Allowing Responsive Web Modules

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ABSTRACT

Categories and Subject Descriptors
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General Terms
Theory

Keywords
ACM proceedings, LaTeX, text tagging

1. INTRODUCTION
A module is an interchangeable and independent part of a program that typically has a single and well-defined responsibility [**?**]. Modular programming is a technique to reduce complexity and enable reusability. In order for a module to be reusable it must not assume in which context it is being used.

Responsive Web Design (RWD) is an approach to make an application respond to the viewport size and device characteristics. This is achieved by using CSS media queries to define conditional style rules. In this paper we will focus on the size responsiveness of modules.

The problem is that there is no way to make a module responsive without it being context-aware, due to media queries only being able to target the viewport. Thus, a responsive module using media queries is layout dependent and has therefore limited reusability.

The desired behavior of a responsive module is having its inner design responding to the size of *its container* instead of the viewport. Only then is a responsive module independent of its layout context.

This can be achieved with the theoretical feature *element queries* that enables conditional CSS rules by the properties of arbitrary elements. This paper presents a novel implementation of element queries in JavaScript named ELQ, and discusses the new possibilities of GUI design that our implementation enables.

1.1 The Problem Exemplified
- MQ is not the solution to RWD. (MQ was not designed for RWD as the feature was released long before RWD)
- All elements adapt their inner design by the viewport width.
- Menu Example shows how MQ are broken.
- Limitations of MQ regarding font-size (em).

Media queries were designed to enable developers to conditionally design content by the media, such as using serif fonts when printed and sans-serif when viewed on a screen. Therefore, it is only applicable for RWD of non-modular static applications. In a world where no better solution than media queries exists for RWD, changing the layout of a responsive application becomes a cumbersome task.

Imagine an application that displays the current weather of various cities as widgets, by using a weather widget module. The module should be responsive, so that more information such as a temperature graph over time is displayed when the widget is big. When the widget is small it should only display the current temperature. Users should also be able to add, remove and resize widgets.

Such application cannot be built with media queries, since the widgets can have varying sizes independent of the viewport (e.g., the width of one widget is 30% while another is 40%). To overcome this problem we must change the application so that widgets always have the same sizes. This implies that the size of the module and the media query breakpoints are coupled/intertwined, i.e. they are proportional to each other. The problem now is that we have removed the reusability of the weather module, since it requires the specific width that is correctly proportional to the media query breakpoints.

Imagine a company working on a big application that uses media queries for responsiveness (i.e., each responsive module assumes to have a specific percentage of the viewport

size). The ability to change is desired by both developers and stakeholders, but is limited by this responsive approach. The requirement of changing a menu from being a horizontal top menu to being a vertical side menu implies that all responsive modules break since the assumed proportionality of each module is changed. Even worse, if the menu is also supposed to hide on user input the responsiveness of the module breaks since the layout changes dynamically. The latter requirement is impossible to satisfy without element queries.

Additionally, it is popular to define breakpoints relative to the font size. Media queries can only target the font size of the document root, limiting the functionality drastically. With element queries, breakpoints may be defined relative to the font size of the targeted element.

As we can see, even with limited requirements there still are significant flaws with using media queries for responsive modules.

1.2 Requirements

- Parents should decide the layout of their children, and the children should adapt their inner design accordingly.
- Valid language syntaxes (HTML, CSS, JS).

First, a solution must provide a possibility for an element to change depending on the properties of the parent element. Elements should automatically respond to changes of the parent size so that the correct design can be presented for each size.

Second, a solution must conform to the syntax of HTML, CSS, and JavaScript so that the compatability of tools, libraries and existing projects is retained.

Third, a solution must have adequate performance for large applications that make heavy use of responsive modules.

2. ELEMENT QUERIES

Media queries and element queries are similar in the sense that they both enable developers to define conditional style rules that are applied by specified criteria. The main difference is the type of criteria that can be used; in media queries device, document, and media criteria are used, while element criteria are used in element queries. It can somewhat simplified be described as that media queries target the document root and up (i.e., the viewport, browser, OS, device, input mechanisms, etc.) while element queries target the document root and down (i.e., elements of the document).

2.1 Standardization

It is stated on the W3C's www-style mailing list [**?**] by Zbarsky of Mozilla, Atkins of Google and Sprehn of Google that element queries are infeasible to implement without restricting them. By limiting element queries to specially separated container elements that can only be queried by child elements, many of the problems are resolved [**?**, **?**]. Therefore, the Responsive Issues Community Group (RICG) is currently investigating the possibility of standardizing *container* queries.

Unfortunately, even such limited container queries requires significant effort to implement [**?**]. Atkins argues that a correct and full implementation is unlikely to be implemented, and therefore it might be wiser to pursue sub-standards that aids third-party solutions instead.

2.2 JavaScript implementations

- Why is this pragmatic? Compatability, no impact (performance, language) on apps that do not need responsive modules.
- Why must it be a client side JS library?
- Note drawbacks (but only drawbacks for added functionality!).
- Mention that there is related work.

Implementing element queries as a third-party solution must be in the form of a client side library to be included in applications that makes sure all element queries are updated when necessary. One could argue that a solution does not need to be executed at client side, but instead generate media queries server side for all modules with respect to the current application layout. However, this is insufficient due to the modules then being limited to applications with static layouts. Also, the generated media queries would not be able to respond to the user changing the page font size correctly as they can only target root-level font sizes.

Although an implementation in JavaScript will most probably be less performant than a native implementation, it can still be beneficial to have such feature implemented as a third-party library to avoid complex and restricting code in browsers.

3. ELQ

To enable element queries today, we have developed a novel JavaScript implementation named ELQ. Our implementation satisfied all requirements given in 1.1. The library have been designed to conform to the standards and specifications of the web languages while providing the features required of building advanced constellations of responsive modules. The novelty lies in having significantly improved performance by batch processing DOM operations, and providing an API that enables nesting of modules. ELQalso has excellent browser compatability as it supports Internet Explorer 8 and upwards.

ELQis designed to be plugin-based for increased flexibility and extensibility. By providing a good library foundation and plugins it is up to developers to choose the right plugins for each project. In addition, by letting the plugins satisfy the requirements it is easy to extend the library with new plugins when new requirements arise.

3.1 The API

As CSS 3 does not support custom at-rules/selectors, responsive elements are annotated in HTML by element attributes. The main idea is to annotate elements with breakpoints of interest so that children can be conditionally styled

in CSS by targeting the different breakpoint states. In this example, we will use the `elq-breakpoints` plugin that observers the element in order to automatically update the breakpoint classes. Although not written in the examples, the library also supports attributes defined with the `data-` prefix to conform to the HTML standard.

In listing 3.1 we see an element that has annotated two breakpoints at 300 and 500 pixels.

```
<div class="foo" elq elq-breakpoints
  elq-breakpoints-widths="300 500">

  <p>When in doubt, mumble.</p>
</div>
```

When ELQhas processed the element, it will always have two classes, one for each breakpoint, that tells if the size of the element is greater or lesser than each breakpoint. For instance, if the element is 400 pixels wide, the element has the two classes `elq-min-width-300px` and `elq-max-width-500`. Similarly, if the element is 200 pixels wide the element the classes are instead `elq-max-width-300px` and `elq-max-width-500`. So for each breakpoint only the min/max part changes. It may seem alien that the classes describe that the width of the element is both maximum 300 and 500 pixels. This is because we have taken a user-centric approach, so that when using the classes in CSS the API is similar to element queries. However, developers are free to change this API at will as ELQis plugin-based.

Now that we have defined the breakpoints of the element, we can conditionally style it by using the classes. See listing 3.1 for an example of how the classes can be used.

```
.foo.elq-min-width-300px.elq-max-width-500px {
  background-color: green;
}

.foo.elq-min-width-500px {
  background-color: blue;
}

.foo.elq-max-width-500px p {
  color: white;
}
```

3.1.1 Nested modules

This API is sufficient for applications that do not need nested breakpoint elements, and similar features is provided by related libraries. However, using such API in responsive modules still limits the reusability since the modules then may not exist in an outer responsive context. Also, it is customary to compose large/complex modules by smaller modules that may also need to be responsive [**?**].

The reason this API is not sufficient for nested modules is because there is no way to limit the CSS matching search of the selectors. The selector of the last example given in listing 3.1 specifies that all paragraph elements should have white text if *any* ancestor breakpoints element is above 500 pixels wide. Since the ancestor selector may match elements outside of the module, such selectors are dangerous to use in the context of responsive modules. The problem may be somewhat reduced by more specific selectors and such, but it cannot be fully solved for arbitrary styling.

To solve this problem, we provide a plugin that let us define elements to "mirror" the breakpoints classes of the nearest ancestor breakpoints element. Then, the conditional style of the mirror element may be written as a combinatory selector that is relative to the nearest ancestor breakpoints element. See listing 3.1.1 for example markup of the mirror plugin to enable nested modules.

```
<div class="foo" elq elq-breakpoints
  elq-breakpoints-widths="300 500">

  <div class="foo" elq elq-breakpoints
    elq-breakpoints-widths="300 500">

    <p elq elq-mirror>...</p>
  </div>

  <p elq elq-mirror>...</p>
</div>
```

As the paragraph elements are mirroring the nearest `.foo` ancestor, we can now write CSS as shown in listing 3.1.1.

```
.foo {
  /* So that the nested module
     behaves differently */
  width: 50%;
}

.foo p.elq-max-width-500px {
  color: white;
}
```

Since we in the previous examples have annotated elements manually, the power and flexibility of the API have not been properly displayed. Only when combined with JavaScript, things get more interesting.

3.1.2 A high-level API

To further prove the potential of ELQ, we have created a plugin that enables a high-level API for responsive modules. The API enables developers to use resposnive grids and utility classes very similar to the ones defined by the CSS Bootstrap framework. See listing 3.1.2 for an example grid that uses the Bootstrap API. The grid is defined to be single columned for small viewports, triple columned for medium viewports, and double columned for large viewports. It should be noted that the last column is hidden for large viewports.

```
<div class="container">
  <div class="row">
    <div class="col-md-4 col-lg-6">
      ...
    </div>
    <div class="col-md-4" col-lg-6>
      ...
    </div>
    <div class="col-md-4 hidden-lg-up">
      ...
    </div>
  </div>
</div>
```

Since this API uses media queries, there only exists a fixed set of breakpoints that can be used to determine when the grid should change layout. The column classes defines the behaviour of a the grid, and has the syntax `col-[breakpoint]-[size]`. Developers may choose which breakpoint to be used by the `sm, md, lg` units of a column class and the size may be between 1 and 12.

4. DISCUSSION AND SUMMARY OF RELATED WORK

- Performance, APIs, Features.
- The mirror functionality of ELQmakes it uniquely suitable for nested modules.

5. CONCLUSIONS

- Production ready.
- Probably no standard (or not in a long time).

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