The Parallel Browser:
Synthesis + Parallelization of Layout Engines

Leo Meyerovich, Eric Atkinson, Matt Torok, Rastislav Bodik
ParLab, UC Berkeley

PLDI
Beijing, China
Where’s the browser?
here?

Surfaces
here?

Surfaces

Big interactive data sets
can we put it there?
can we put it there?
Power Wall

sequential perf = \( f(\text{power}) \)
2012 phones
2012 phones

Tegra 3, S4, OMAP5, ...

4 core CPU
128b-wide SIMD
12 core GPU
CPU Profile of the Top 25 Sites

CPU Profile of the Top 25 Sites

JavaScript: 20% CPU
~30 talks

CPU Profile of the Top 25 Sites

JavaScript: 20% CPU
~30 talks

Not JavaScript: 80% CPU
~2 talks
~0 performance solutions

The Parallel Browser

webpage

parse

layout

render

pixels

2009, 2010
The Parallel Browser

webpage

parse

layout

render

pixels

Fail.
The Parallel Browser

CSS spec

webpage

parse

layout

render

pixels
The Parallel Browser

formalization

CSS spec

webpage

parse

layout

render

pixels
The Parallel Browser

- formalization
- CSS spec
- FTL
- synthesizer

webpage →

parse →

layout →

render →

pixels
The Parallel Browser

**formalization**

CSS spec

FTL synthesizer

behavioral props

webpage

parse

layout

render

pixels
The Parallel Browser

Formalization
CSS spec

FTL

Synthesizer

Behavioral props

Webpage

Parse

Layout

Render

Pixels

Multicore

SIMD

GPU
The Parallel Browser

- **formalization**
  - CSS spec
  - FTL
  - synthesizer

- webpage
  - parse
  - layout
  - render
  - pixels

- code gen + algorithms
  - multicore
  - SIMD
  - GPU

- behavioral props
The Parallel Browser

- **formalization**
- **CSS spec**
- **FTL synthesizer**
- **behavioral props**

**webpage**

- **parse**
- **layout**
- **render**

**pixels**

- **code gen + algorithms**
- **multicore SIMD GPU**
CSS spec \rightarrow \text{FTL synthesizer}
CSS spec $\rightarrow$ FTL synthesizer $\rightarrow$

```
sched: botUp\{w,h\}; topDown\{x,y\}; botUp\{r\}
```

synthesize sequence of traversal template instantiations
Can specify behavior as input instead of as output:

\[
\text{sched: botUp\{w,h\} ; topDown\{x,y\} ; botUp\{r\}}
\]
Can specify behavior as input instead of as output:

```
sched: botUp\{w,h\} ; topDown\{x,y\} ; botUp\{r\}
```

Parallelization querying, refinement, and autotuning

```
sched: (botUp\{w\} || botUp\{h\}) ; ?? ; inorder{??}
```
Welcome to Wikipedia, the free encyclopedia that anyone can edit. 3,880,583 articles. English

Today's featured

Banksia cuneata is an endangered species of flowering plant in the Proteaceae family. Endemic to southwestern Australia, it belongs to the subgenus Isotylis, which contains three closely related species with flower clusters that are dome-shaped heads rather than characteristic Banksia flower spikes. A shrub or small tree up to 5 m high, it has prickly foliage and pink and cream flowers. The common name Matchstick Banksia arises from the blooms in late bud, the individual of which resemble matchsticks. The species is pollinated by honeyeaters. Although B. cuneata was first collected before 1880, it was not until that Australian botanist Alex George formally described and named the species. There are two genetically distinct population groups, but no varieties. This Banksia is classified as endangered, surviving in remnant bushland in a region which has been cleared for agriculture. As Banksia cuneata is killed by fire and regenerates from seed, it is sensitive to bushfire frequency; fires recurring every four years could wipe out populations of plants yet mature enough to set seed. Banksia cuneata is rarely cultivated, and its prickly foliage limits its use in the cut flower industry.

In the news

Vladimir Putin (pictured) is elected president of Russia for a third term.
A series of disasters in Brazil and the Republic of the Congo killed at least 238 people and hundreds more.
A train crash near Szczekociny, Poland, kills 16.
A tornado outbreak in the Midwestern and Southeastern United States at least 30 fatalities.

On this day

March 6: Independence Day in Ghana (1957)

1447: Tomaso Parentucelli became Pope Nicholas III.
1834: York, Upper Canada, was incorporated.
1893: Giuseppe Verdi's La Traviata premiered in Venice as La Traviata, but the performance was so bad that it caused the composer to revise portions of the opera.
1999: German chemical and pharmaceutical company Bayer registered Aspirin as a trademark.
1945: Petru (pictured)
End-to-end Results

**Multicore**
7x speedup on 8 cores

**SIMD**
4x speedup, 4x energy

**GPU**
1 million nodes @ 30fps
Recap

• Parallelize 80% case

• Spec -> synthesizer -> specialized algorithms

• Future: smart UI tools that actually work?