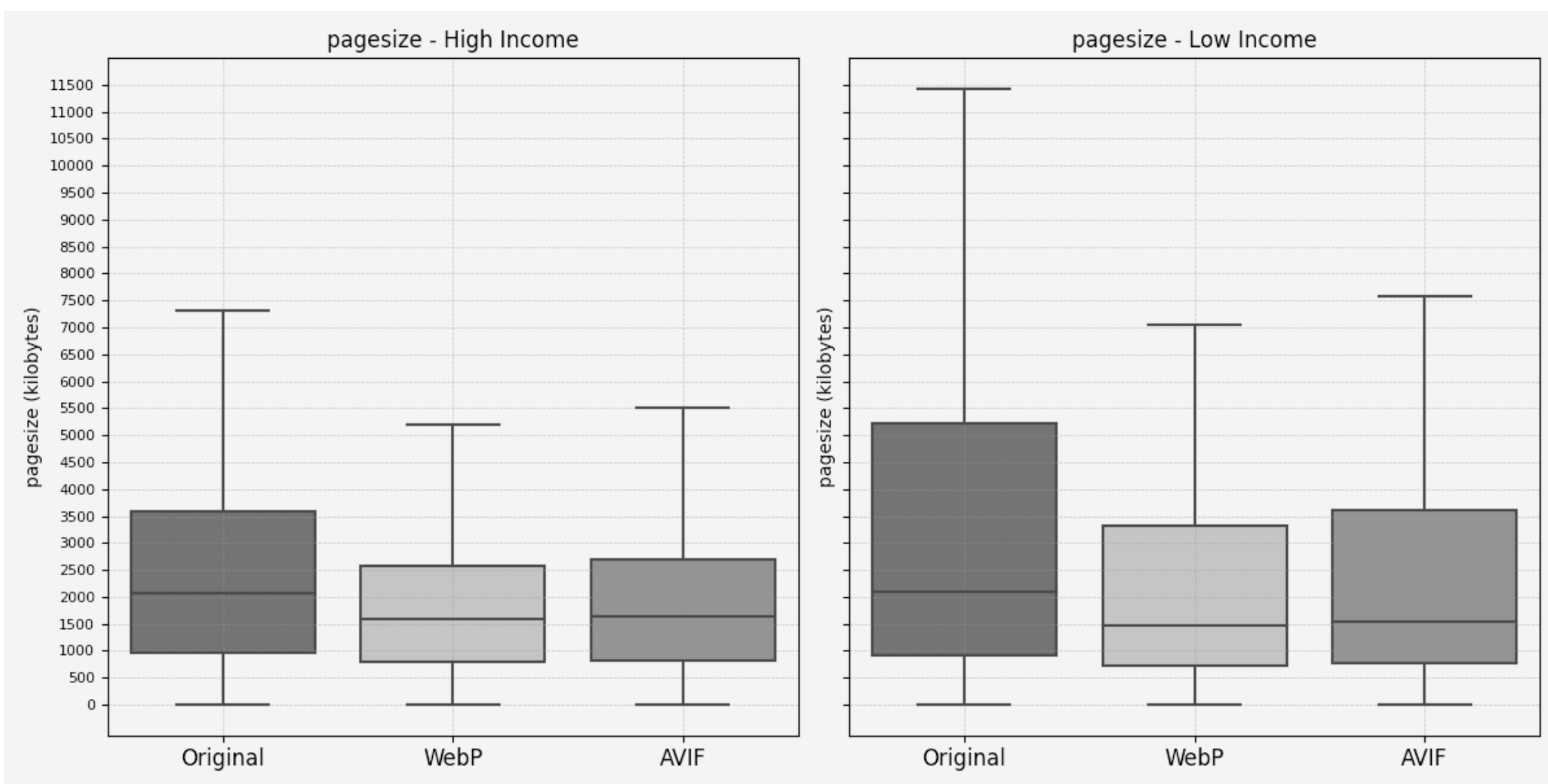


A COMPARATIVE EVALUATION OF NEXT-GENERATION IMAGE FORMATS ON LOW-COST MOBILE HARDWARE

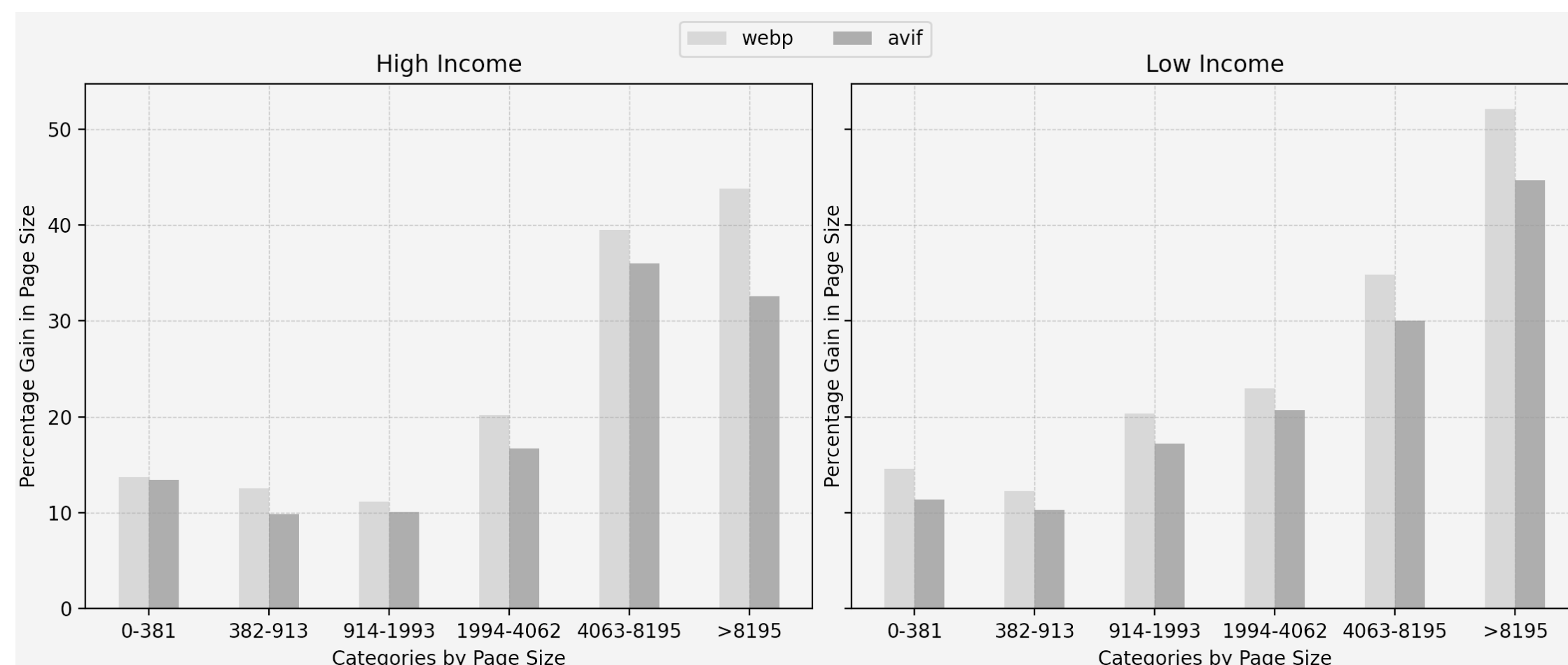
This study presents a thorough evaluation of next-generation WEBP and AVIF image formats in comparison to the established JPEG and PNG standards, specifically targeting resource-constrained, low-cost hardware.

We seek to quantify the performance improvements resulting from the transition to these advanced formats across an extensive range of web pages and investigate the variations in gains based on numerous factors, such as page size, economic context of the country of origin, and webpage popularity.

RESULTS



Low-income countries build websites with larger page sizes, even though they also suffer from slower networks and hardware. In fact, even with all these problems, low-income countries using WEBP and AVIF can be competitive with high-income countries as shown in the above graph. Both high and low-income countries can benefit from much lower page sizes, and the percentage gains do follow some trends in relation to the original page size:



The categories mentioned in the x-axis are not arbitrary. They represent the 10th, 25th, 50th, 75th, and 90th percentile values for page sizes of the top 1 million web pages as of April 2023 (HTTP Archive).

We also notice that the Speed Index readings are significantly impacted by the usage of WEBP and AVIF formats. SpeedIndex is a measure that quantifies the perceived pace at which the page loads and becomes usable, and as per Google Lighthouse, the following benchmarks are typically used:

0 - 3.4 FAST
3.4 - 5.8 MODERATE
Above 5.8 SLOW

The graphs and the associated table shows that when WEBP and AVIF formats are used, the Speed Index percentages tend to migrate towards a more efficient rating.

The proportion of slower websites decreases, and more moderate/fast measurements tend to be recorded, suggesting significantly better speed and efficiency.

REFERENCES

[1] [n.d.]. Google Next Billion users - research. <https://nextbillionusers.google/research/>
[2] [n.d.]. Usage statistics of image file formats for websites. https://w3techs.com/technologies/overview/image_format
[3] 2021. Mobile data costs fall but as demand for internet services surges, progress remains too slow. <https://webfoundation.org/2021/03/mobile-data-costs-fall-but-as-demand-for-internet-services-surges-progress-remains-too-slow/>

[4] 2022. Page weight. <https://httparchive.org/reports/page-weight>
[5] Byungjin Jun Northwestern University, Byungjin Jun, Northwestern University, Fabián E. Bustamante Northwestern University, Fabián E. Bustamante, Sung Yoon Whang Northwestern University, Sung Yoon Whang, Zachary S. Bischof IJ Research, Zachary S. Bischof, IJ Research, and et al. 2019. Amp up your mobile web experience: The 25th Annual International Conference on Mobile Computing and Networking. <https://dl.acm.org/doi/abs/10.1145/3300061.3300137>

AUTHORS

Shaurya Singh
Computer Science, 2023

AFFILIATIONS

New York University Abu Dhabi
Research conducted under the guidance of:
Professor Yasir Zaki
Assistant Professor of Computer Science
Global Network Assistant Professor of Computer Science,
Courant Institute of Mathematical Sciences, NYU
NYU Abu Dhabi

INTRODUCTION

Google's Next Billion Users research project estimates that by 2025, a billion more people¹ will purchase their first smartphone. Armed with ever-decreasing mobile data rates, this will put significant pressure on the existing web infrastructure. Major capital investments into increasing the internet's load-carrying capacity is a feasible long-term approach but in the short term, we require creative software solutions to de-clog the web and efficiently service a larger user base than ever before.

This project aims to explore some of these solutions (namely, the new WEBP and AVIF image formats), particularly in the field of optimizing image formats over low-bandwidth networks to devices with scarce onboard hardware resources.

OBJECTIVE

To measure the impact of WEBP and AVIF image formats on page speed metrics such as Page Size, First Contentful Paint, Page Load Time, Document Complete Time, and Speed Index as opposed to traditional JPEG and PNG formats.

To determine if the impact of the newer formats is greater/lower for websites originating in low-income countries compared to their high-income counterparts.

METHODOLOGY

Analysis 1: Country-Wise Analysis

The paper utilizes a set of 750 web pages originating from 30 countries, equally split between low-income and high-income countries that together account for over 70% of the world's population. The purpose of this analysis is to quantify and compare the gains offered by newer formats to websites from low and high income countries.

Analysis 2: Representative Set Analysis

This analysis is run on a statistically representative set of 1200 webpages selected from the world's top 1 million websites to help measure the performance gains offered by the newer formats as a function of the page's popularity.

