Introduction

When it comes to websites, user experience is all that matters. The loading time of a website is an important factor in determining the quality of experience. In the paper, ‘Scaling Up Your Web Experience, Everywhere’, James Newman, Robert H. Belson and Fabián E. Bustamante present an interesting idea of dynamically adjusting website complexity by probing the network. They present the design of a chrome extension which changes the scale of a webpage as it loads, depending on the speed of the network. If the network is slow, zooming in to the page reduces the content on the display that is in the user’s initial viewport, hence the loading time of that part could reduce. As some of the content shifts below the fold(the display), loading time for that content is hidden in the time the user looks at the initial display and then in scrolling time.

Aim

1. Deploy the ‘ScaleUp’ chrome extension presented in the paper and test it over a period of one month to analyze its performance.
2. Create a new chrome extension, our implementation of ‘ScaleUp’.
3. Test our extension over 30 websites with different zoom factors.
4. Compare the results presented in the paper to ours and report any new observations.
5. Perform a user survey to judge the performance of the extension in improving user experience on websites.

Implementation

Our chrome extension uses a background script that relies on the webRequest API. Two listeners are created in this script, one is triggered by the event ‘*onSendHeaders’,* which is fired when the request headers are ready to be sent across the network and another is triggered by the event ‘*onResponseStarted’*, which is fired when receipt of response body has started. These events are filtered to run their respective functions only for initial HTML page loading, using the ‘*responseFilter*’ called “main_frame”. We capture the timestamps at the above events and take their difference. This basically gives us the time taken to receive all headers of the initial HTML page. This is the time that is compared to a threshold of 200 ms. If it is more than the threshold, the page is zoomed in.

We created a content script that is injected into the webpages as they load. Performance API was used to get a list of resources in the webpage, from which the image resources were filtered. The content script calculates the above-the-fold time, which is the time taken to load the images in the initial display. It also tracks the total number of images on the page and the number of ATF images. We do this by getting the current display window's coordinates and checking for image objects that have any of its 4 coordinates in the area enclosed in the window's coordinates. The ATF time is measured by taking a difference between the maximum end-time of loading of any ATF image and the starting of the page load. The link of google drive of the extension is added in the reference[2].

Evaluation setup

We then deployed this extension on our browsers and tested it on over 50 websites. Some websites did not contain many images, were loading fast enough to be below the threshold and hence, we only noted the results for 30 websites. Some of these are from the Alexa top 50 websites list and the rest are randomly chosen to cover different categories like E-Commerce, News, Blogging, Social Media, Video Streaming, Search engine, Pornography. We tested each website on zoom scale factors of 90%, 100%, 110% and 125%, measured total Images, ATF images, ATF load time and averaged the results over 5 runs per scale per website. (30 websites * 4 scale factors * 5 runs per scale). The results are included in reference[3].

Results

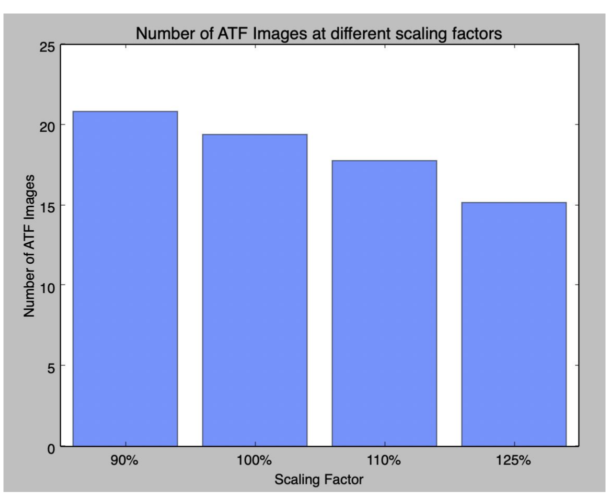

Fig 1

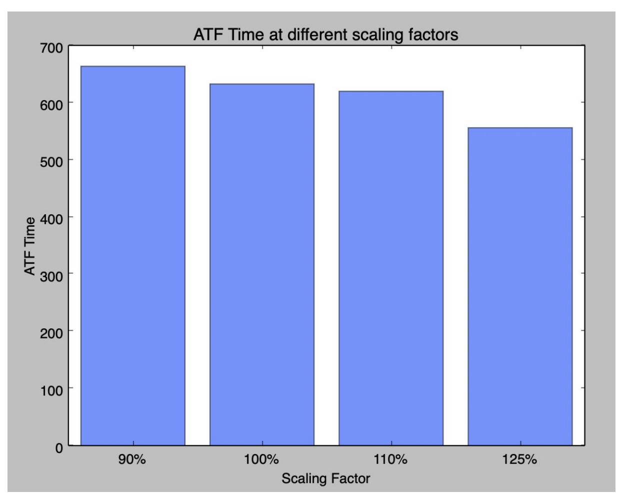

Fig 2

Fig 1 shows the average number of ATF Images for different scaling factors for all websites.
Fig 2 depicts the average ATF time for different scaling factors for all websites.

We can clearly see a decreasing trend in both these graphs as the scaling factor increases from 90% to 125%. This suggests that as we increase the scaling factor, it results in more ATF images being pushed below the fold and hence it leads to a reduction in ATF time.

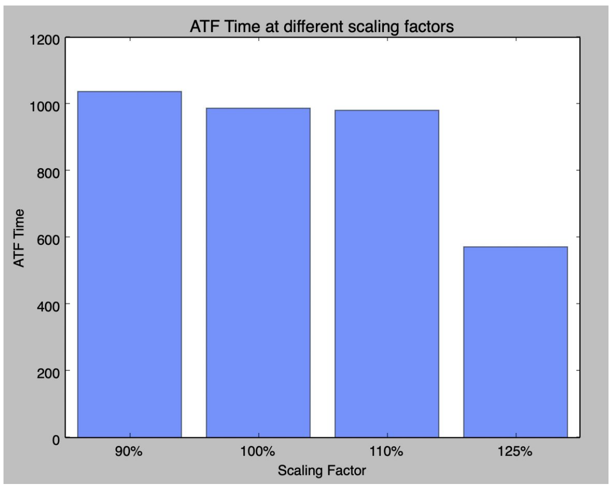

Fig 3

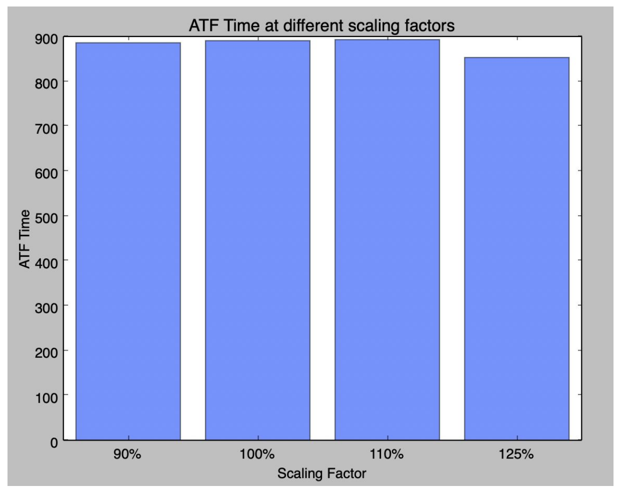

Fig 4

Fig 3 displays the average ATF time for different scaling factors for all corporate websites.
Fig 4 shows the average ATF time for different scaling factors for all e-commerce websites.

Corporate websites showed a steady and consistent decrease in ATF time with an increasing scale from 90% to 100% to 110% to 125%. It showed an improvement in ATF time of ~42% at 125% scale when compared with a 100% scale.

Whereas, E-Commerce websites were hardly affected by the increase in scale. Only at 125% scale, we saw a little improvement in the ATF time. This could be due to the fact that images in E-Commerce websites are of very different sizes and the images that went below the fold were small-sized images and hence, did not affect the ATF time.

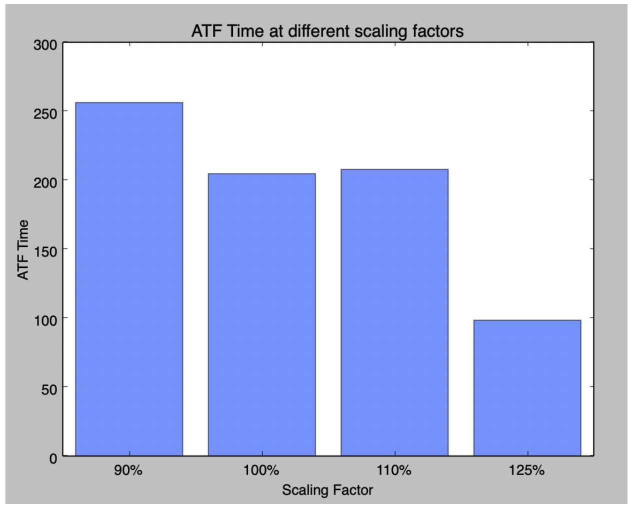

Fig 5

Fig 5 shows the average ATF time for different scaling factors for all photography websites.

Photography websites showed a major reduction in ATF time (~52%) at 125% scale factor. This was directly proportional to the reduction in ATF images (~50%). This could be due to the fact that the image sizes were very similar.

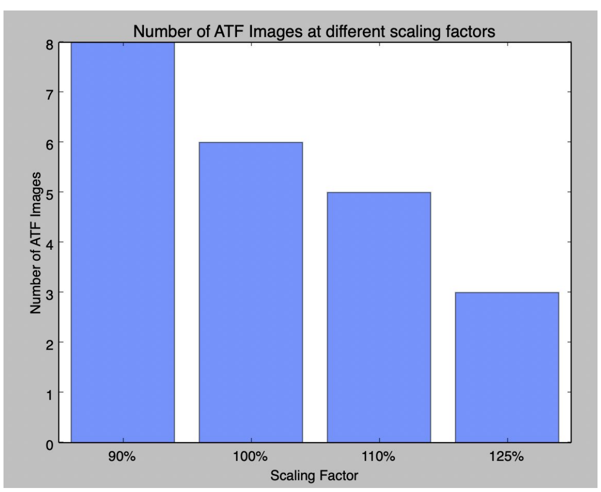

Fig 6

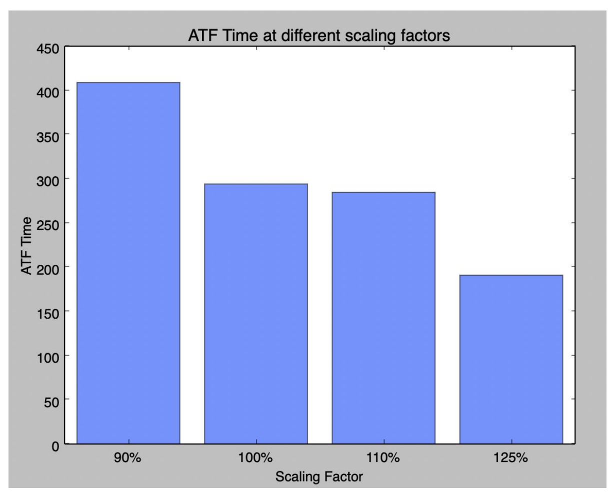

Fig 7

Fig 6 and 7 are bar graphs for the average number of ATF Images for different scaling factors for reshot.com and the average ATF time for different scaling factors for reshot.com respectively.

For reshot.com, we can see that when the ATF images reduced from 8 to 6 (25% reduction), the ATF time reduced considerably. But, when the number reduced to 5 from

6, it hardly affected the ATF time suggesting that the image that went below the fold was a small-sized image. Then when the number went down to 3 from 5, we see another considerable reduction in the ATF time suggesting that the images that went below the fold were large images.

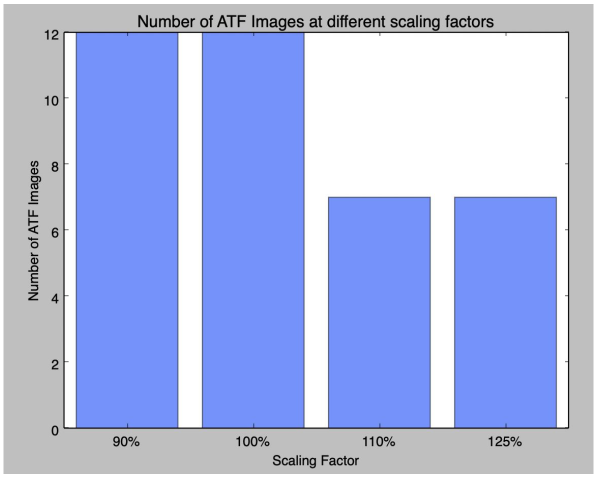

Fig 8

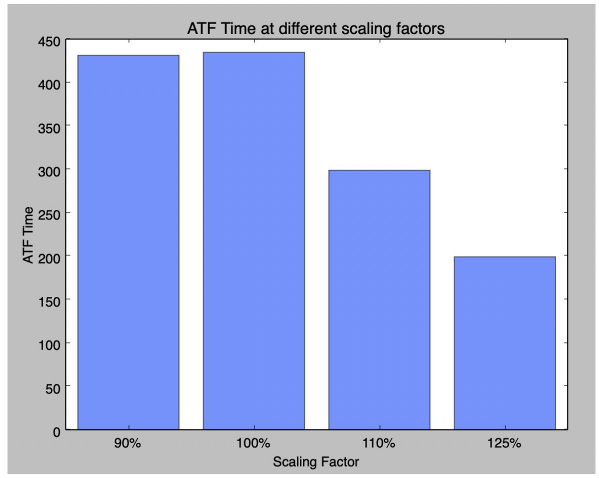

Fig 9

Fig 8 and 9 are bar graphs for the average number of ATF Images for different scaling factors for reshot.com and the average ATF time for different scaling factors for amazon prime video respectively.

For amazon prime video, we can see that changing the scale from 90% to 100% did not affect the number of ATF images and hence we see no change in ATF time. Whereas, when the scale increases to 110%, we see a significant drop in ATF time as the number of ATF images reduces by ~42%.

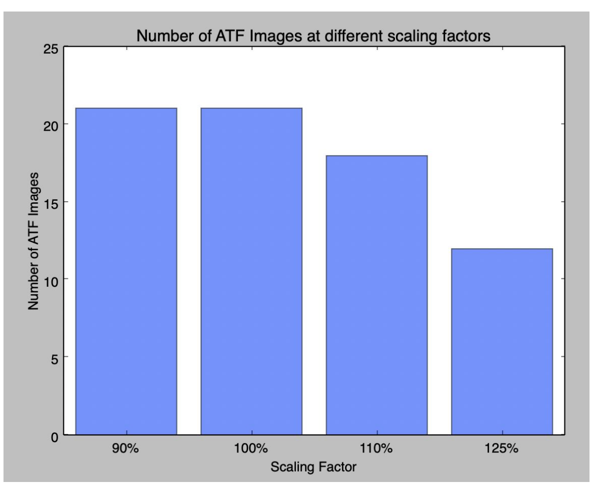

Fig 10

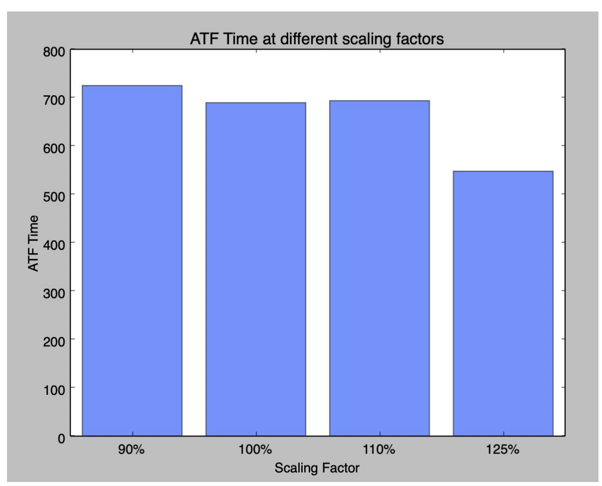

Fig 11

Fig 10 and 11 are bar graphs for the average number of ATF Images for different scaling factors for naver.com and the average ATF time for different scaling factors for naver.com respectively.

For naver.com, we see that that the ATF time is unaffected at 110% scale even though the ATF images dropped from 21 to 17, suggesting that the reduction was of smaller images. But. when we increase the scale to 125%, we see a further drop in ATF images which now affects the ATF time indicating that larger images went below the fold at this scale.

Conclusions

1. ATF time decreased or remained the same with increasing scale as the number of ATF objects reduced or remained the same respectively.
2. The decrease in ATF time is not just affected by the number of ATF images. The size of the images also matters.
    a. On many occasions, the ATF time was not affected by increasing scale, which resulted in a reduction of ATF images, as the size of the images that went below the fold was insignificant. eg. Naver.com
    b. Sometimes the ATF time reduced significantly when very few images went below the fold since they were big images.
3. If websites adapt their layout according to the scale factor, that would enhance UX. Some websites did this. Deviantart.com did this whereas Shutterfly.com did not.
4. Websites with minimal images ATF were unaffected by the scaling

Comparison with paper

Claim: As the scale factor increases, the corresponding number of images decreases as images are pushed below-the-fold.

Our Result: Depending on the type of website and its layout/structure, as the scale factor increases, the number of images above the fold remains the same or reduces.

Claim: Scaling from 100% to 110% improved the ATF time by 19% and scaling from 100% to 125% only improved the ATF time by 3%.

Our Result: Using the browser extension that we created, we got an improvement in ATF by 3% when we changed the scale from 100% to 110% and an improvement of 12% when we changed from 100% to 125%. The difference in results could be due to the choice of websites.

User experience survey

We deployed the extension and asked 50 users about their experiences of using it over 3 websites: reshot.com, vmware.com, and shutterfly.com. For each website, we set the scale factors to 90%, 100%, 110%, and 125% and asked them 3 questions: the scale at which website loading seemed the fastest, the slowest and looked the best. Finally, we asked them if they would like to use such an extension in the future. The results of the survey are summarized in the table below:

User Survey Aggregation					
	90%	**100%**	**110%**	**125%**	
Loaded Slowest	**103**	47	0	0	
Loaded Fastest	0	0	51	**99**	
Looked Best	0	43	**89**	18	
Would you use it?	21 say yes, 29 say no				

Digging Deeper into the problem

1. To gain additional insights into the impact of our tool, we did the following additional analysis.
    a. The paper shows a general analysis of websites. We divided the websites into categories (E-Commerce, Corporate, Blogging, Social Media, News, Photography, Search Engine, Video Streaming, Pornography) and evaluated the performance of our tool for each category. The detailed analysis is included above in the results section (Fig 3, 4, 5).
    b. We also looked at the structure of individual websites and presented it's analysis to further understand the reliance on the structure of the website in affecting the performance of our extension. (Fig 6 - 11)

2. We conducted a user experience survey to understand the impact of our tool and to gain more understanding about the positives and negatives of using the tool. The links to the survey results are provided in References[4][5][6].

References

1. Paper: https://dl.acm.org/citation.cfm?id=3302368
2. Code Repo: https://drive.google.com/open?id=18NxxyRKfBBb-4fGs-r92I4DYdfCBaNgH
3. Results: https://docs.google.com/spreadsheets/d/1TSkqfPZlZq4DKZCKeeYCz0BO2v7XAcMywGSZOJVOdHQ/edit#gid=0
4. Survey for reshot.com: https://docs.google.com/spreadsheets/d/1TSkqfPZlZq4DKZCKeeYCz0BO2v7XAcMywGSZOJVOdHQ/edit#gid=397452943
5. Survey for vmware.com: https://docs.google.com/spreadsheets/d/1TSkqfPZlZq4DKZCKeeYCz0BO2v7XAcMywGSZOJVOdHQ/edit#gid=1270941748
6. Survey for shutterfly.com: https://docs.google.com/spreadsheets/d/1TSkqfPZlZq4DKZCKeeYCz0BO2v7XAcMywGSZOJVOdHQ/edit#gid=577147131