Fast layout for big data and small battery.
  – No search, no fixed-point.
  – Instead, linear time, parallel.

Mud compiler based on two-step synthesis.
  – Local constraints to functions.
  – Functions to global solver.