Synthesizing Adaptive Layout Engines

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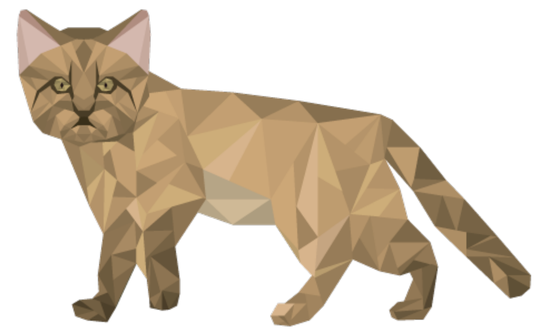
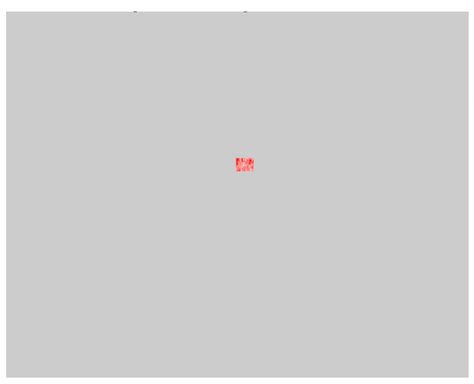
In the age of big data, humans need new tools to visually and interactively explore their ever-growing data sets.

Adaptive layout engines will enable this by adjusting runtime behavior based on available resources and properties of the problem at hand.

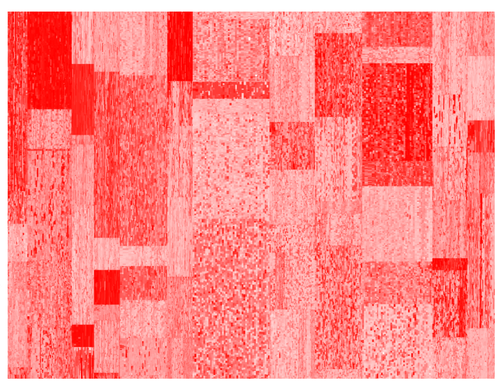


ex: treemap visualizations



500 data points

versus



95,000 data points

```
...
interface HVBox {
    var width : int;
    var height : int;
    var right : int;
    var bottom : int;
}
class VBox : HVBox {
    children {
        upper : HVBox;
        lower : HVBox;
    }
    actions {
        self.height := lower.height + upper.height;
        self.width := max(lower.width, upper.width);
        upper.right := self.right;
        lower.right := self.right;
        lower.bottom := self.bottom;
        upper.bottom := self.bottom + lower.height;
    }
}
...
```

Using a declarative domain-specific language, visualization designers specify layout problems as *attribute grammars*.

With a fine-tuned constraint model, an SMT solver takes less than a minute (rather than 8+ hours) to find valid *traversal schedules*, which compile to layout engines.

ex: sequential schedule

```
post{height, width} ;; pre{bottom, right}
```

ex: parallel schedule

```
(post{height};;pre{bottom}) || (post{width};;pre{right})
```

Adaptation happens both...

Ahead of time

By augmenting synthesis with a *cost model*, the search can find a set of schedules, each optimal under different circumstances.

Just in time

Given an input tree, a *cost predictor* will dispatch to one of the layout engines based on properties such as tree size, shape, number of cores, cache size, *etc*.