Rich Layout from First Principles

Specification, Generation, and Parallelization

Adam Jiang, Leo Meyerovich
with Seth Fowler, John Ng, and RasBodik

Hot Par 2009, WWW 2010
Why Layout?

parser
dOM
CSS rules
selector engine
rendering

JavaScript interpreter
layout engine
selector engine
parser

43% in IE8
9%
23%
12%

our group
WWW2010
this talk

laptop: ... 2s
mobile: ... 15s

2.4 GHz Macbook Pro, Safari 4.0.3
Slashdot, Netflix, MSNBC, Gmail, Facebook, deviantART
The Layout Problem

Standard and implementation strategy are unclear
Towards a Mechanized Layout Engine

CSS, JavaScript, ... (LL1 grammar) → grammar analyzer → (parallel, incremental, ...) parser

layout specification (attribute grammar) → grammar analyzer → (parallel, incremental, ...) layout engine → renderer

CSS → DOM
Attribute Grammars

- Knuth ‘67: executable language semantics
- Automation: parallel, incremental, ...
- Good for IDEs, compiling Pascal-like languages

\[
\text{this.val} = E0\text{.val} + E1\text{.val}
\]
Is Layout Inherently Sequential?
Dependencies prevent parallelism

fs: 50%
- w=100, fs=6
- x=0, y=0
- h=10

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=0
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs: 12
- w=100, fs=12
- x=0, y=10
- h=40

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w

fs, Δ, w
Parallelism from isolating dependencies
1. Compute local dependencies

2. Compute transitive dependencies
   
   for all layouts in this grammar, if dep(a, b, ... z), then E(a, b), E(b, c), ...

3. Schedule by stitching together (topological sort)
Automatic Incrementalization of Rendering

Render img1
Render img2
... Render img-n

Move display list
Move display list 2

(John)

Render img1
... Render img-n
Render img z
... Render img m
• Attribute grammar specification promising

• New attribute grammar language

• Big benefits
  Users: fast and conformant browser
  Designers: analysis tools
  Browser developers: separate feature from optimization
  Standards: verification (well-defined, backwards compat..)
Questions?