

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

No more interruptions

Notifications appear at the top of your screen and disappear quickly.



One-swipe access

Swipe down to reveal Notification Center.

See more at a glance

View stocks and weather, too.

Modern interface = visualization with interaction

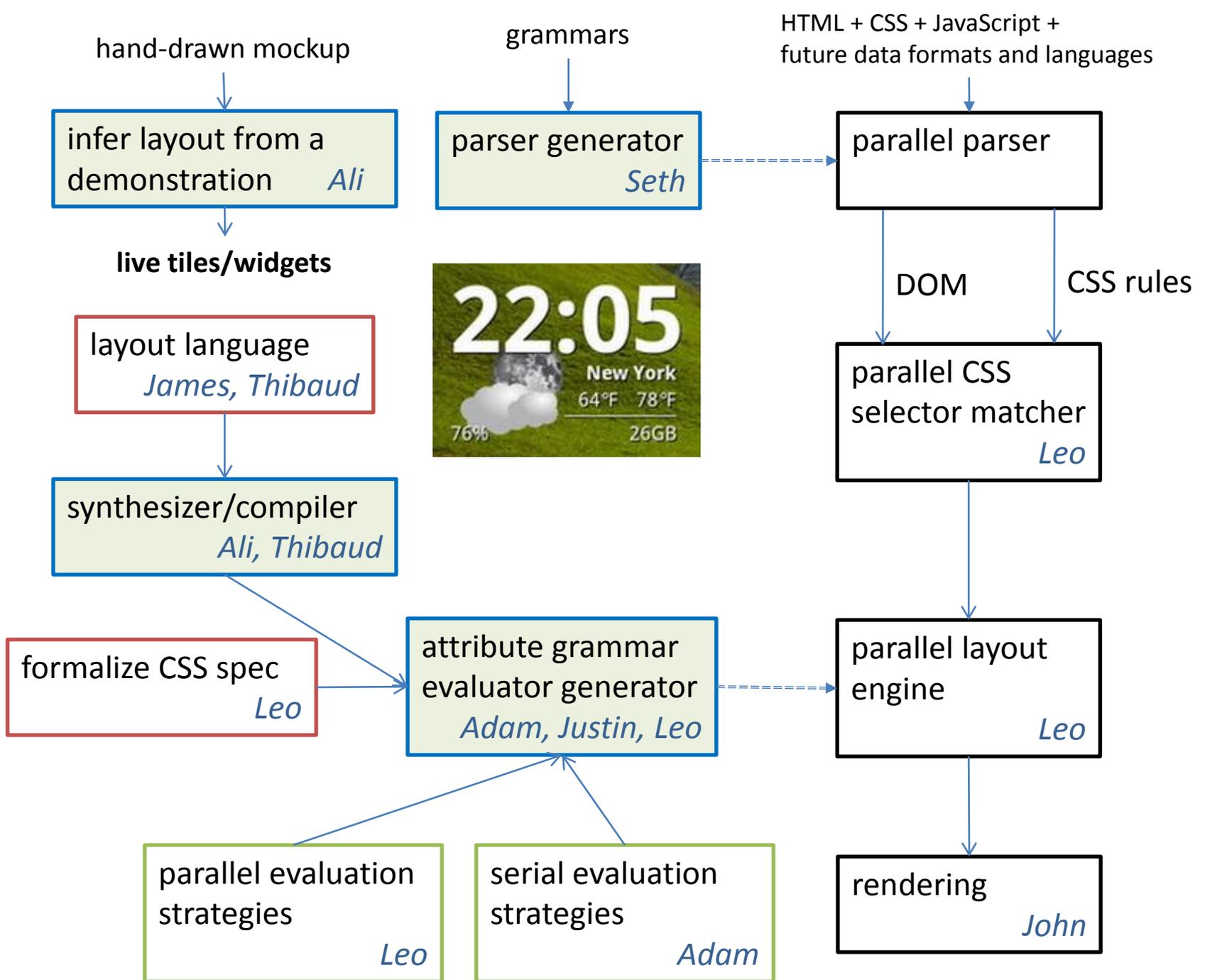
This involves mostly the **layout** of three kinds:

data visualizations: charts, ...

user interface: the modern scrollbar, ...

documents: pages in HTML, ...





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](#)

[Show more theaters »](#)

[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](#)



[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 »](#)

[Shattuck Cinemas](#)

2230 Shattuck Avenue, Berkeley, CA

[1:45](#) [2:45](#) [4:30](#) [5:30](#) [7:05](#) [8:00](#) [9:45pm](#)

[Regal Cinemas Jack London Stadium 9](#)

100 Washington Street, Oakland, CA

[12:45](#) [4:30](#) [7:20](#) [10:00pm](#)

Readable Layouts (tomorrow)



★★★★★ 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)



★★★★★ Die Hard With More Intensity

Drama: A streetwise cop confronts loneliness in Tokyo.

Sofia Coppola, Bill Murray, Bruce Willis, Jet Li

"Extraordinarily powerful ... A masterpiece of cinema." (Ebert)

"Beautiful and haunting." (filmscritic.com)

"Moves slow but packs a punch." (Boston Sun)



★★★★★ 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)



★★★★★ 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)



★★★★★ The Little Schemer

Adventure: An elephant journeys to find Lambda the Ultimate.

Friedman & Fellesen, Car, Cdr, Cons, Cond

"Cons is magnificent! ... Add this movie to your list!" (Ebert)

Old Joe's Showhouse	11:55		3:00			7:15			
AMC Lilliput		1:25	2:45	4:20	6:15	7:30	9:25	10:35	
UA Easy Street		12:45	3:00	5:00	7:20	9:00	11:00		
Gulliver Theater			1:40	4:25	7:20	10:00			
Little-End Cinemas			2:15	4:45	7:15	9:35			

AMC Lilliput	11:45	12:40	2:00	3:30	5:00	6:30	7:30	8:30	9:50	11:30
	12:00	1:20						8:05	9:15	10:10
UA Easy Street		1:00	2:30	4:30	7:00	8:50	10:00			
Landmark Quinbus				4:30		8:00	10:00	11:50		
Little-End Cinemas	11:55	1:15	2:30	3:50	5:05	6:25	7:40	9:05	10:15	

AMC Lilliput	12:00	2:25	4:45	7:05	9:25				
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Landmark Quinbus	12:05	2:45							
Gulliver Theater				8:30	10:30				
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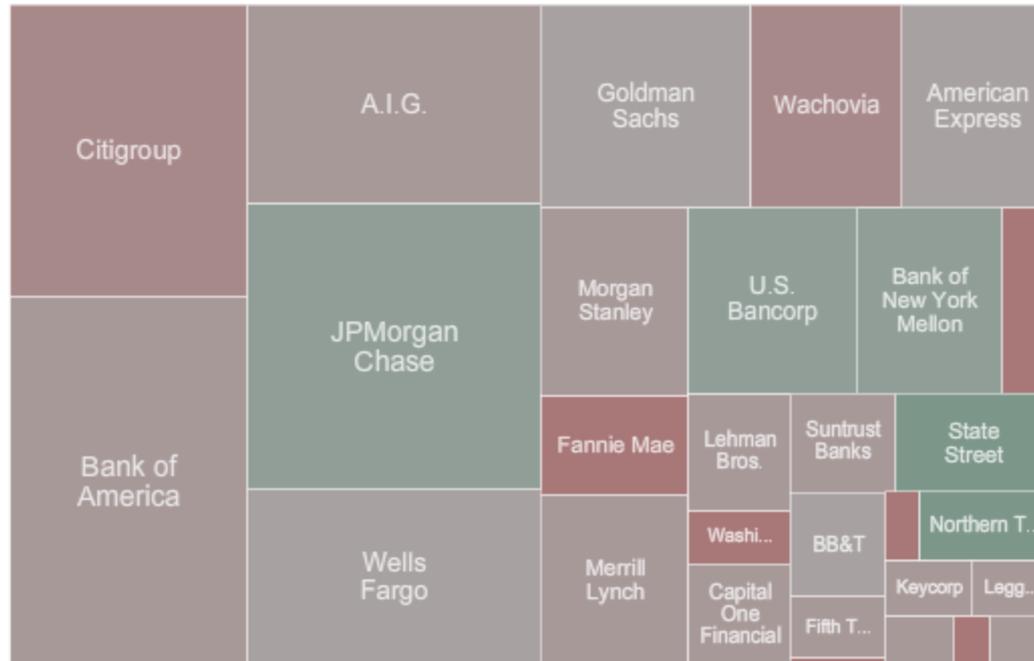
Old Joe's Showhouse	1:15	5:15	9:30		
Gulliver Theater	12:35	2:20	4:55	8:20	11:10
Little-End Cinemas				7:00	9:30

PLT Arthouse		7:30	9:30		
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Can we avoid designer frustrations?



Data visualization = layout + animation



<http://www.nytimes.com/interactive/2009/09/12/business/financial-markets-graphic.html>

<http://www.nytimes.com/interactive/2010/02/01/us/budget.html>

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

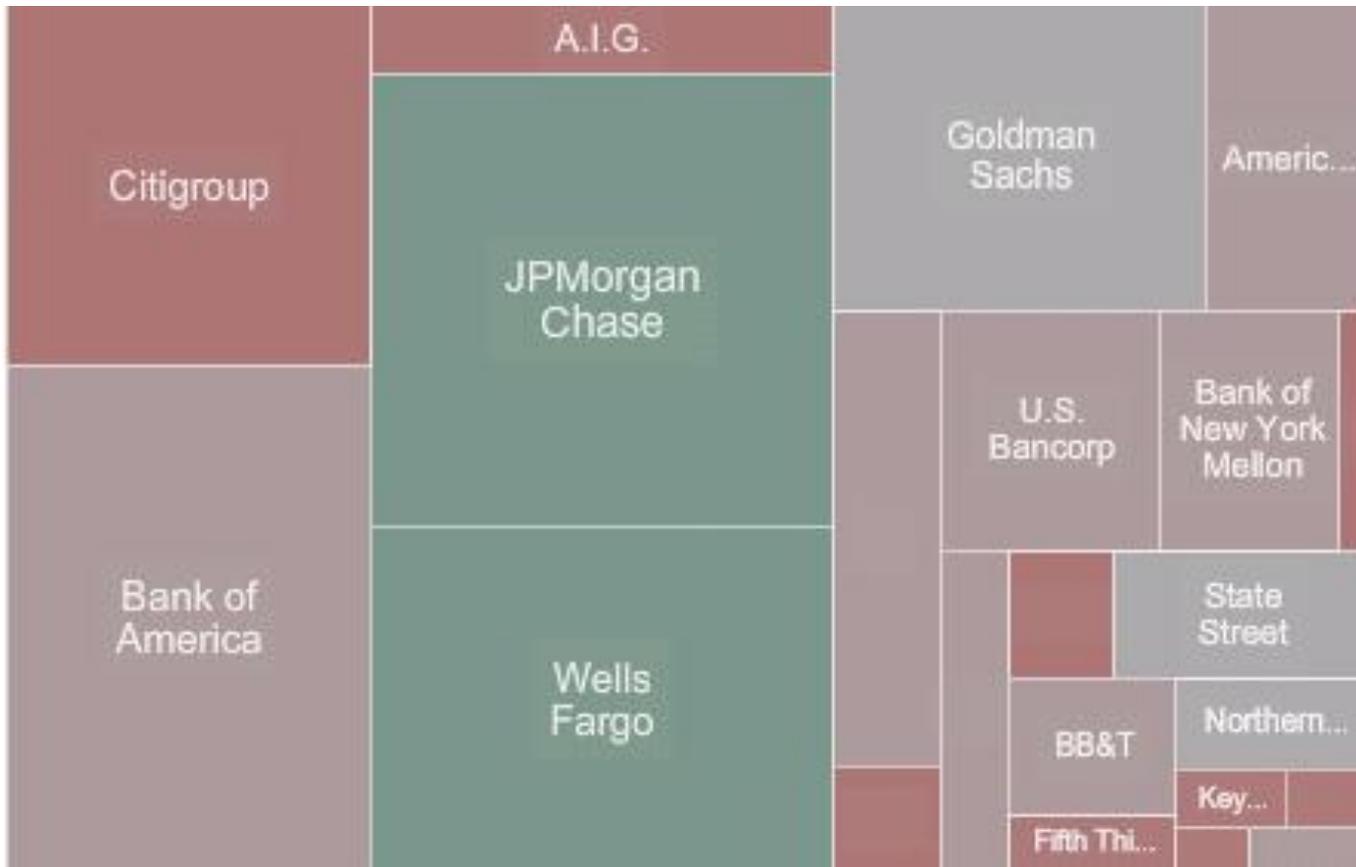
We choose **declarative programming** because

- for designers, who know “what” but not “how”
- seeks to naturally map to designer’s thought process
- believe that it supports programming by demonstration

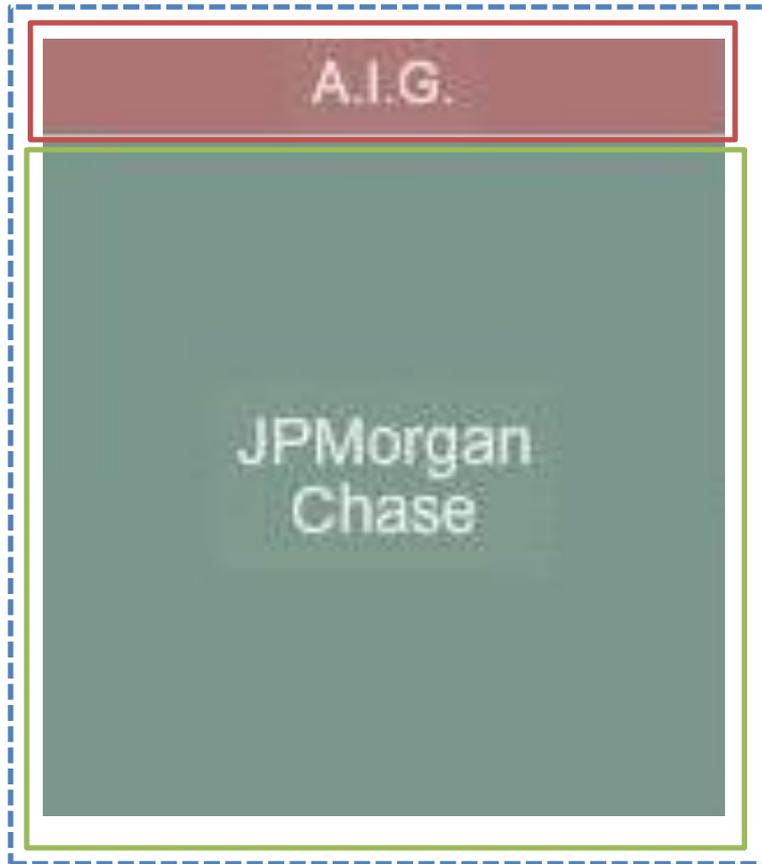
Our compiler does **synthesis**. Why not use off-the-shelf solver?

- Performance
- We compile down to tree passes. Linear Time. In parallel.
- No search and backtrack.

TreeMap of Financial Industry



TreeMap on the Drawing Board



Designer's Intention:

Area \sim market capitalization

Companies stacked vertically
(or horizontally)

Parent exactly encompasses
children

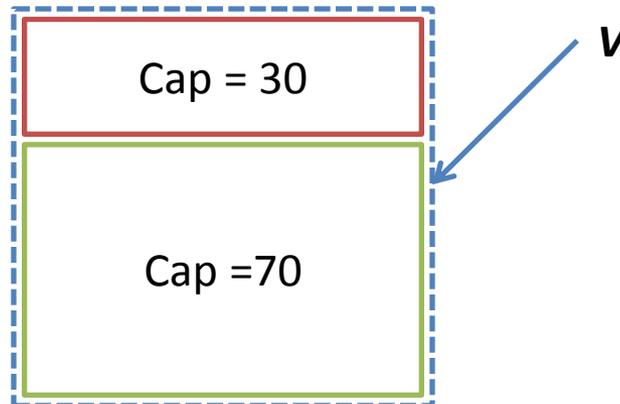
Specification of V

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

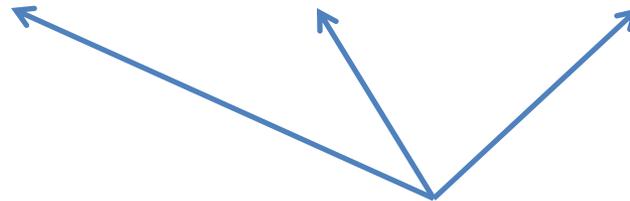
Now we declare our two building blocks:

```
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:”



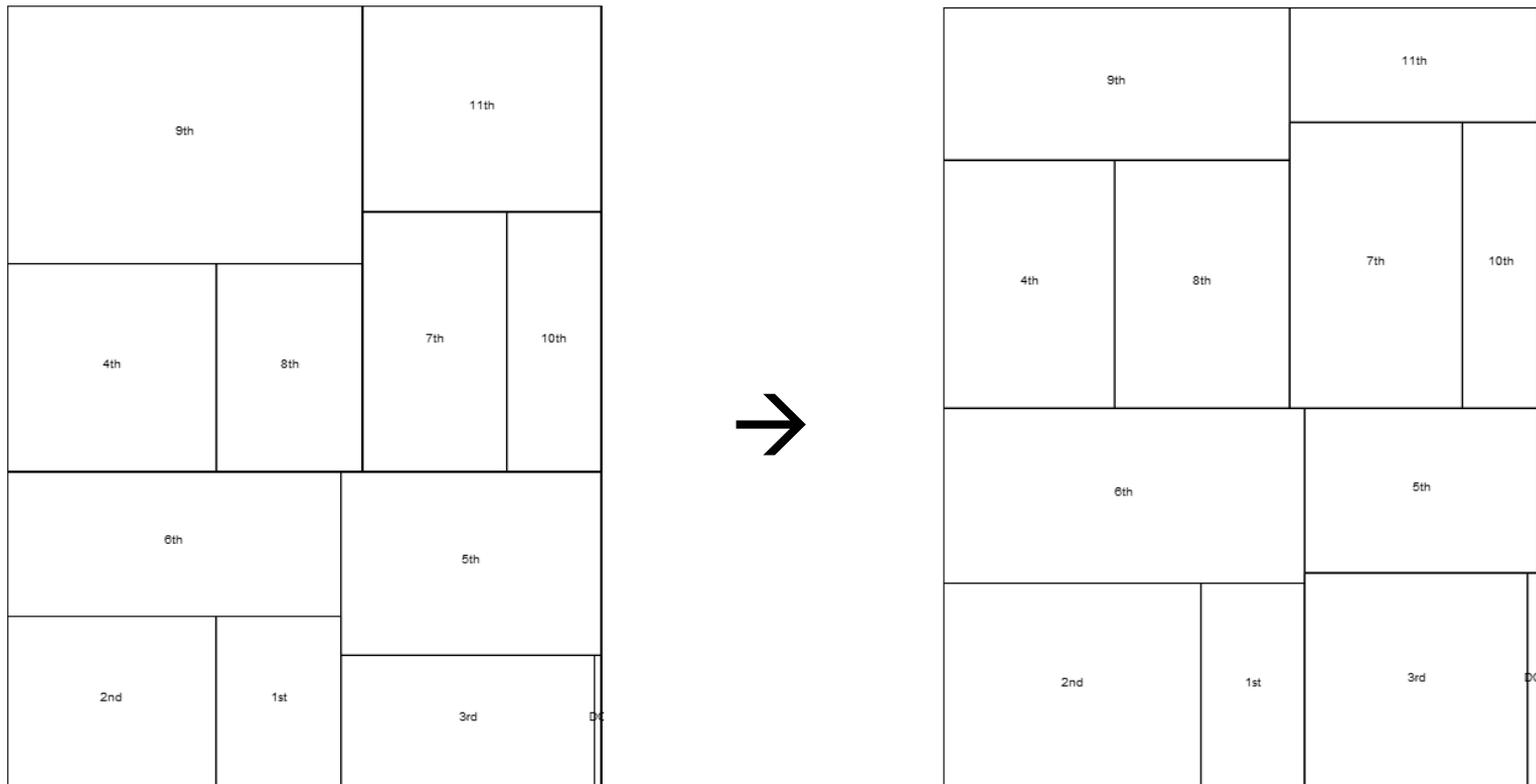
A fix: $\text{Root.h} = 640$ **An alternative fix:** set the aspect ratio.

Benefits of our semantics:

- Show possible solutions ==> Designer-friendly debugging
- Unique solution ==> predictable layout.

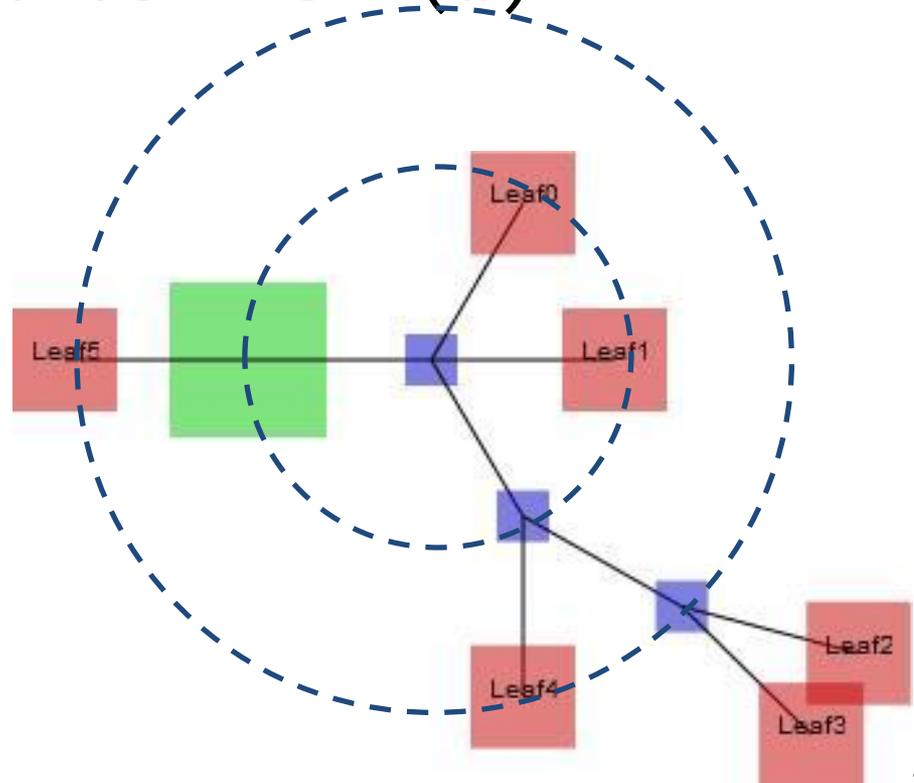
Demo of a Mud program

<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.