# AUTOMATIC VISUAL VERIFICATION OF LAYOUT FAILURES IN RESPONSIVELY DESIGNED WEB PAGES

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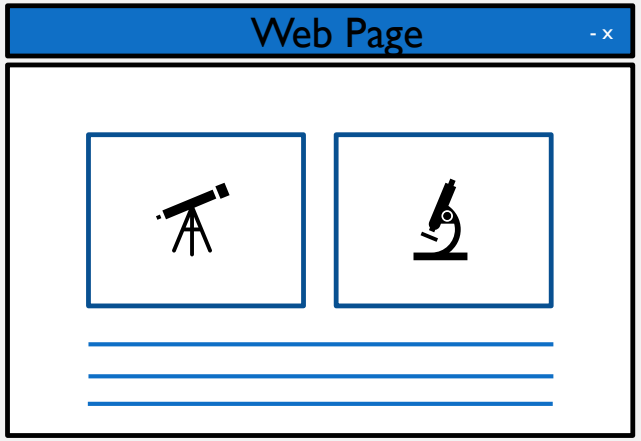
# IMPORTANCE OF A WEB PAGE LAYOUT

## User Loyalty

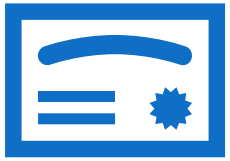
Willingness to visit the web page again is linked the design.

Cyr et al. I&M 2006

## Confidence in Services




## Credibility



Web page design and instant credibility are statistically linked.

Robins and Holmes IP&M 2008

# LAYOUT FAILURE EXAMPLES

**MidwayMeetup** Where do you want to meet up?

Where is everyone?

Enter a starting address | Add

What do you want to do?

'coffee', 'bar', 'Italian food' | Go!

Enter the starting location for each member of your group, one at a time, in the box above. You can use a full address, a zip code, a city name, or even just cross streets -- we'll do our best find it.

Then, enter the type of place you'd like to go ('coffee', 'movie theater', 'Italian food', etc.) in the search box above the map, and click Go!

MidwayMeetup will find places where all of your friends can meet up and display them on the map!

Once you've entered the starting locations of the members of your group, and told us the kind of place for which you're looking, we'll list your results here.

Clicking on a result will highlight its location on the map, and will give you the option to read reviews, visit their website, or even get directions!

**MidwayMeetup is currently in open beta.** If you have any suggestions or ideas for improvement, please contact the developer at midwaymeetup@gmail.com.

**Thank you!**

Map data ©2016 Google

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**Thank you!**

Map data ©2016 Google

# WHAT IS A WEB PAGE?

## HTML

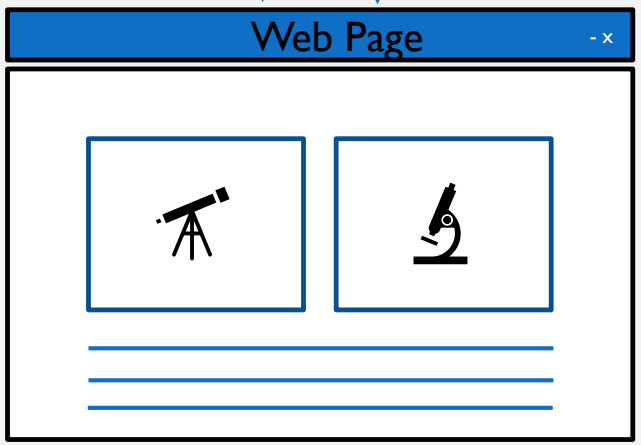
```
<!DOCTYPE html>
<html>
    <head>
        <title>ICST 2019</title>
    </head>
    <body>
        <h1>Xi'an China</h1>
    </body>
</html>
```

## CSS

```
body{background-color: black;}
h1{color:  blue;}
a:link{color: blue; }
a:visited{color: green;}
a:hover {color: red;}
a:active {color: yellow;}
```

## JavaScript

```
<script>
window.onload = function() {
  var element =
document.createElement("script");
  element.src = "main.js";
  document.body.appendChild(element);
};
</script>
```



# INFLUENCE ON THE LAYOUT

## HTML

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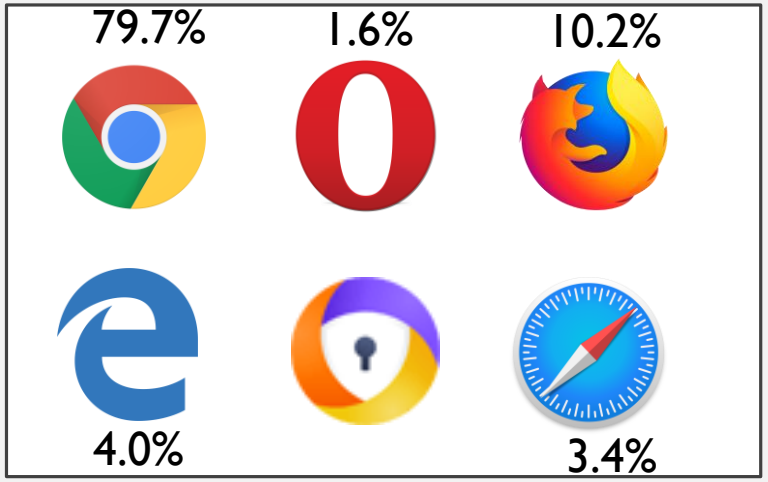
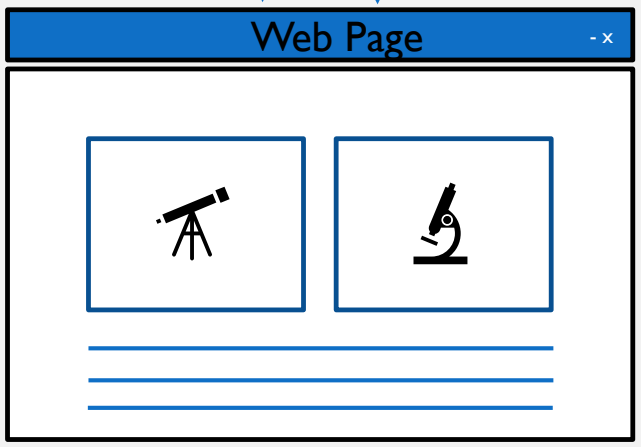
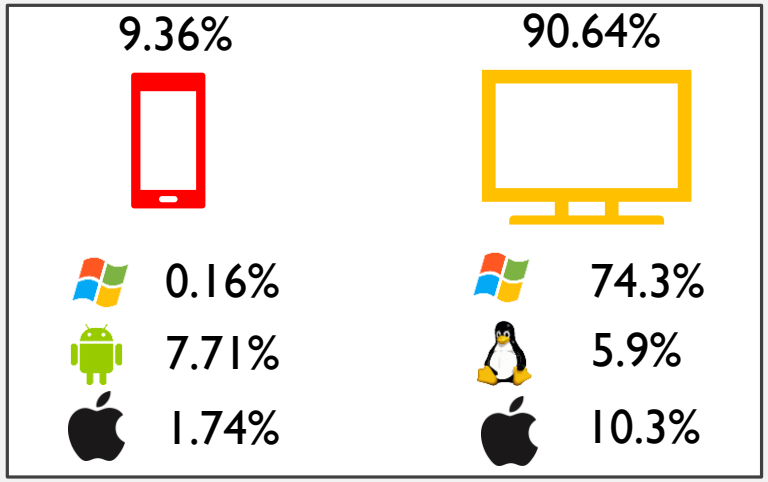


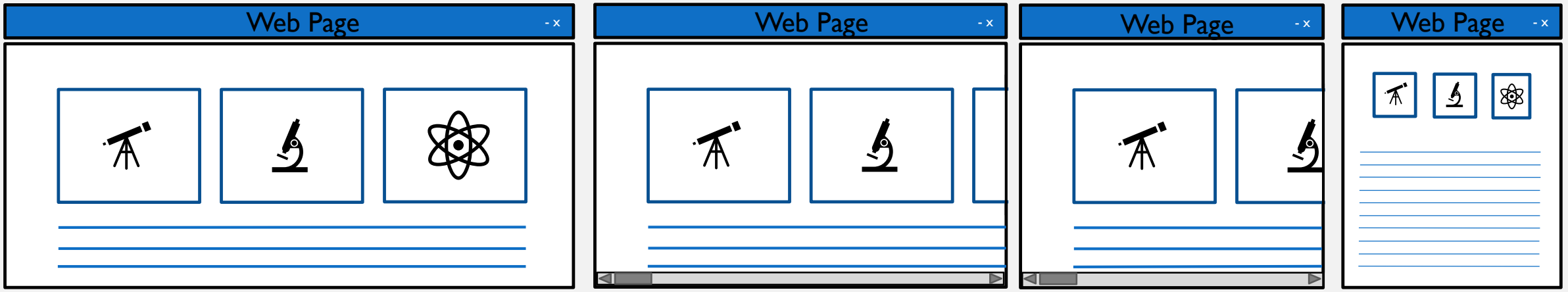




English - Mandarin - Hindi - Spanish - Arabic

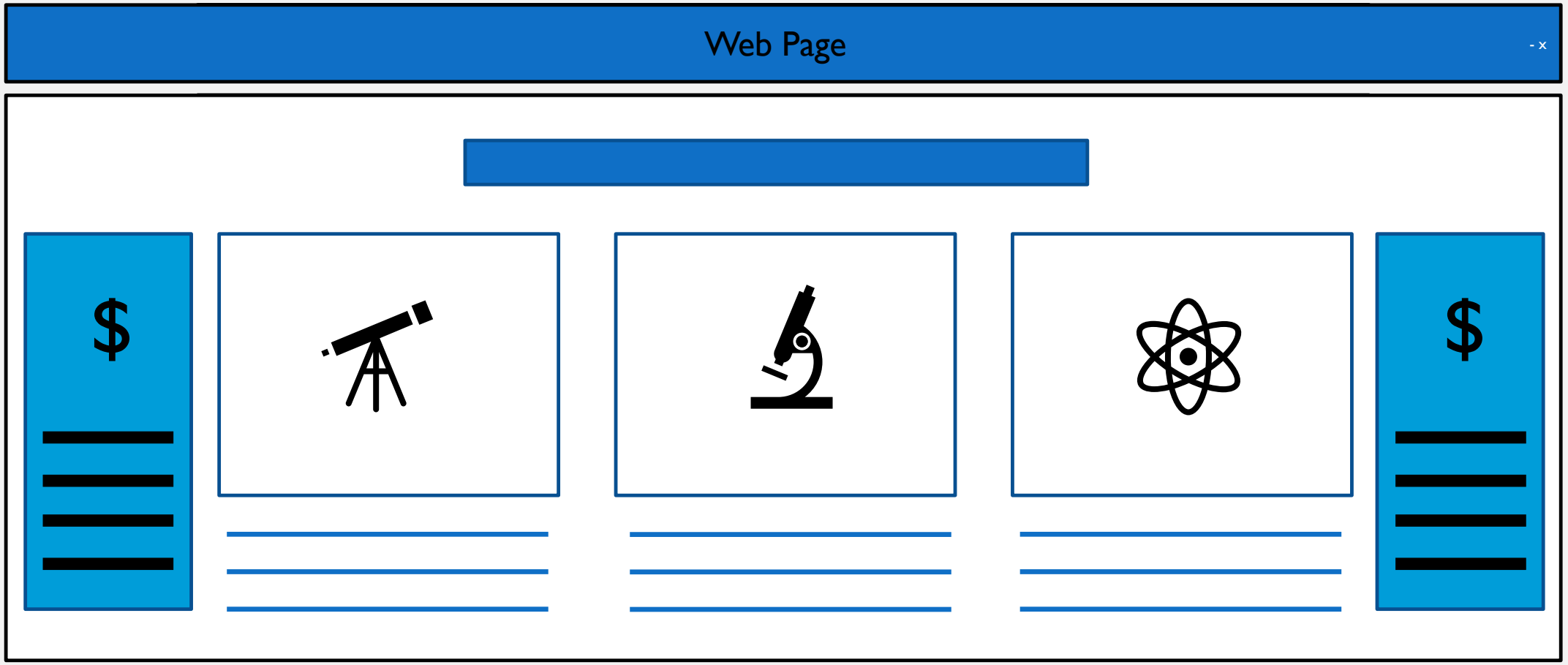


# MANY DISPLAYS SIZES

| Higher | 1920x1080 | 1366x768 | 1280x1024 | 1280x800 | 1024x768 | Lower |
|---|---|---|---|---|---|---|
| 32.9% | 18% | 34% | 4% | 3% | 2% | 6.1% |



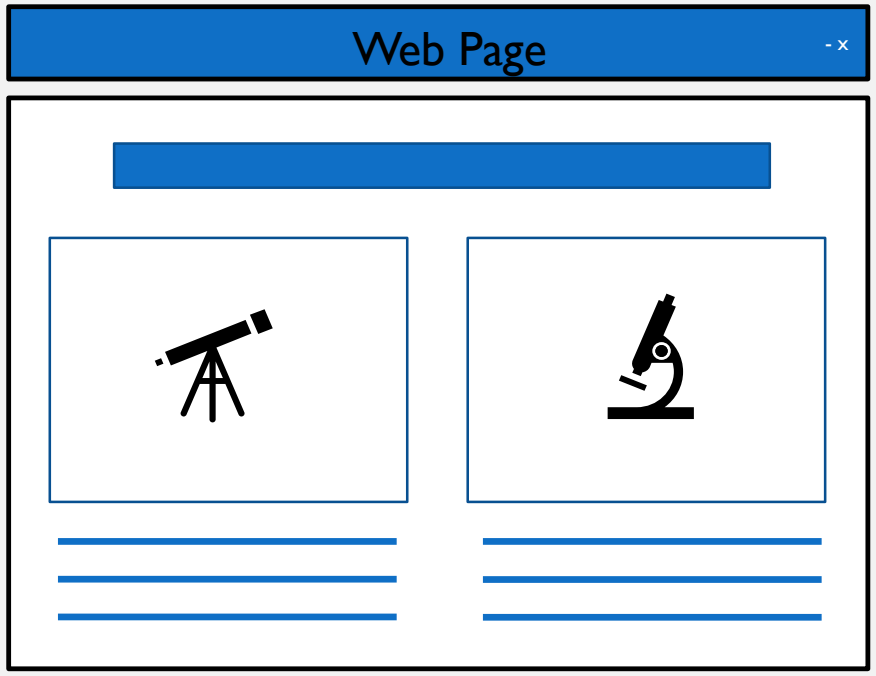
# RESPONSIVE WEB DESIGN



# RESPONSIVE WEB DESIGN

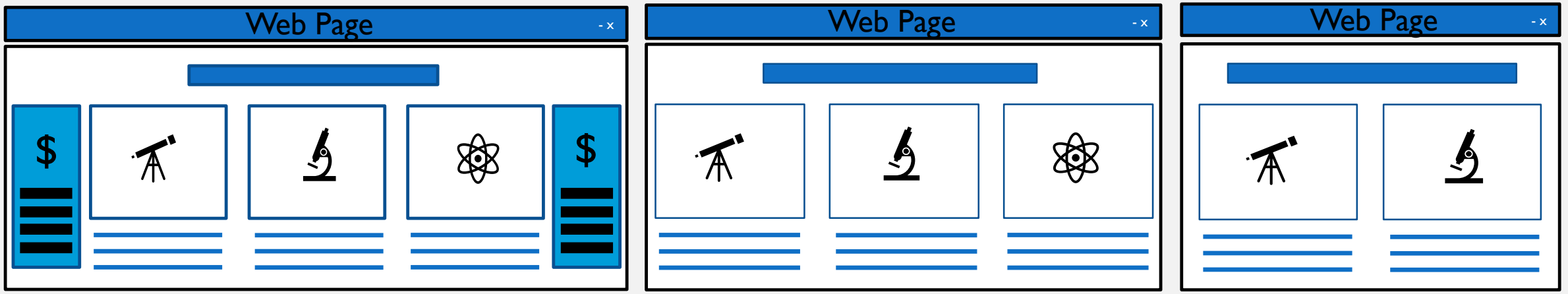
- Percentage for image width.
- Text size set to viewport width.
- Change images using pictures tag.
- Media queries.

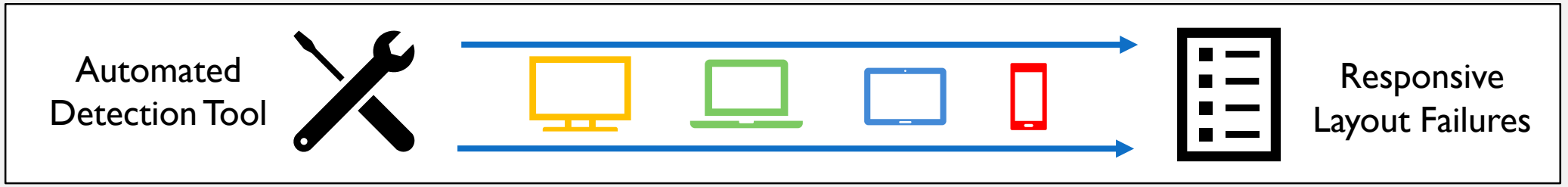
- CSS frameworks:
  - Bootstrap.
  - Foundation.




Addresses the challenge of presenting the web page at different viewport widths

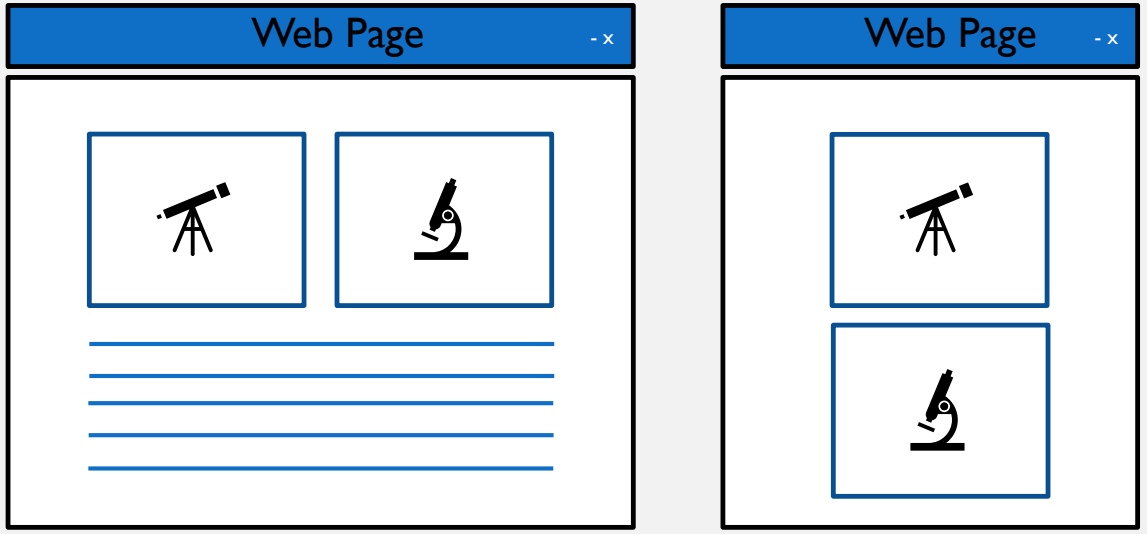
# RESPONSIVE WEB IS GREAT BUT…
# TOO MANY DISPLAYS TO TEST



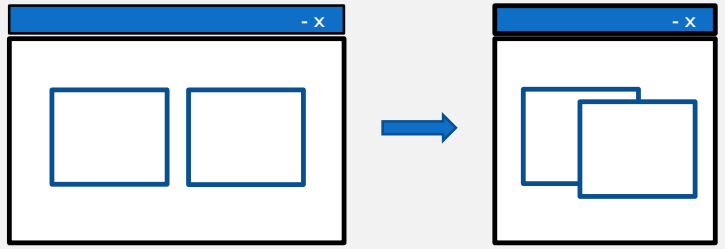
# REDECHECK

- ReDeCheck:
  - Opens a browser.
  - Loads the target web page.
  - Searches a range of sequential viewport widths.
  - Captures relationships between elements.
  - Determine any relationship discrepancies.
  - Report different types of layout failures.

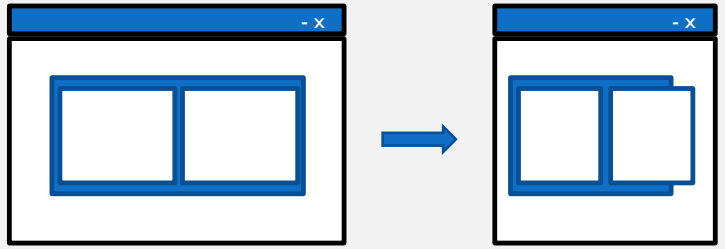


# SOME TYPES OF RESPONSIVE LAYOUT FAILURES

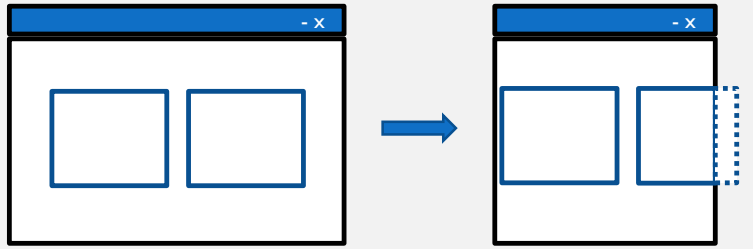
- Element Collision:
  - Viewport width gets smaller until elements overlap each other.



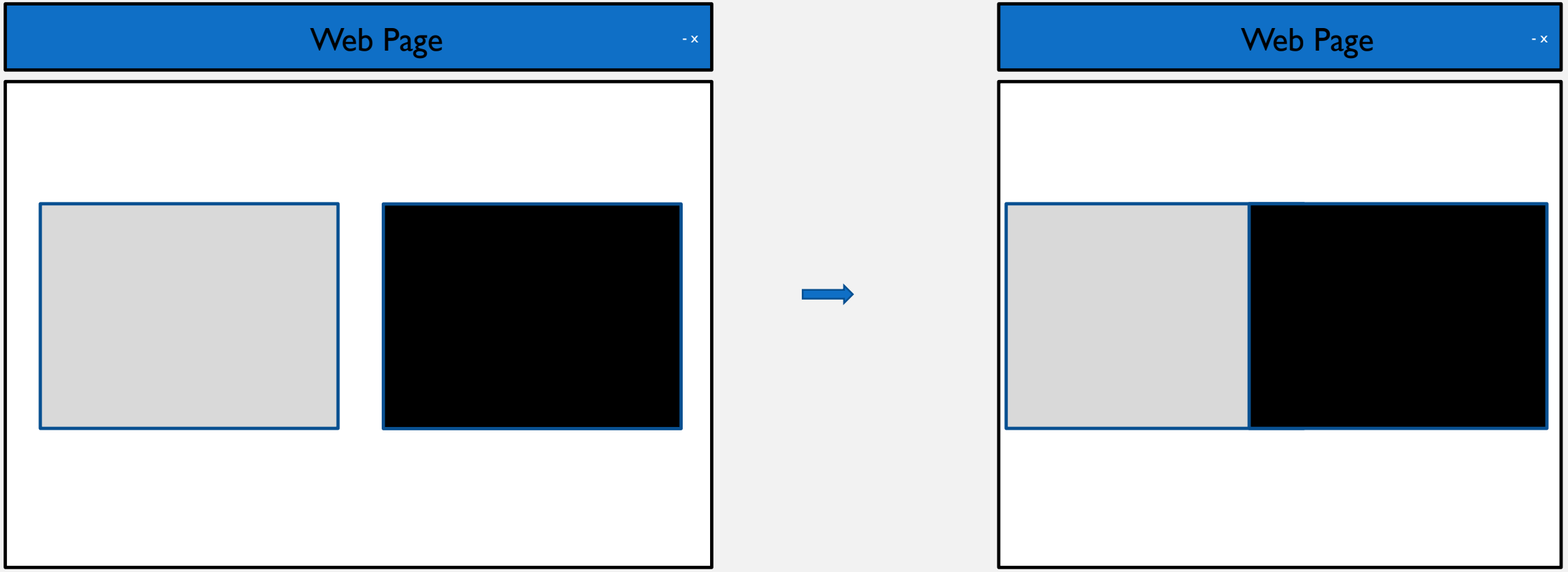
- Element Protrusion:
  - Elements that overflow their container.



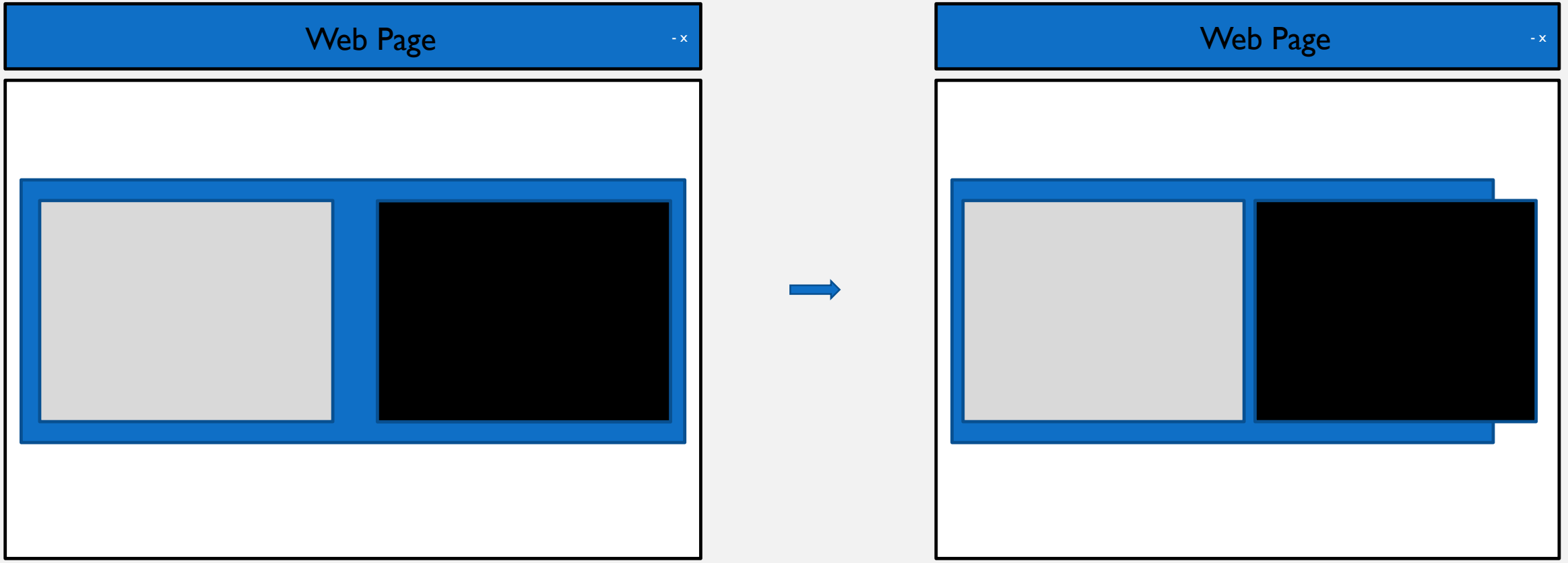
- Viewport Protrusion:
  - Elements that overflow the main body element.



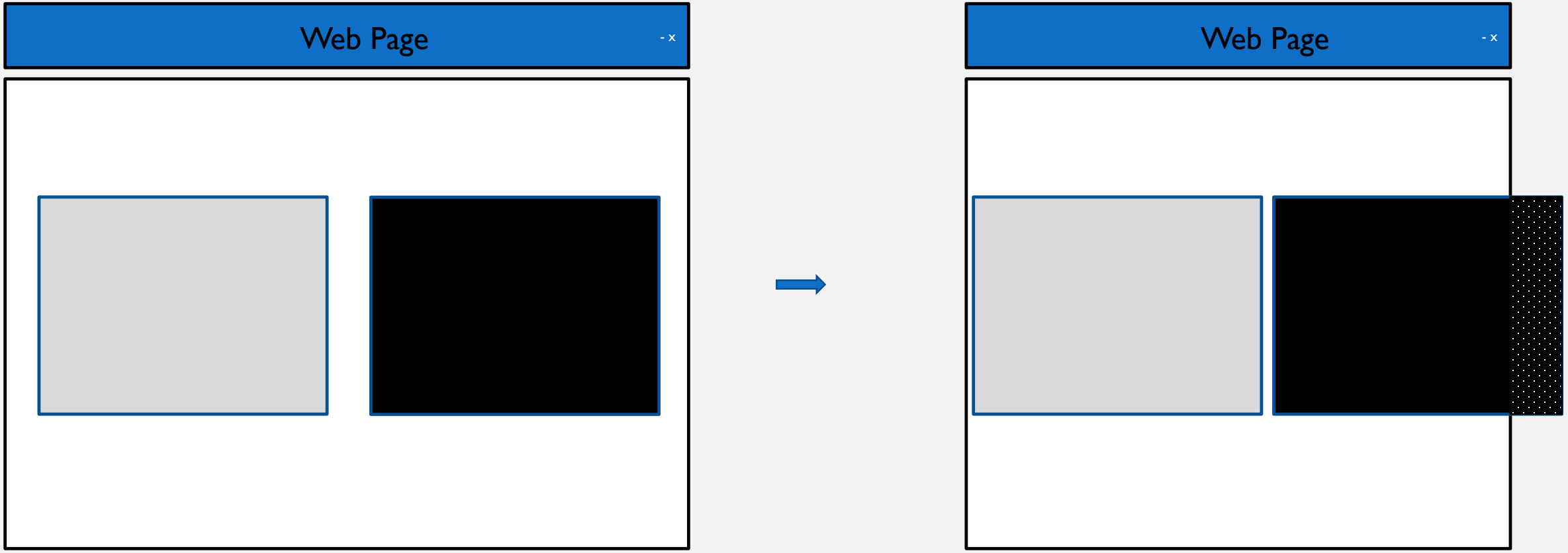
# ELEMENT COLLISION



# ELEMENT PROTRUSION



# VIEWPORT PROTRUSION



# REDECHECK - OUTPUT

- Type of responsive layout failure.
- **Failure Range:**
  - Viewport range where the failure was detected.
- Problematic HTML Elements:
  - XPath of the elements.

Type: Element Collision
Range: 320-767
/HTML/BODY/DIV[2]
/HTML/BODY/DIV

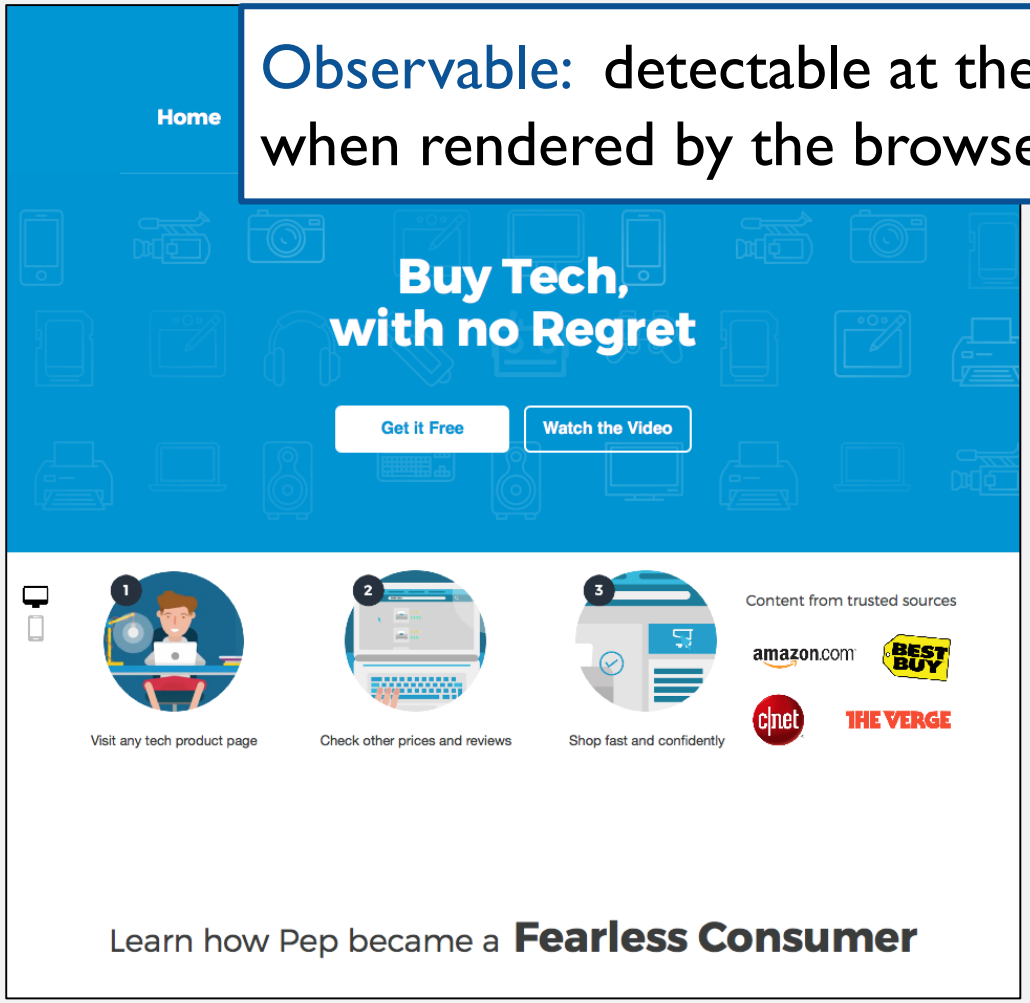
Type: Viewport Protrusion
Range: 320 - 710
/HTML/BODY
/HTML/BODY/MAIN/DIV/DIV/DIV/UL/LI/IMG

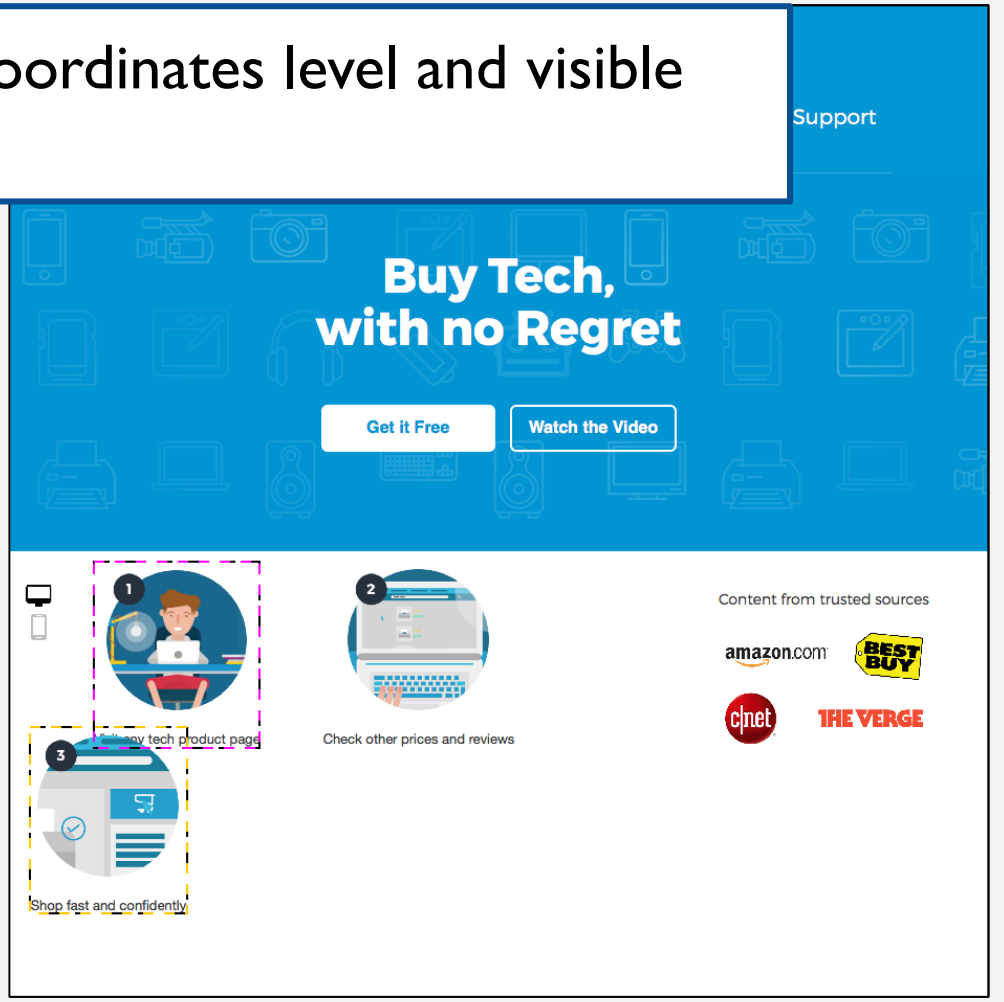
# OBSERVABLE LAYOUT FAILURE

966 px

933 px

Observable: detectable at the DOM coordinates level and visible when rendered by the browser.



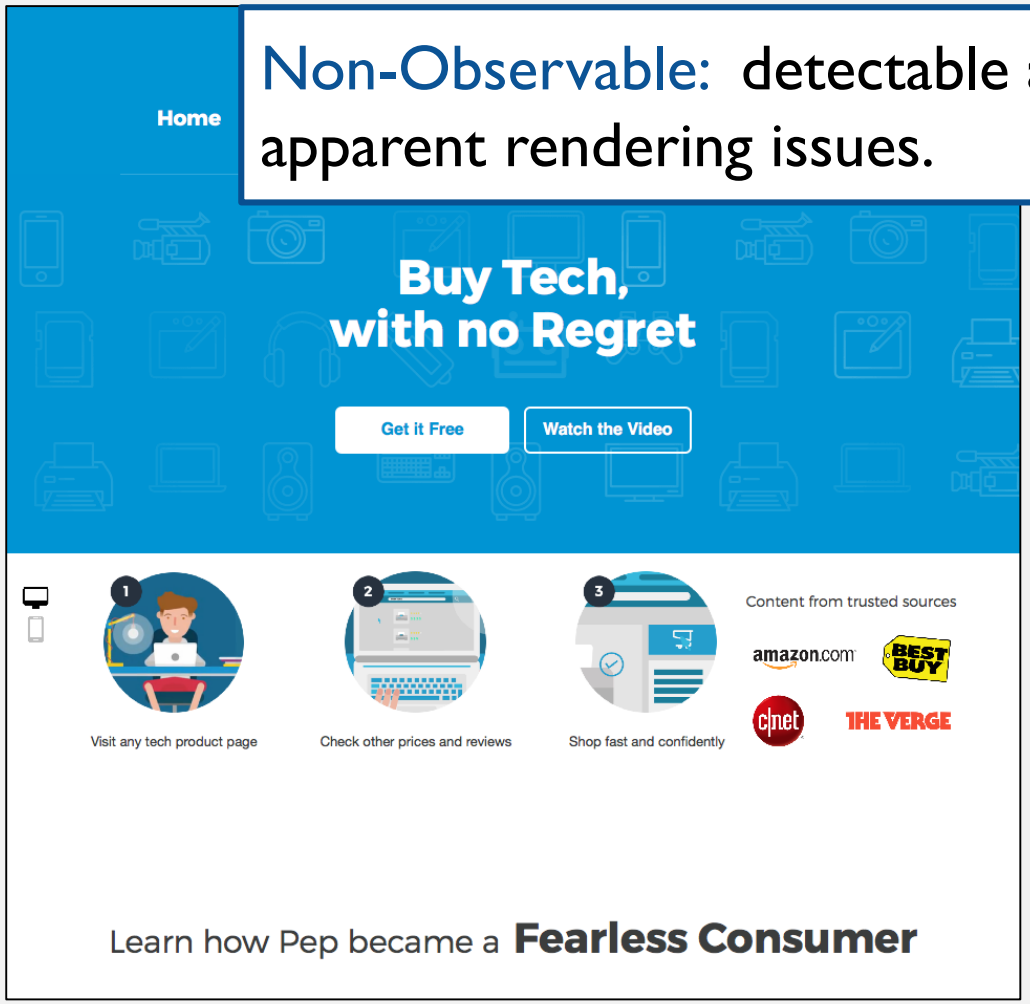



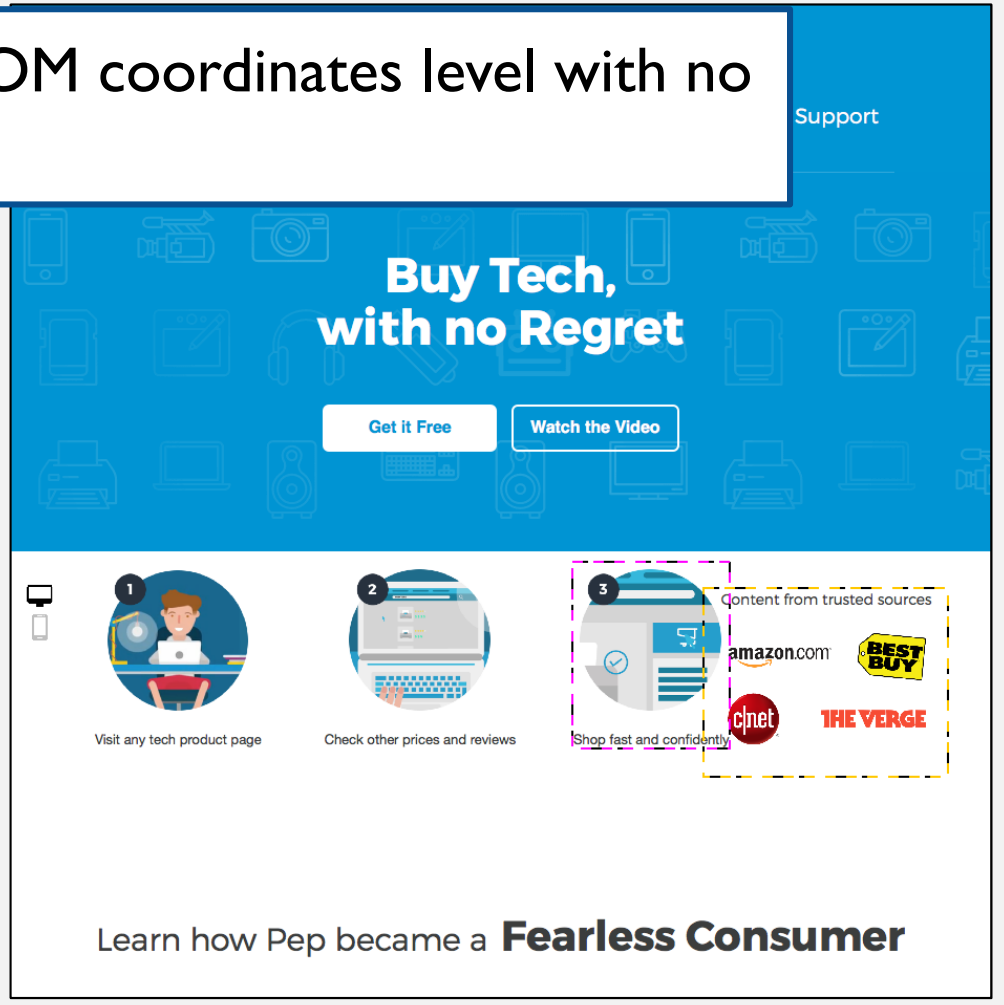
# NON-OBSERVABLE LAYOUT FAILURE

966 px

934 px

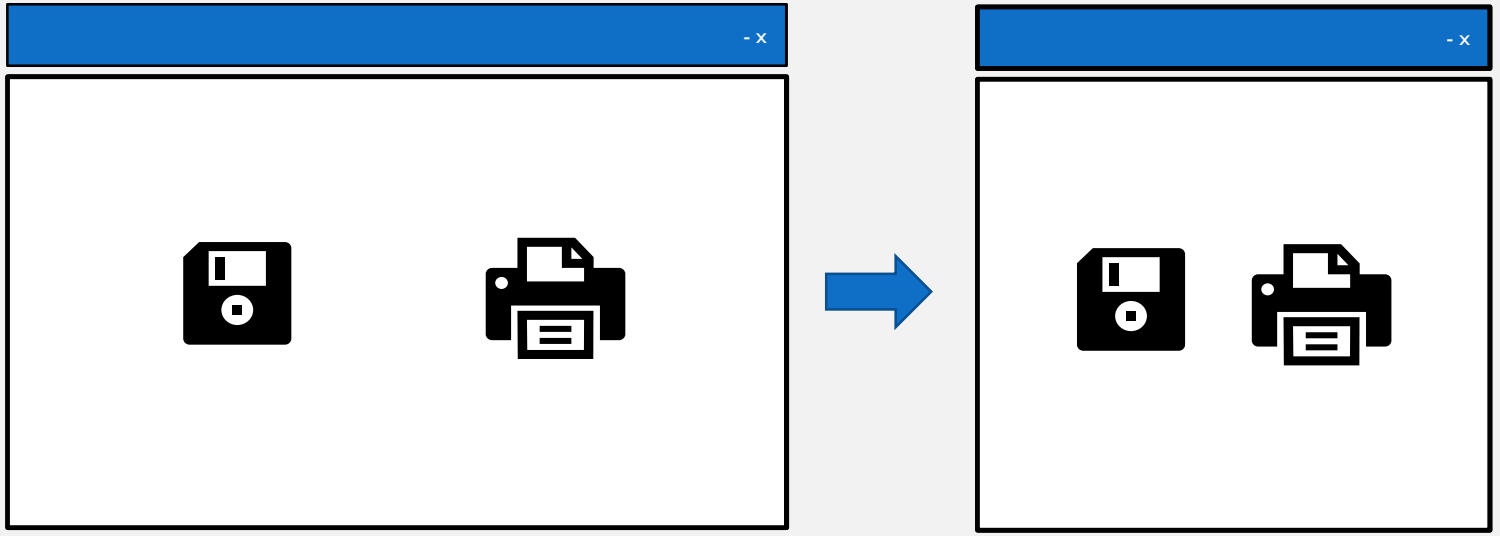
Non-Observable: detectable at the DOM coordinates level with no apparent rendering issues.



# THE PROBLEM

- DOM based detection of layout failures is **not enough.**
- Developer must do a **manual** visual verification of the reported failures:
  - Set the right viewport size.
  - Scroll to problematic elements.
  - Visually verify the issue.
- Observable Failures:
  - Apparent layout issue.
- Non-observable Failures:
  - DOM level issues.



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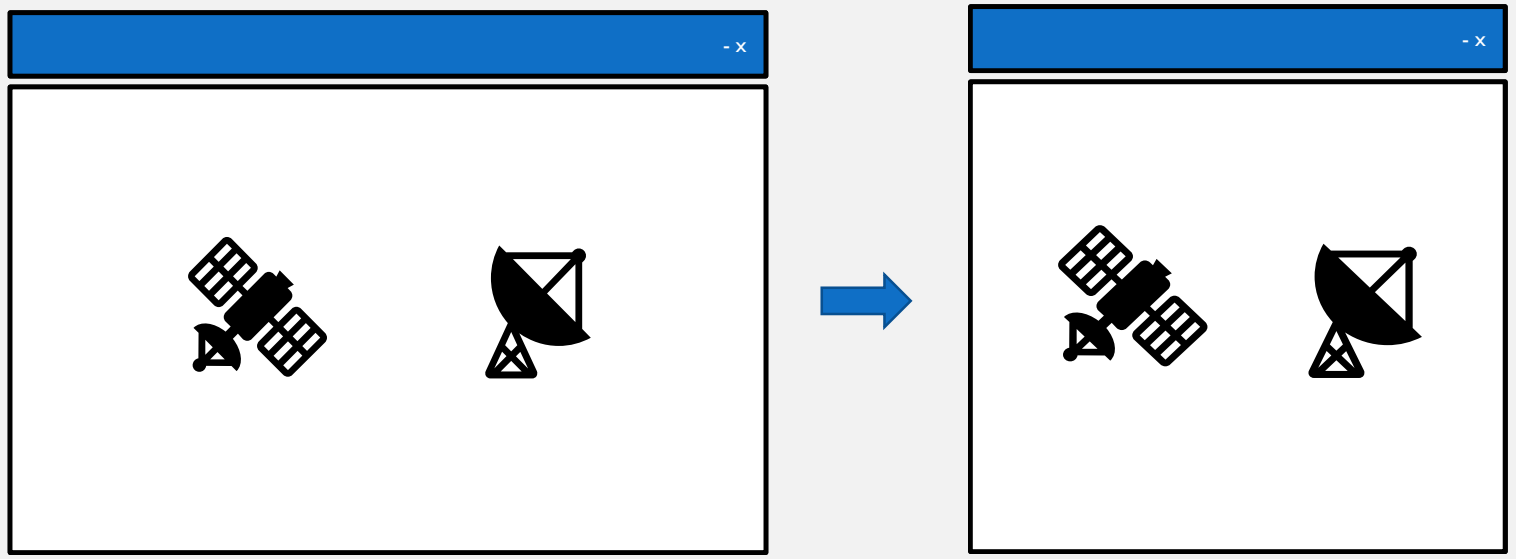
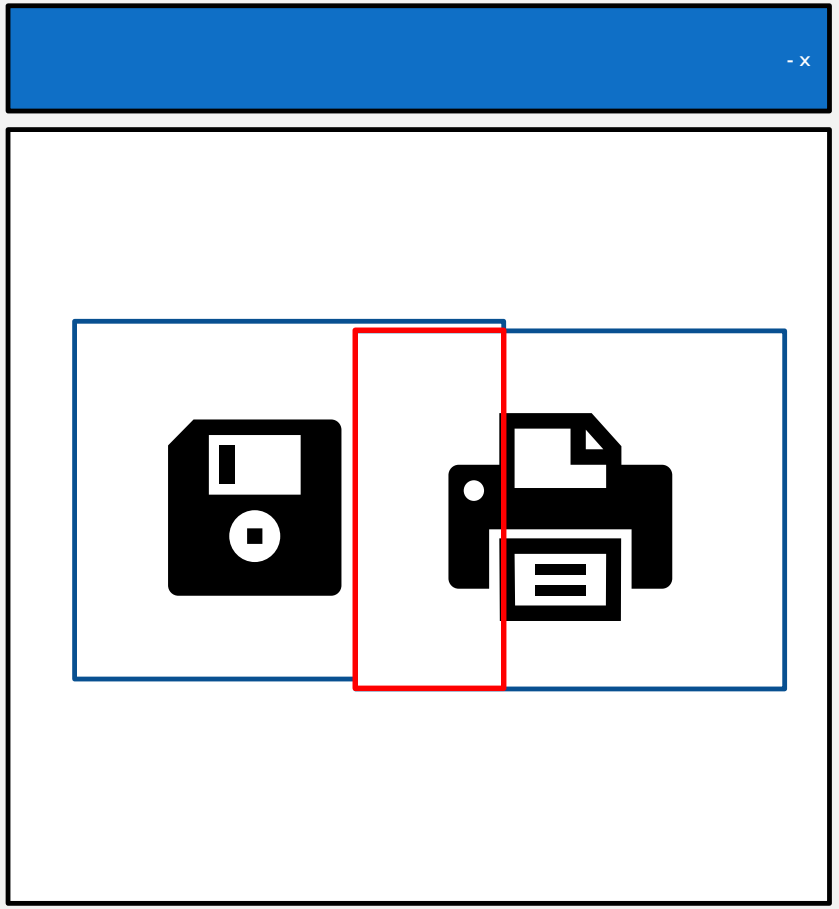


# PROPOSED SOLUTION

- Determine area requiring analysis.
  - Areas of Concern (AOC)
- Check pixels of problematic area.
  - Use the opacity property to reveal layers.
  - Take snapshots.
  - Analyze snapshots for pixel differences.



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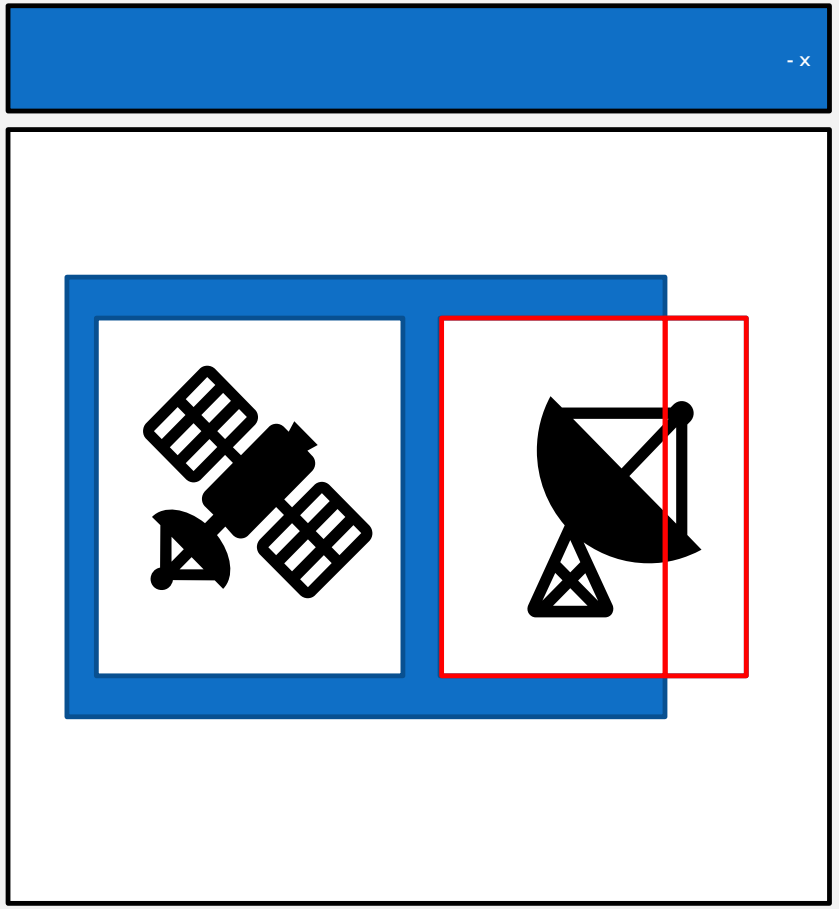
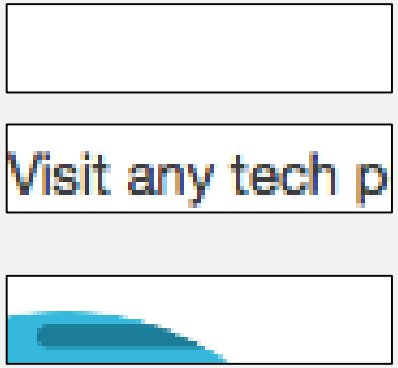
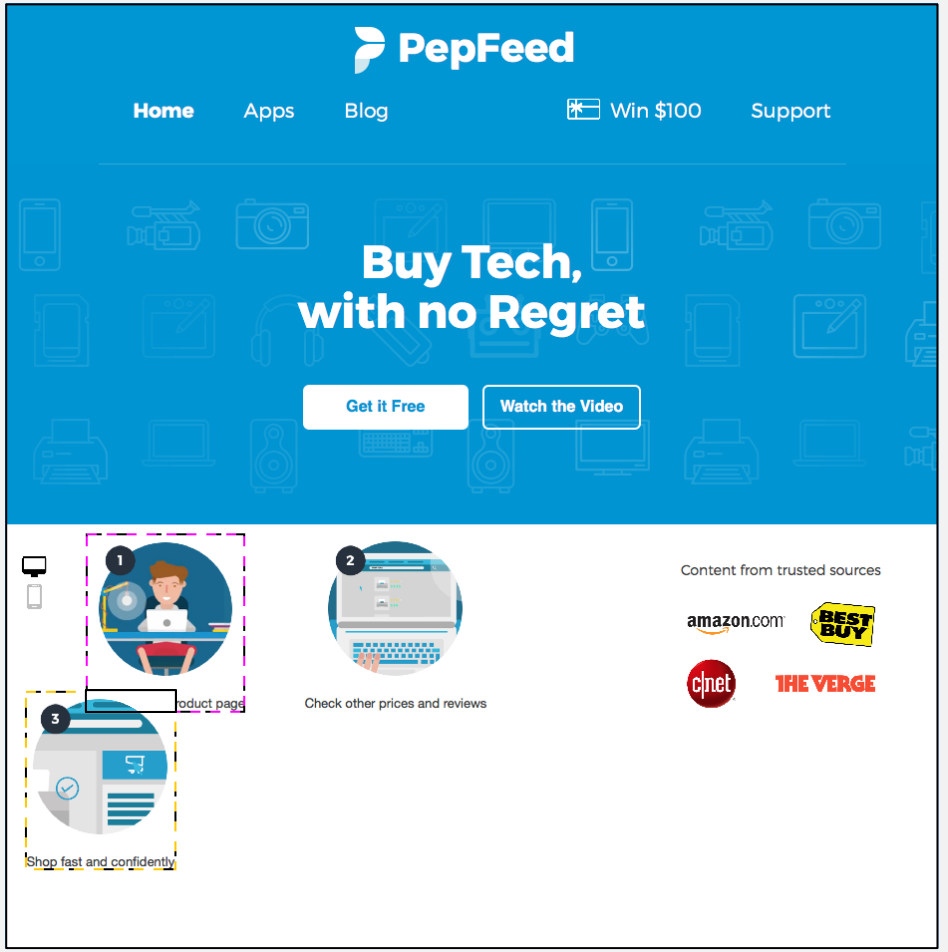


# OBSERVABLE FAILURE EXAMPLE

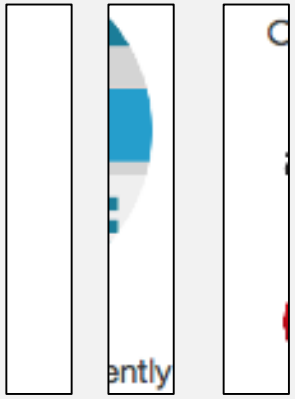
- Current Viewport
  - 933 px
- Failure Type
  - **Element Collision**
- Failure Range
  - 769-933 px

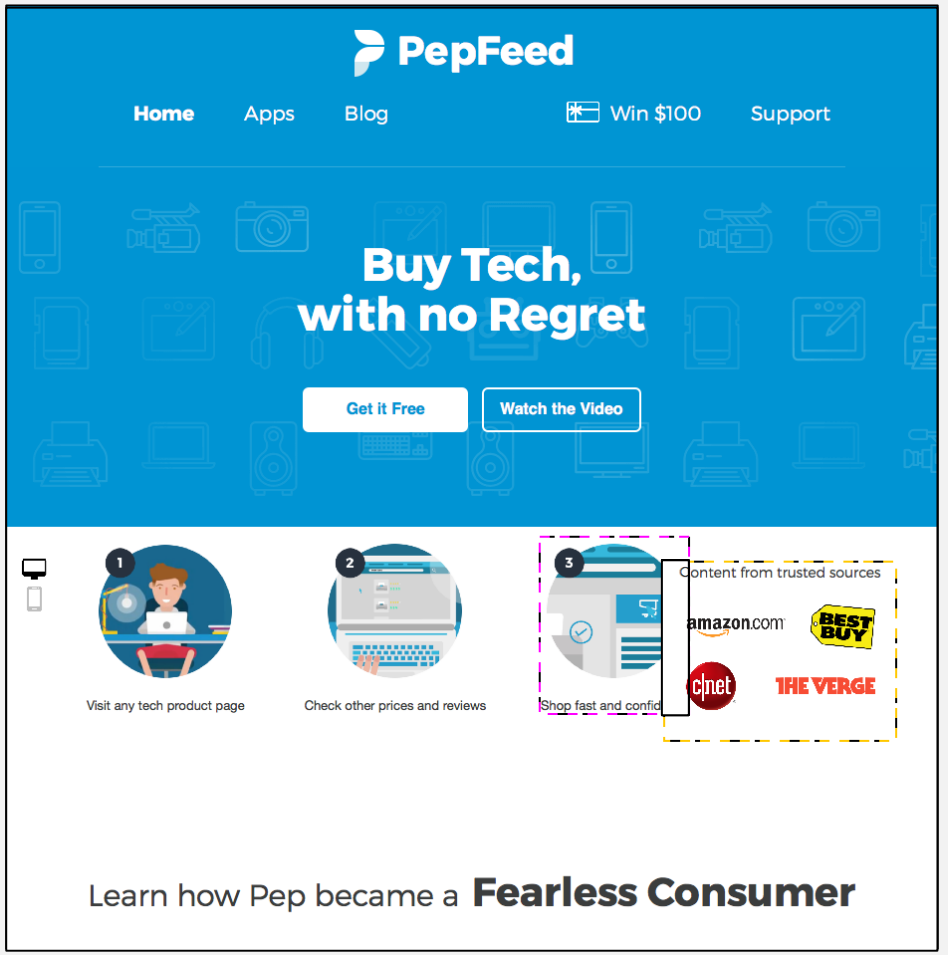


# NON-OBSERVABLE FAILURE EXAMPLE

- Current Viewport
  - 934 px
- Failure Type
  - **Element Collision**
- Failure Range
  - 934-965 px



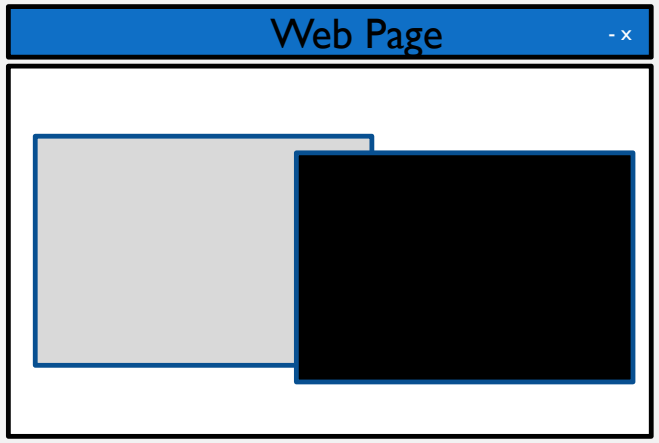



# COLLISION

1. Only check where both element intersect.
2. Snapshot 1 - Background
3. Snapshot 2 - Gray element
4. Snapshot 3 - Black element
5. For each pixel in the three images
    1. If Snapshot 2 & Snapshot 3 != Background

        □ ≠ □ & ■ ≠ □

        - Observable layout failure

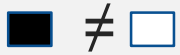


# PROTRUSION

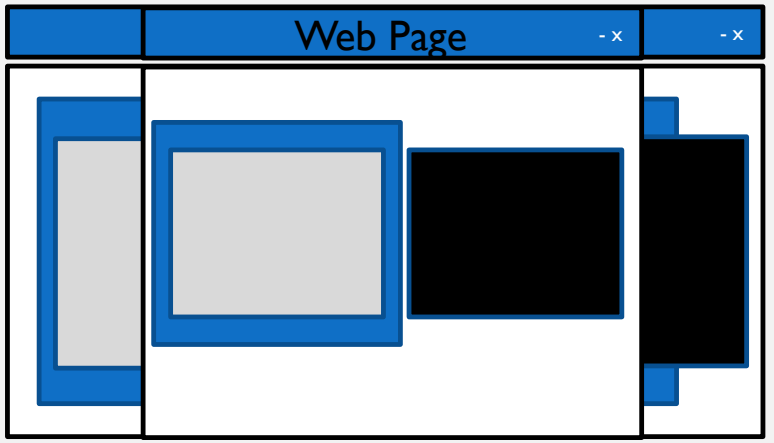
~~1. Check for collision~~

~~2. If observable collision~~

1. Check the area protruding
2. Snapshot 1 - Background
3. Snapshot 2 - Protruding element
4. If Snapshot 2 ≠ Background



- Observable layout failure

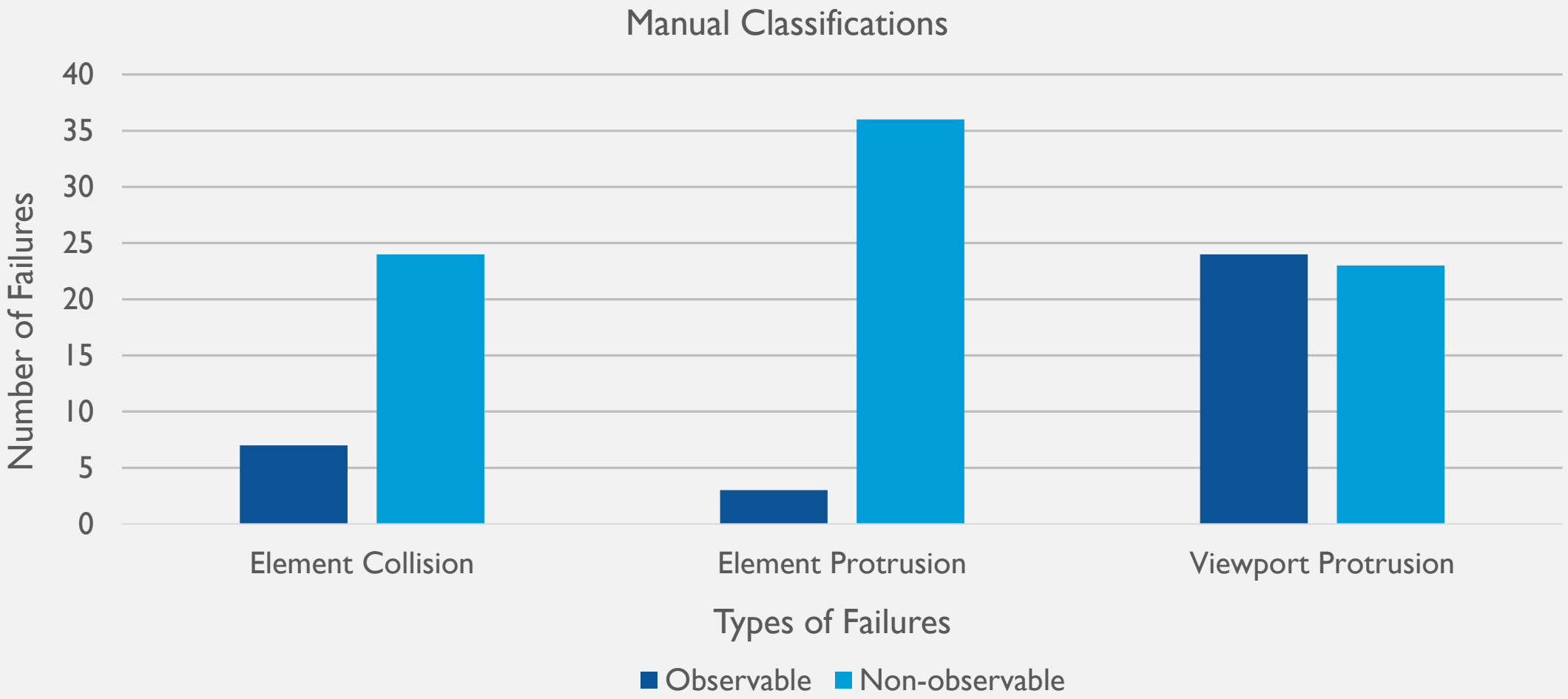


# RESEARCH QUESTIONS

- RQ1: Can we automatically distinguish non-observable failures?
  - Compare to manual classifications.
- RQ2: Which viewport has the best chance of revealing an observable failure?
  - Compare to manual classification.
- RQ3: How long does it take to verify a layout failure?

# MANUAL RESULTS

Walsh et al. ISSTA 2017



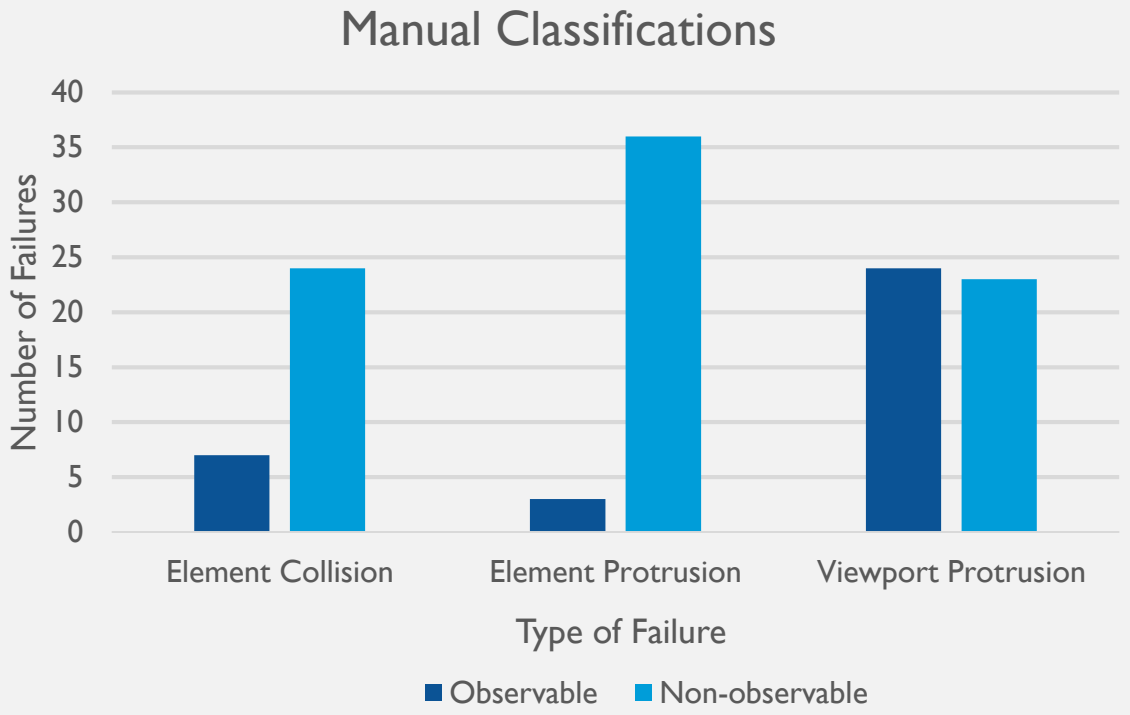

117 Responsive Layout Failures

20 Web Pages

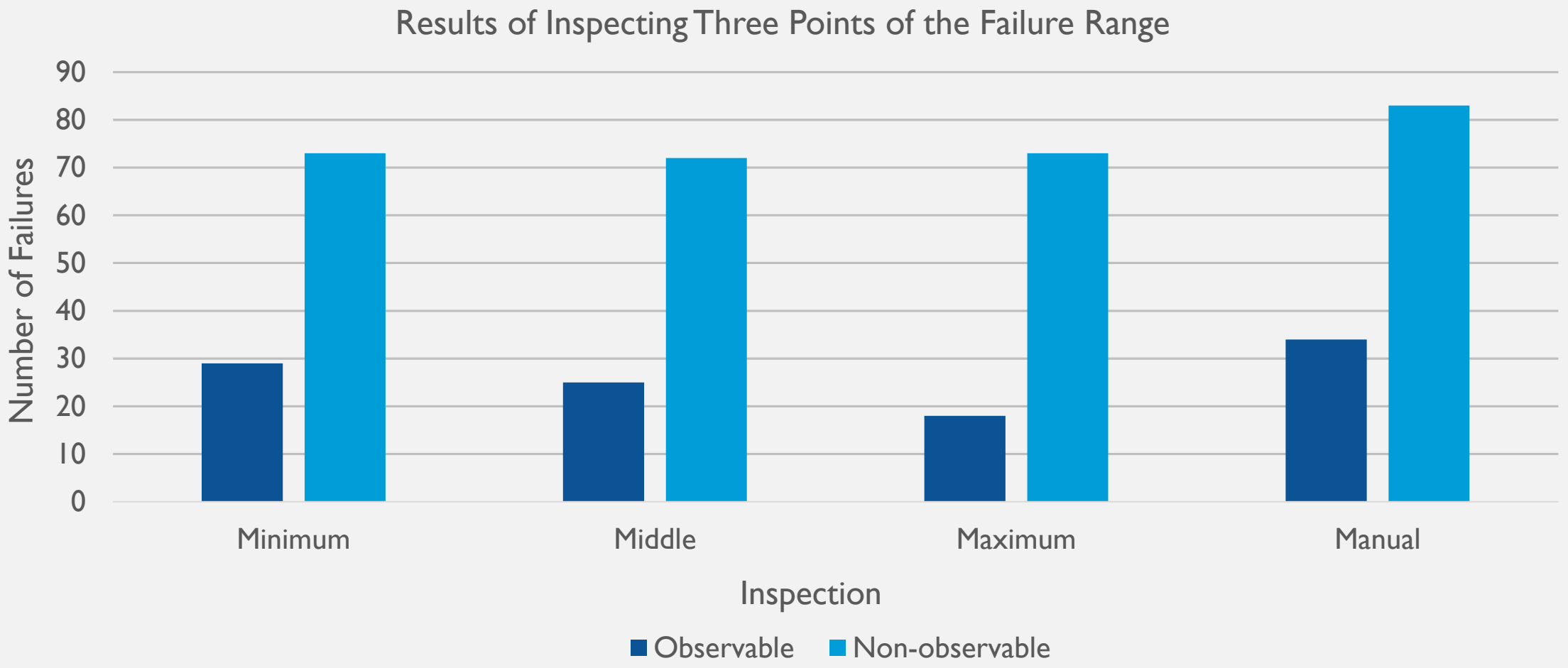
# RQ1: CAN WE AUTOMATICALLY DISTINGUISH NON-OBSERVABLE FAILURES?

- Compared to manual…

- Minimum of the failure range.
  - Agreed with manual 87.2%
- Middle of the failure range.
  - Agreed with manual 82.9%
- Maximum of the failure range.
  - Agreed with manual 77.8%



# RQ2: WHICH VIEWPORT HAS THE BEST CHANCE OF REVEALING AN OBSERVABLE FAILURE?



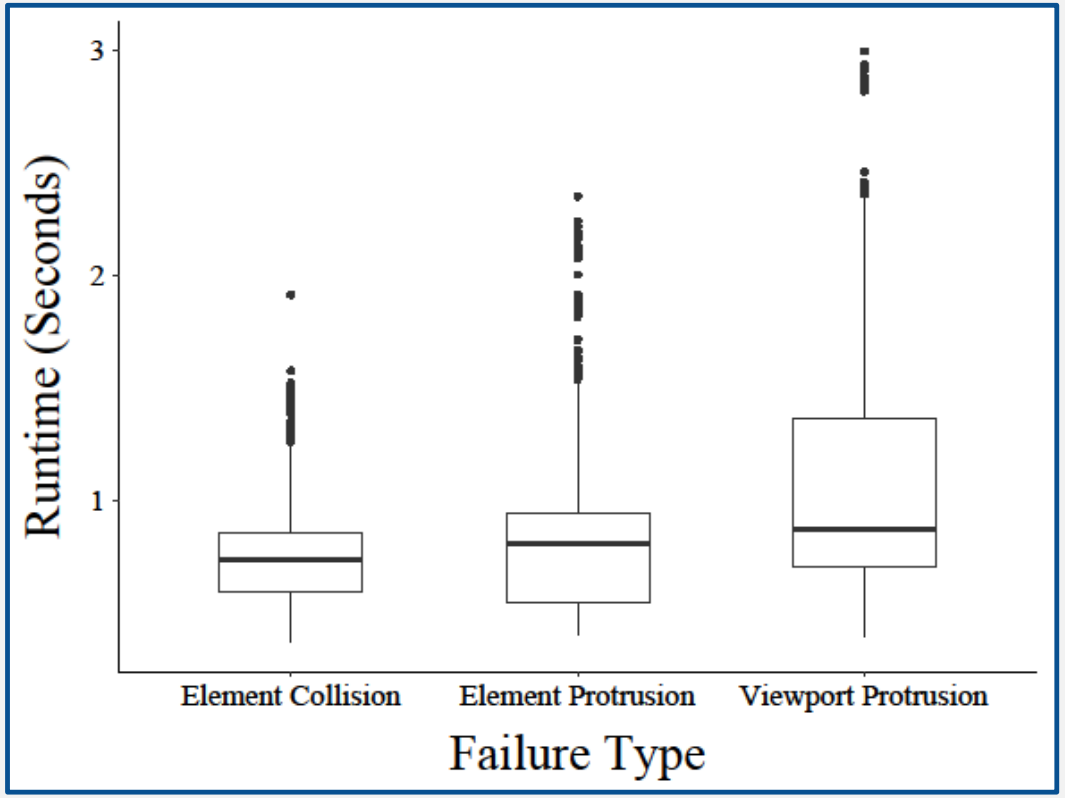

Classifications change depending on viewport

More failures are observable at the lower range

# RQ3: HOW LONG DOES IT TAKE TO VERIFY A LAYOUT FAILURE?

- How long does it take to verify a layout failure?
  - Carried out the experiment 30 times.
  - 0.91 Seconds - mean
  - 0.80 Seconds - median

- Excluded
  - Time to load the web page
  - Resize the browser



# SUMMARY

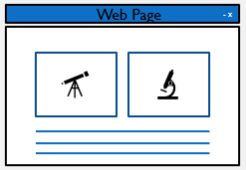
## IMPORTANCE OF A WEB PAGE LAYOUT

User Loyalty

Willingness to visit the web page again is linked the design.

Cyr et al. I&M 2006

Confidence in Services




Credibility

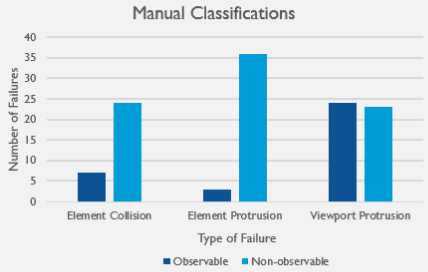
Web page design and instant credibility are statistically linked.

Robins and Holmes IP&M 2008



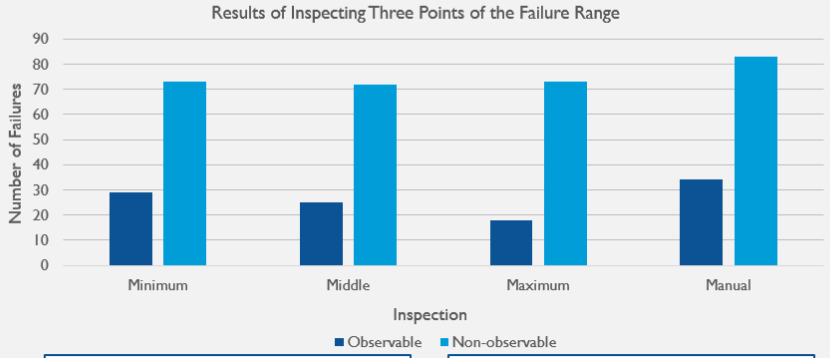
## RQ1: CAN WE AUTOMATICALLY DISTINGUISH NON-OBSERVABLE FAILURES?

- Compared to manual…
- Minimum of the failure range.
  - Agreed with manual 87.2%
- Middle of the failure range.
  - Agreed with manual 82.9%
- Maximum of the failure range.
  - Agreed with manual 77.8%





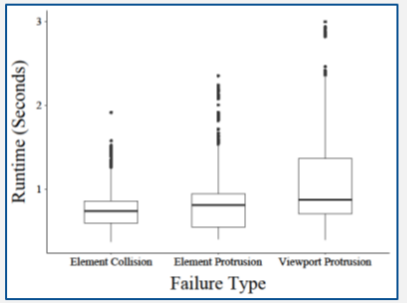

## RQ2: WHICH VIEWPORT HAS THE BEST CHANCE OF REVEALING AN OBSERVABLE FAILURE?




Classifications change depending on viewport

More failures are observable at the lower range



## RQ3: HOW LONG DOES IT TAKE TO VERIFY A LAYOUT FAILURE?

- How long does it take to verify a layout failure?
  - Carried out the experiment 30 times.
  - 0.91 Seconds - mean
  - 0.80 Seconds - median
- Excluded
  - Time to load the web page
  - Resize the browser