Client/browser productivity language (for layout)

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Millions of Designers Struggle With CSS

“I need help sorting out the problem with a website I designed which uses DIV tags to allow me to use a background image with layers of editable text over it. What I have works fine in all browsers EXCEPT when the screen resolution changes and/or the browser is resized. Then the text no longer properly or predictably lines up with the background image. [...]”

CSS is hard. Why?

- Is it too large, bloated?
- Or is something missing?
- Do the language concepts map onto how users think?

→ Brokenness by Example
CSS Spec is Contradictory

- Browser tries to guess user’s intent
  - Deviate from Spec

- CSS is too low level
  - Does not let you specify the constraints yourself

→ Silently dropped constraints lead to unpredictability
CSS Spec is Ambiguous

```html
<div style="float: left; width:200px">
  <div>
    <div style="float: left;">
      inner float
      <div style="float: left;">
        inner inner float
      </div>
    </div>
  </div>
  outer float
</div>
```
Summary of Motivation

Users are confused

- Limited Expressiveness; results are unpredictable.

CSS Spec confusing because

- Contradictory, constraints silently dropped
- Ambiguous, diverging browsers
- Complicated, hard to implement

We address these by

- Simpler, domain languages
- Tool support for checking specs
- Tool for generating layout engine
Different needs -> Different languages

NY Times
WSJ

Flickr
Picasa
Gmail
Hotmail

CSS
Eventually

Successful if we can embed in our model

- GUIs: QML, XAML, etc.
- New Grid-Based Layouts
- Core/Subsets CSS [Meyerovich’09]
Roles

Today

- **Webpage-writer**
  - Write HTML+CSS
  - DOM Tree

- **User/Client**
  - Render page

Tomorrow

- **Layout-designer**
  - Specify Layout System
    - Ex: Tex

- **Webpage-writer**
  - Create document by instantiation of layout system
    - Ex: Write a paper

- **User/Client**
  - Render document
    - Ex: Acroread
Example

Designer Intent: Pictures + Captions all on first page.

Computation: Left: $\text{width} := F(\text{height})$

Right: $\text{height} := G(\text{width})$
Free The Constraints

Let the designer express declaratively his intent via constraints.

\[
\text{box.width} =\text{box.height}
\]

Bi-directional constraints:

- Conciseness
- Split specified behavior and computation
  - You specify, We Solve
Redundancy in GUI:

Multiple knobs/indicator for a single variable.

Thus, many ways to update it.

With bi-directional constraints:

\[ R_1(\text{height}, \text{doc\_height}, \text{slider\_size}) \]
\[ R_2(\text{doc\_pos}, \text{slider\_pos}, \text{height}, \text{doc\_height}) \]
Summary of Design Choices

Our proposed solution is

- Domain-specific Layout Languages (DSLL).
- Bi-directional constraints exposed to the document writer.

We want all documents in a DSLL to be

- Fast to solve.
- Always well defined: Can always layout.

We need to

- Generate efficient solver (layout engine).
- Check DSLL is “Good”
  - Compilation to tree traversals (AGs)
    - With synthesis of local evaluation rules.
Safe: Forall Tree in G, Forall Input in Tree, Tree(input) is Satisfiable and the solution can be found with propagation only.

Title
Paragraph 1
Paragraph 2

Client
Runtime Inputs
Ex: Win size

Document Writer

Is Safe?

Layout Designer

Counter-Example

Engine

G ::= Side-Bar | Scroll-Box
Scroll-Box ::= Vbox | Text

Scroll-Box Side-Bar ...
Related Work On Solving

- What would you do?

- Use a generic solver
  - Cassowary [Badros]: Analyze documents online and figures out layout.

- For performance, we want
  - Reduce runtime work by doing offline pre-computation.
  - Modular & Specialized solver.
On Solving

What is the fastest solver?

- Set of traversals on Tree
- This is given by scheduling an AG
  - Can do parallel traversal
  - Can do incremental evaluation
  - ...

[Leo & Adam]
Example

Relations (input)

Hbox ::= Box1 Box2
Box1.x + Box2.x == Hbox.x
Box1.x == Box2.x
Box1.y == Box2.y == Hbox.y

Functions

Box1.x := Hbox.x / 2
Box2.x := Hbox.x / 2
Hbox.y := Box1.y
Hbox.y := Box2.y
Box1.y := Box2.y
Box2.y := Box1.y

Tree Traversals

Hbox .visit() {
    Box1.y = this.y;
    Box1.visit();
    Box2.y = this.y;
    Box2.visit();
    thix.x = Box1.x + Box2.x
}
Which Functions Do We Choose

- Picks some subset of functions to cover the whole graphs.

- Here on a single document but generalizes to grammars.

→ Reachability on hyper-graphs.
Future Work

- **Events**
  - Web-pages are dynamic (AJAX)
  - We are actively working on reactive semantics, ask me about it!

- **Programming by demonstrations**
  - Best paradigm for designer.
  - From a set of documents, infer the layout.

- **Richer layout**
  - Expressiveness vs. Speed trade-offs.
That is it!