



A Framework for Improving Web Affordability and Inclusiveness



Rumaisa
Habib*



Sarah
Tanveer*



Aimen
Inam



Haseeb
Ahmed



Ayesha
Ali



Zartash
Uzmi



Zafar
Qazi



Ihsan
Qazi

**Joint first authors*

How 'worldwide' is access to the World Wide Web?

How would stakeholders benefit from Web equity?

How do we work towards equitable Web access?

Coverage

Digital Literacy

Social stigma

Censorship

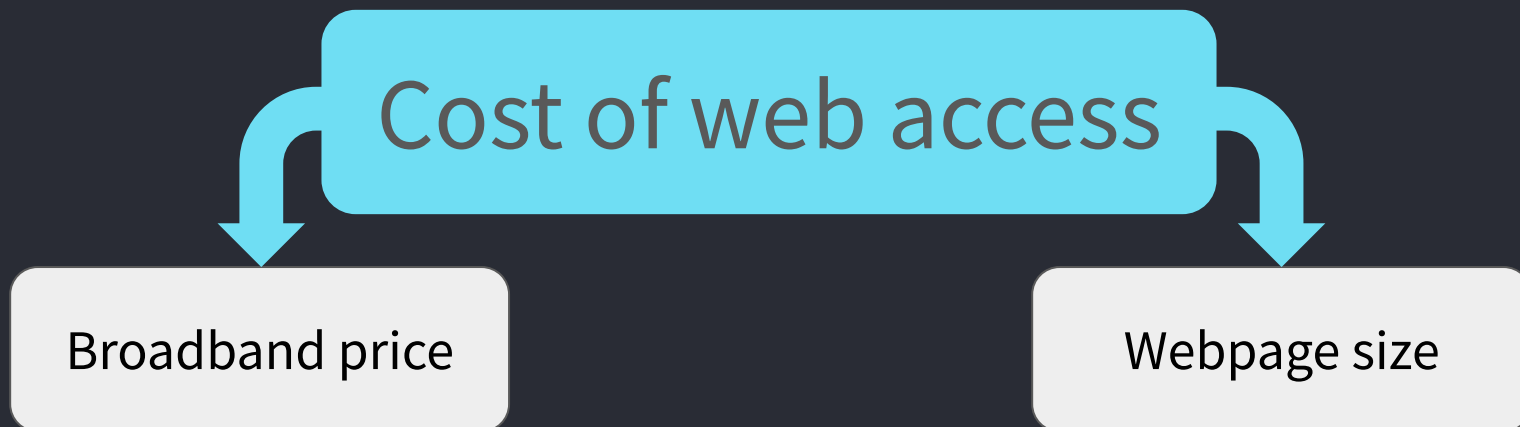
Coverage

Digital Literacy

Cost of web access

Social stigma

Censorship



Difficulties in web access



- **48%** of respondents had difficulty paying for their mobile data
 - World Bank survey in 11 emerging countries
- Rising **webpage sizes** and stagnant **broadband prices**
- **Each** access has become **more expensive**

Variations in...

broadband price

206 countries
ITU dataset

web complexity

99 countries
Alexa top 1000
~72k webpages

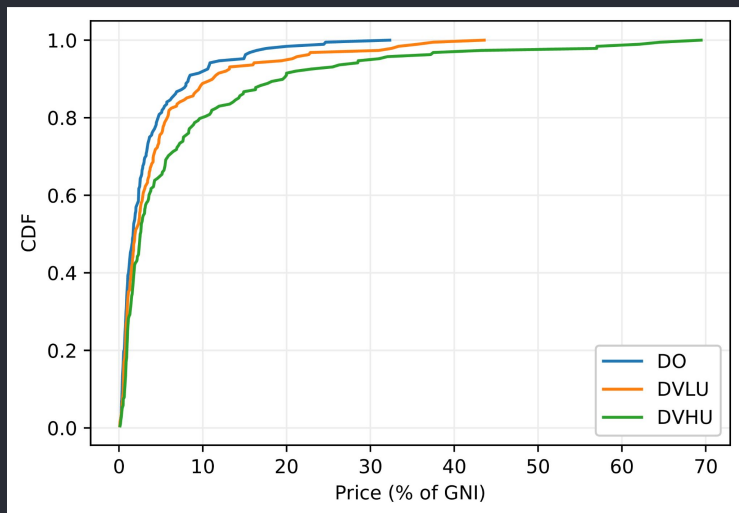
Variations in...

broadband price

206 countries
ITU dataset

web complexity

99 countries
Alexa top 1000
~72k webpages



94 countries do not meet the **2%** target
(set by the UN Broadband commission)
for the 2GB DO plan

} *Three data plans*

Variations in...

broadband price

206 countries
ITU dataset

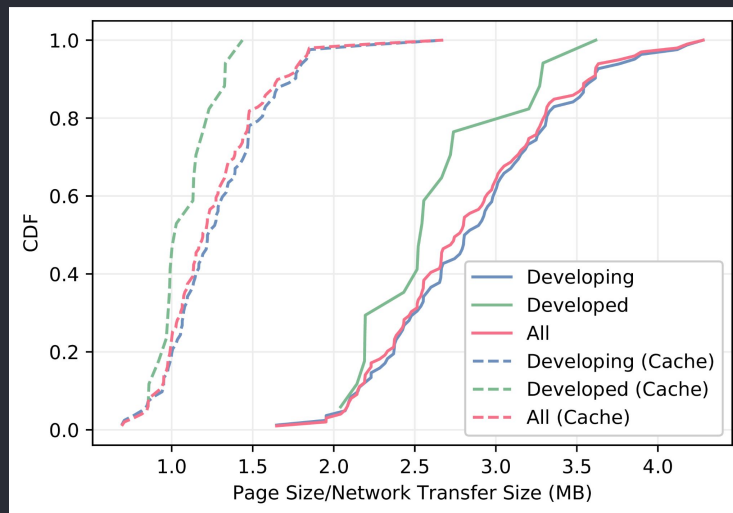
web complexity

99 countries
Alexa top 1000
~72k webpages

non cached Page sizes in...

...**developing** regions: **2.87 MB**

...**developed** regions: **2.64 MB**



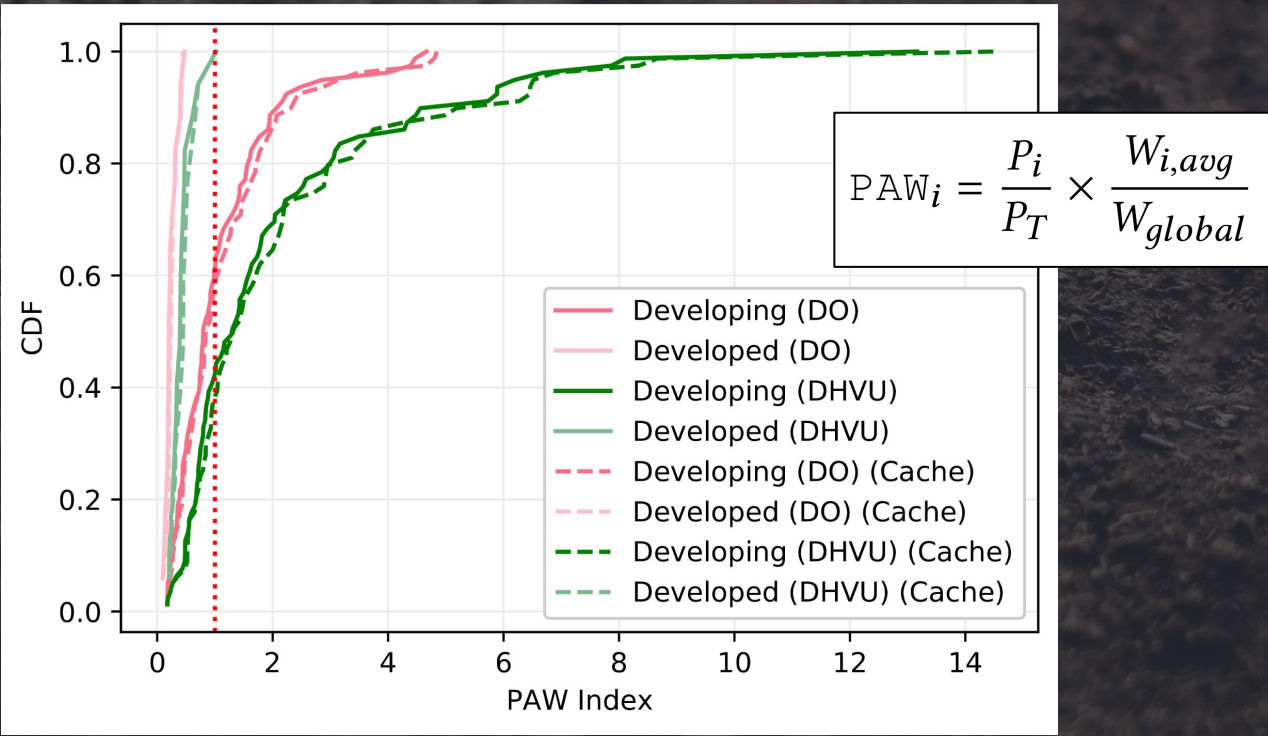
novel fairness metric to quantify affordability...

PAW Index

reduction required in avg. page size by each country to equalize web access

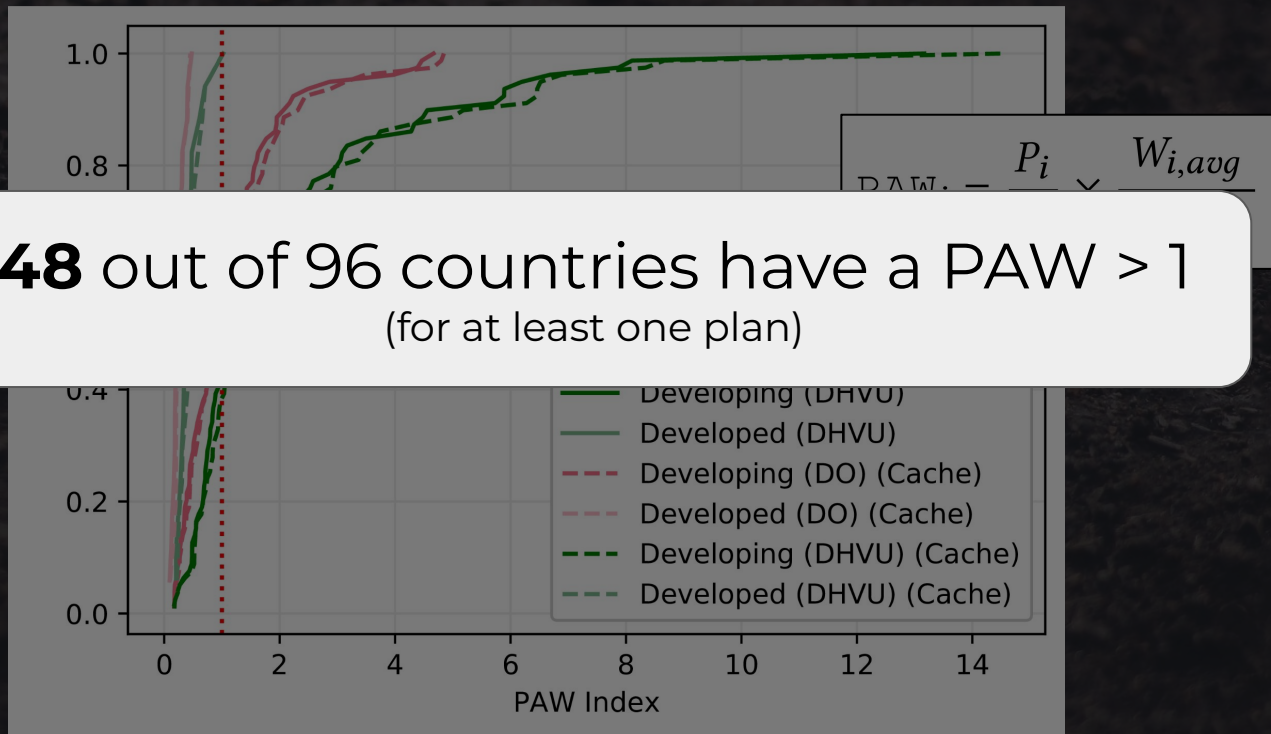
PAW Index

reduction required in avg. page size by each country to equalize web access



PAW Index

reduction required in avg. page size by each country to equalize web access

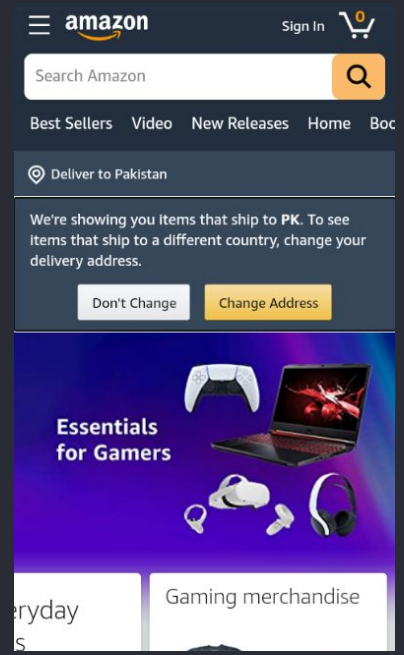


~~How 'worldwide' is access to the World Wide Web?~~

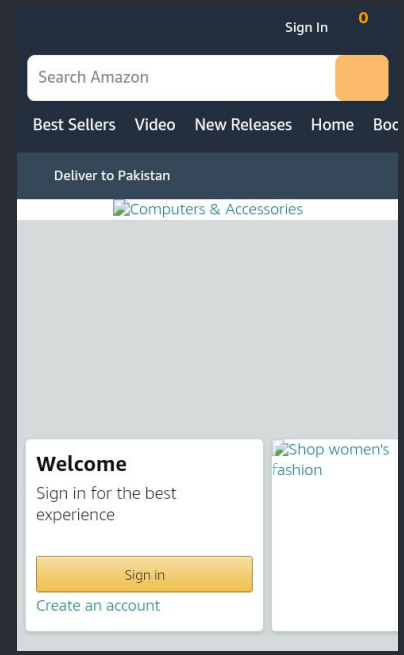
How would stakeholders benefit from Web equity?

How do we work towards equitable Web access?

Do users even *want* their webpages reduced?



↑ Quality
↓ Accesses



↓ Quality
↑ Accesses



Do users even *want* their webpages reduced?

- **100** participants
- **10** webpages
with varying levels of reduction



Do users even *want* their webpages reduced?

- **100** participants
- **10** webpages
with varying levels of reduction



willing to trade off **webpage quality** for **number of accesses**

Other Stakeholders

Website Operators

Mobile Network Operators

more users online → increased revenue

So now that we know that...

... this problem **exists**

So now that we know that...

... this problem **exists**

... it **matters**

So now that we know that...

... this problem **exists**

... it **matters**

... people are **willing** to adopt solutions

~~How 'worldwide' is access to the World Wide Web?~~

~~How would stakeholders benefit from Web equity?~~

How do we work towards equitable Web access?

AW4A

Affordable Web For All

Prior work

What went wrong?

Prior work

What went wrong?

Google
Weblight ^{1,2,4}

Facebook
Free Basics ³

Opera Mini ^{1,2}

Brave ^{1,2}

¹ Breaks pages

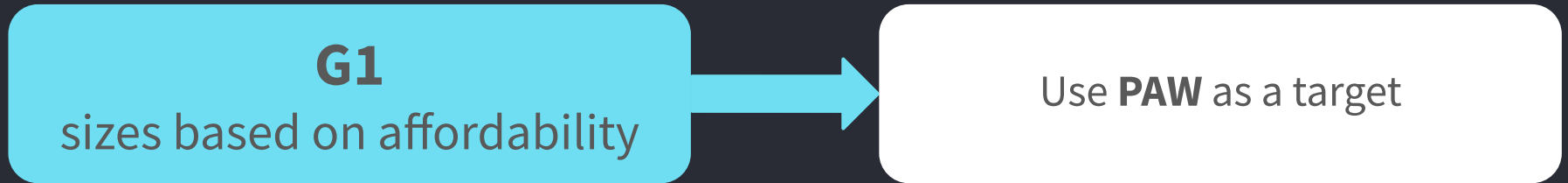
² Lack of web developer consent (impacts revenue)

³ Violated net neutrality principles

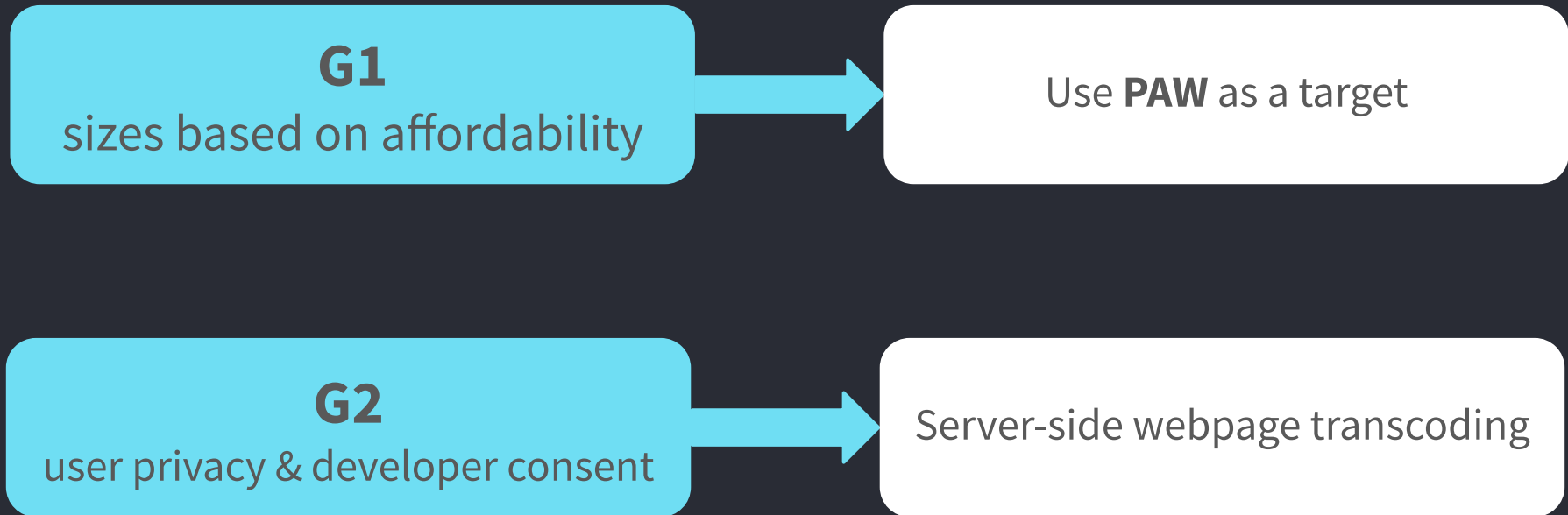
⁴ Broke end-to-end encryption

Goals & principles

Goals & principles

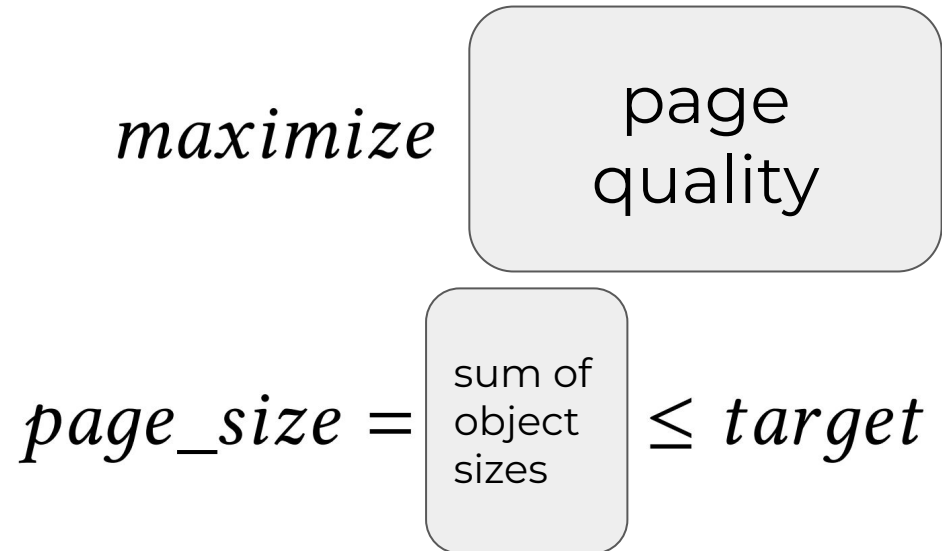


Goals & principles



Optimization problem

1. Maximize **page quality**
2. Given a **page size** limit



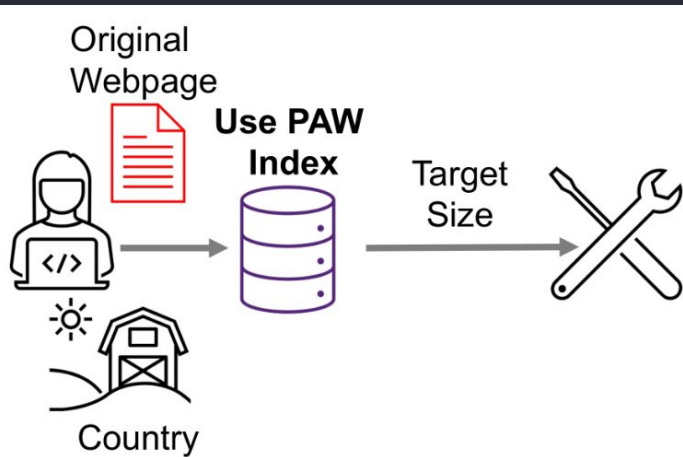
Optimization problem

1. Maximize **page quality**
2. Given a **page size** limit

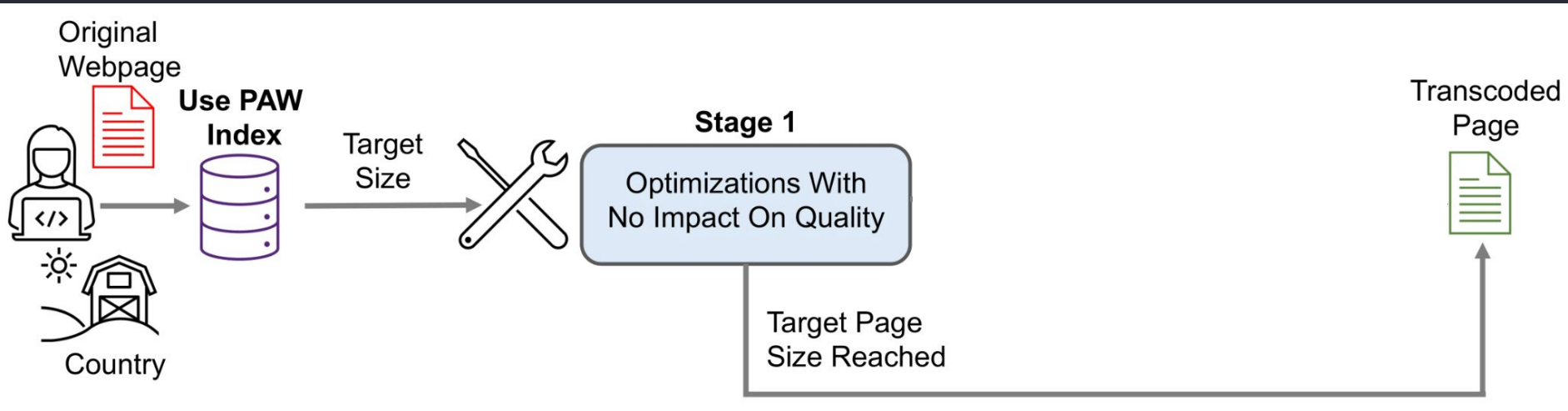
$$\textit{maximize} \frac{\sum_{i=1}^k w_i \times Q_i}{\sum_{i=1}^k w_i},$$

$$\textit{page_size} = \sum_{i=1}^k b_i \leq \textit{target}$$

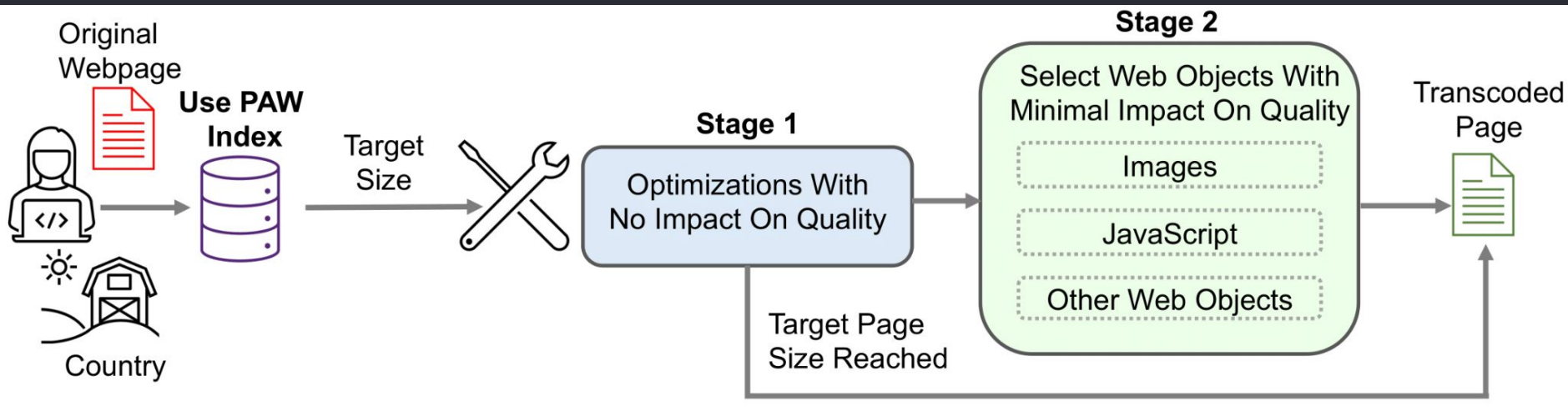
Two stages



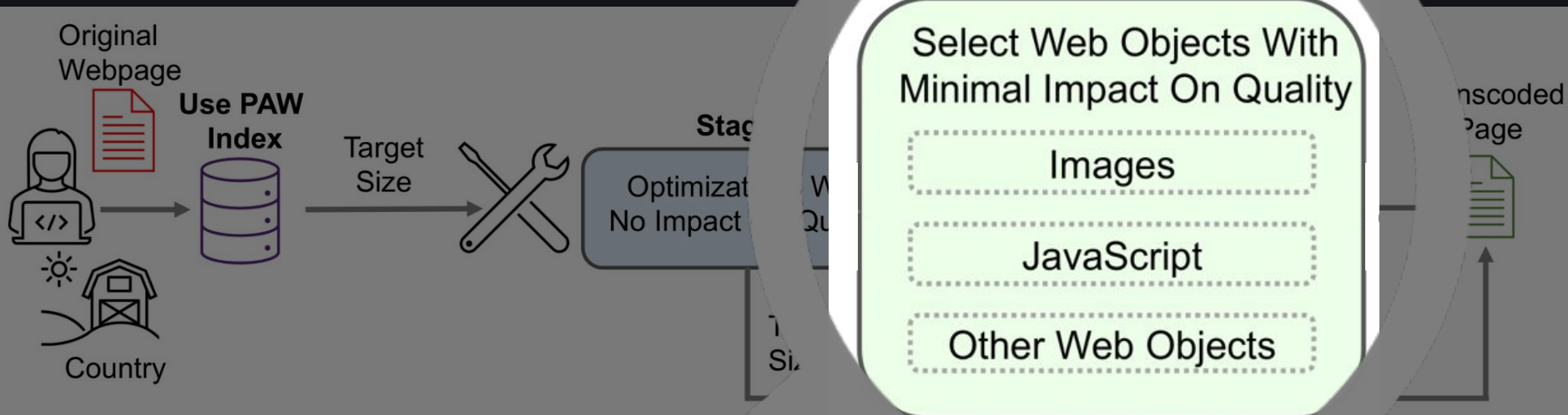
Two stages



Two stages



Two stages



Zooming into stage 2...

Grid Search

- Brute Force Approach
- Searches discrete space
- Higher quality pages
- Exponential run time

VS

HBS

- Heuristics Based Approach
- Uses a set of heuristics
- Lower quality pages
- Linear run time

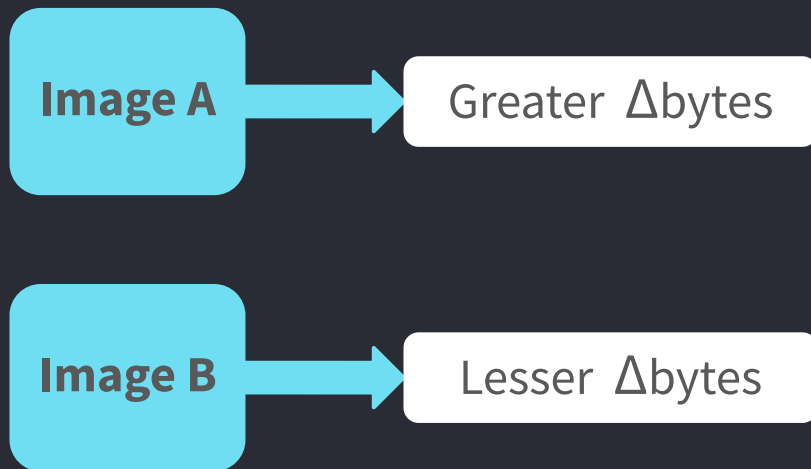
A sneak peak into the (image) heuristics

Area on the webpage



Bytes efficiency

for the same **change in quality**:



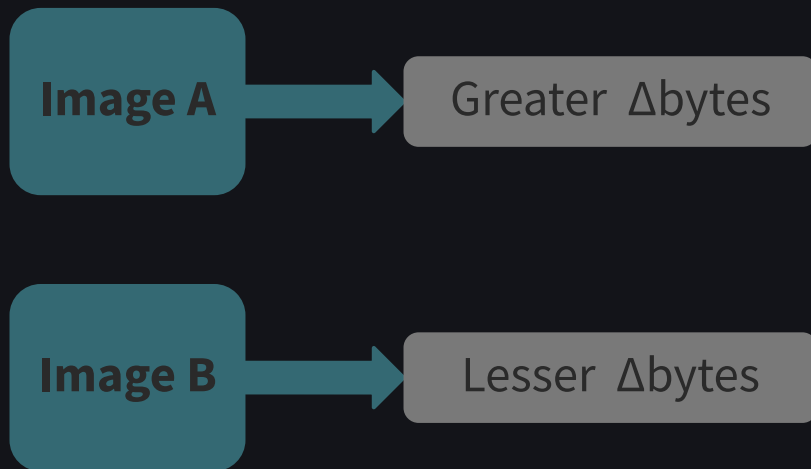
A sneak peak into the (image) heuristics

Area on the webpage



Bytes efficiency

for the same **change in quality**:



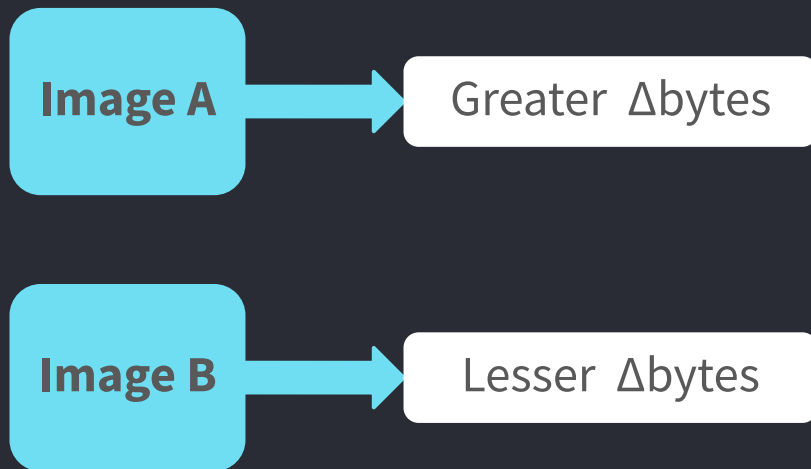
A sneak peak into the (image) heuristics

Area on the webpage

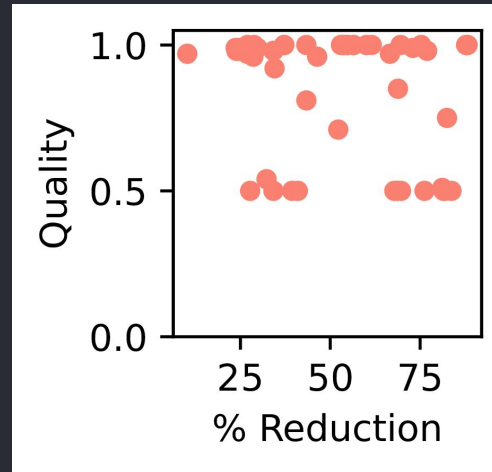


Bytes efficiency

for the same **change in quality**:



Quality of webpages produced by HBS



Half of the pages maintain a quality* of **0.98 or higher**

* weighted avg. of the quality of objects on a page

Quality of webpages produced by HBS

Users slightly **preferred HBS** over

Brave



Opera Mini



Conclusion

We show that...

... lack of affordability is a **key barrier** in accessing the web

... users are **willing to trade quality** for quantity of access

... there are practical **solutions** to improve affordability

Thank you!

For more details...

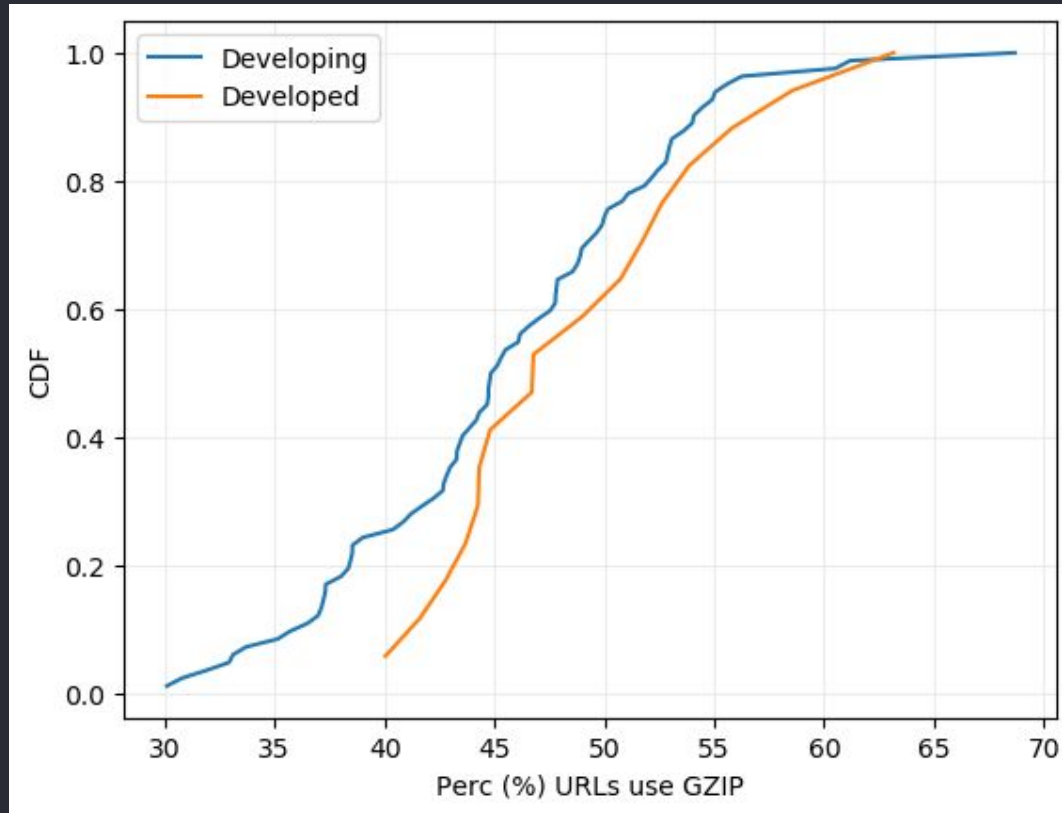
... **contact** ✉️ us at rumaisa@stanford.edu or 23100099@lums.edu.pk

... view our **source code** 💻 at <https://github.com/nsgLUMS/sigcomm2023-aw4a>

... and check out the full paper 🕶️

Backup Slides >>

Gzip compression



PAW Index equation

$$PAW_i = \frac{P_i}{P_T} \times \frac{W_{i,avg}}{W_{global}}$$

P_i : average broadband price in region i

P_T : target broadband price (2% of a country's GNIpc)

$W_{i,avg}$: average page sizes in region i

W_{global} : average page size globally