

Landmark Challenges: New Fairer Dataset

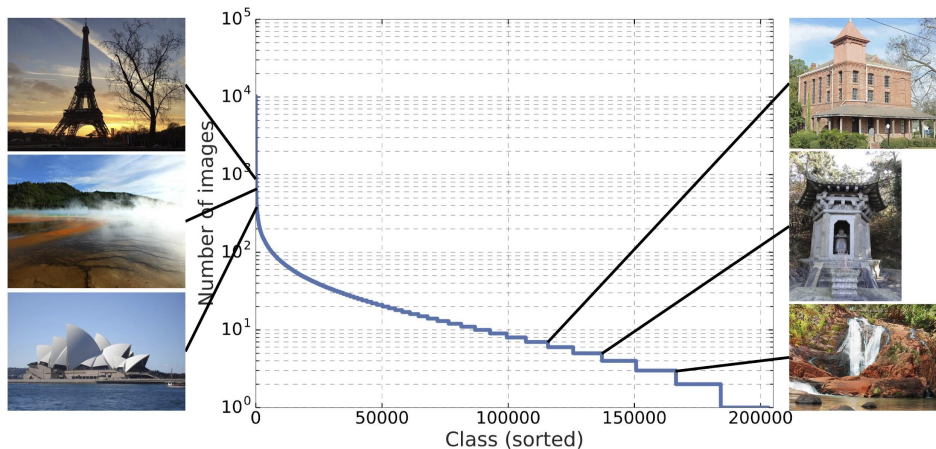
Zu Kim, Google Research

[Towards A Fairer Landmark Recognition Dataset, Kim et al, <https://arxiv.org/abs/2108.08874v1>]

Background: GLDv2

[Google Landmarks Dataset v2, Weyand et al, CVPR'20](#)

- **>5M** images of **>200K** human-made and natural landmarks from Wikimedia Commons
- Consists of train, index, and test datasets
- Real-world challenges:
 - Long-tailed distribution
 - Hard matching problems
 - Intra-class variability
 - Out-of-domain queries



Uneven Data Distributions in GLDv2

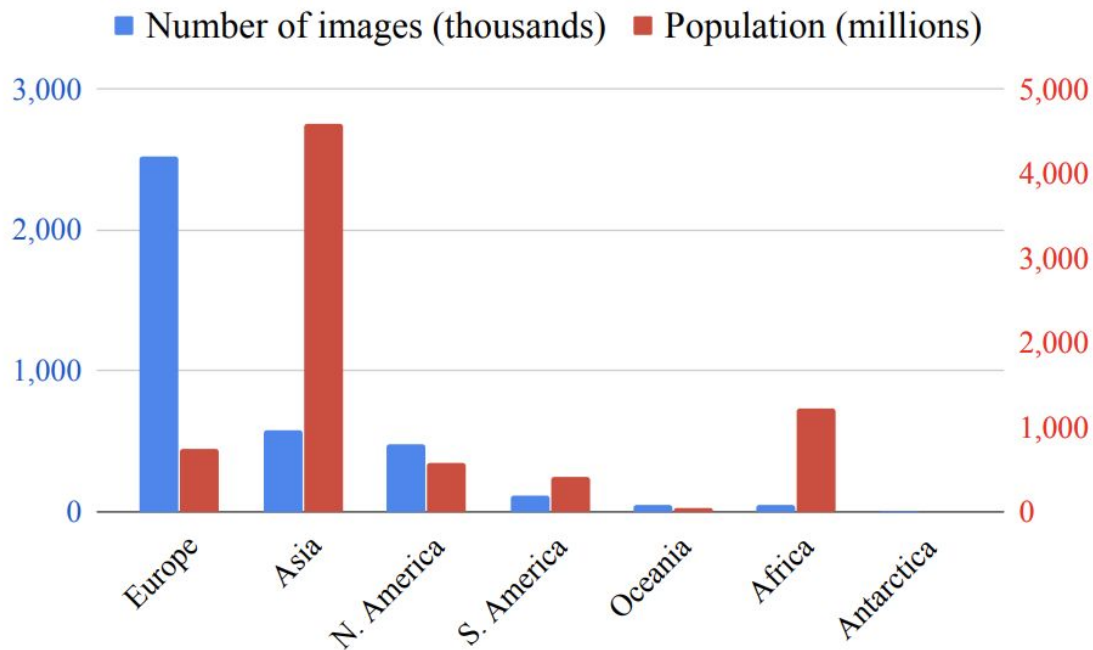


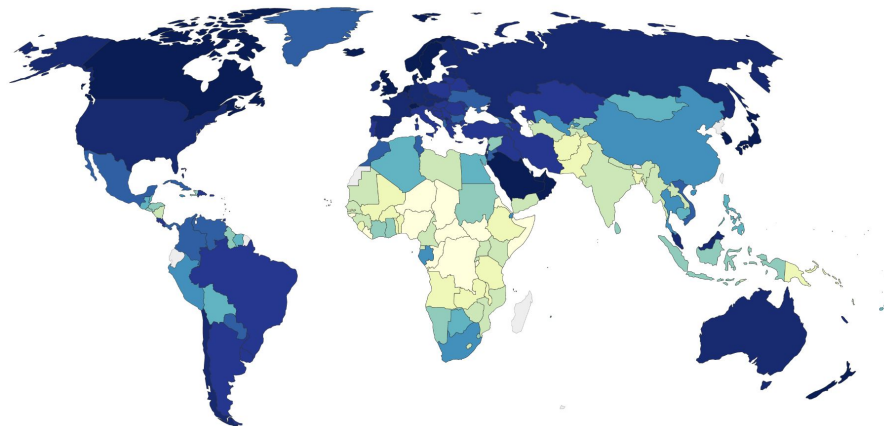
Figure 4: Histogram of the number of images per continent (blue) compared to their populations (red).

Bias in Crowdsourced Datasets

- Internet user distribution does NOT represent the world population

Share of the population using the Internet, 2018

All individuals who have used the Internet in the last 3 months are counted as Internet users. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.

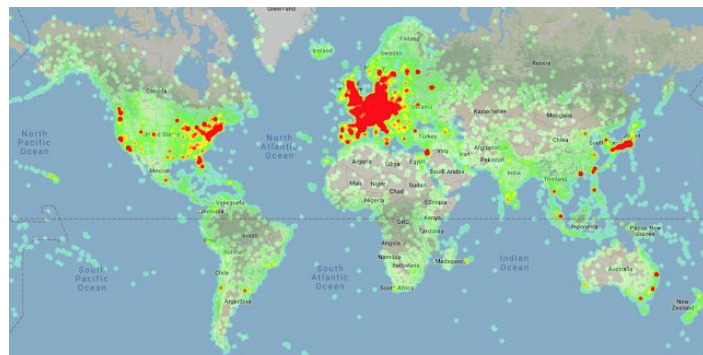


Source: International Telecommunication Union (via World Bank)

OurWorldInData.org/technology-adoption/ • CC BY

Bias in Crowdsourced Datasets

- Internet user distribution does NOT represent the world population
- The bias affects:
 - Which object (landmark) is included in the dataset?
 - How many images per object are included in the training/evaluation dataset?



IN CONGRESS, JULY 4, 1776.

The unanimous Declaration of the thirteen united States of America.

"It is in the course of human events, it became necessary for us to declare the political bonds which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the laws of Nature, and of Nature's God, entitled them; that the principles of the Declaration of Independence, a document rejected by the opinions of mankind require that they should declare the causes which impel them from the former situation. We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are life, liberty and the pursuit of Happiness. — That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed. — That whenever any form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such Principles, and organizing its powers in such form, as shall seem to them best to secure their safety and Happiness. Prudence, indeed, forbids that Governments long established should not be changed, for light and transient causes; and accordingly all experience hath shewn, that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by overthrowing the forms to which they are accustomed. — But when a long train of abuses and usurpations, pursuing invariably the same Object, evinces a design to reduce them under absolute Tyranny, it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future safety. — Such has been the patient suffering of these Colonies; and such is now the necessity which constrains them to alter their former form of Government. — The history of the present struggle of Great-Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States. — To prove this, let Facts be submitted to a candid world."

"We have signed no Oath to leave, the most absolute and necessary for the parties who...
 We have signed no Oath to leave these States. — The history of the present struggle of Great-Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States. — To prove this, let Facts be submitted to a candid world."

[illegible]

People Are Created Equal

And therefore, the Representatives of the united States of America, in General Congress, Assembled, appealing to the Supreme Judge of the world for the rectitude of our intentions, do, in the Name and by Authority of the good People of these United States, solemnly publish and declare, That these United Colonies are, and of Right ought to be, Free and Independent States; that they are absolved from all Allegiance to the British Crown, and that all political connection between them and the State of Great Britain, is and ought to be totally dissolved; and that as Free and Independent States, they have full Power to levy War, conclude Peace, contract Alliances, establish Commerce, and to do all other Acts and Things which Independent States may of right do. And for the support of this Declaration, with a firm reliance on the Protection of Divine Providence, we mutually pledge to each other our Lives, our Fortunes, and our sacred Honor.

[illegible]

NOT all landmarks are equally important

- Eiffel Tower vs Binoculars Building (Google Los Angeles)



NOT all landmarks are equally *relevant*

- Eiffel Tower vs Binoculars Building (Google Los Angeles)



Goal

Estimate *fair* landmark relevance and
enhance the datasets using it

What is a fair landmark relevance?

Definitions depend on the application / use cases:

Personal Importance / Utility

“Which places are personally important (or useful)? (e.g., grocery market, school, local government office)”

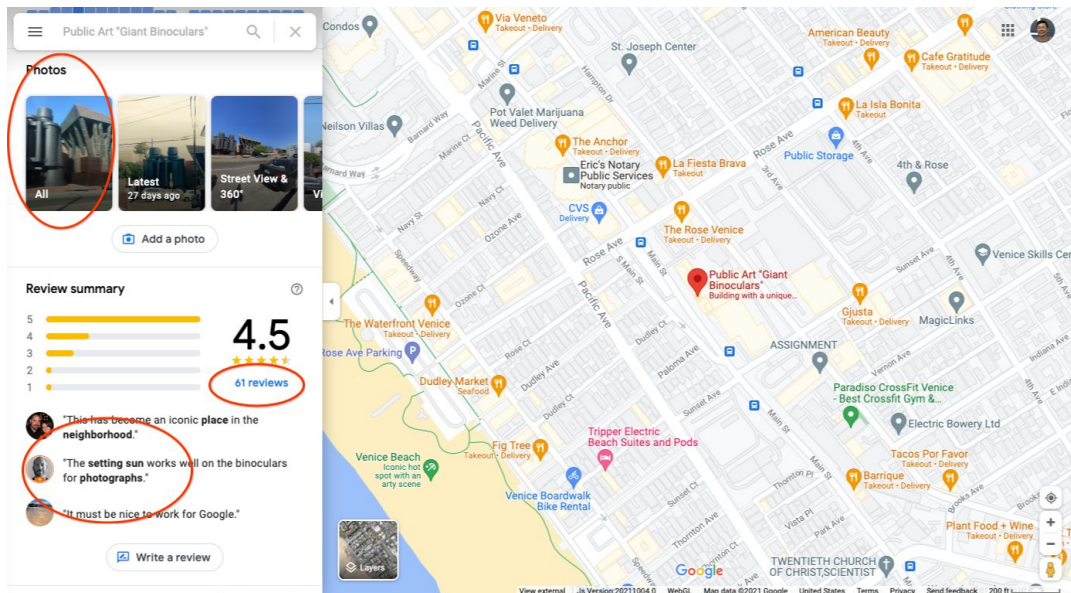
Tourism

“If everyone in the world can go anywhere in the world, what is the place they would like to go or remember?”

Estimate: **fair** aggregation of the **individual** relevance

How to estimate aggregated relevance?

- Google Maps aggregated user contributions per place
 - # of photo uploads, comments, etc.



How to estimate aggregated relevance?

- Google Maps aggregated user contributions per place
 - # of photo uploads, comments, etc.
 - Crowdsourced contributions reflect the relevance
- Potential sources of biases
 - Internet / product accessibility and proficiency
 - Gender, age, ...
 - Continents / countries
 - Ability to travel
 - Cities vs rural

Reducing Bias From Google Maps Statistics

- Idea: use user demographics
 - Gender, age, country of residence
 - Fair contribution from each demographic group
 - Method: stratification
 - Caution: highly private information
 - Thorough reviews and procedures required
 - Set minimum aggregation level to protect the user demographics from being inferred from the result

Formulation

$$P(c) = \sum_h P(c|h)P(h)$$

Formulation

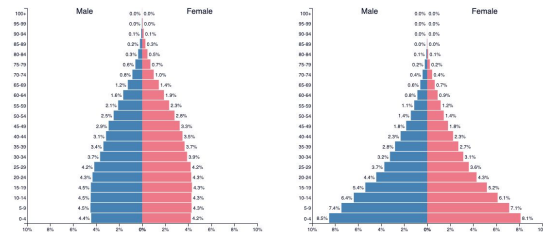
$$P(c) = \sum_h P(c|h)P(h)$$

Ideal class distribution
(relevance)

Demographic group

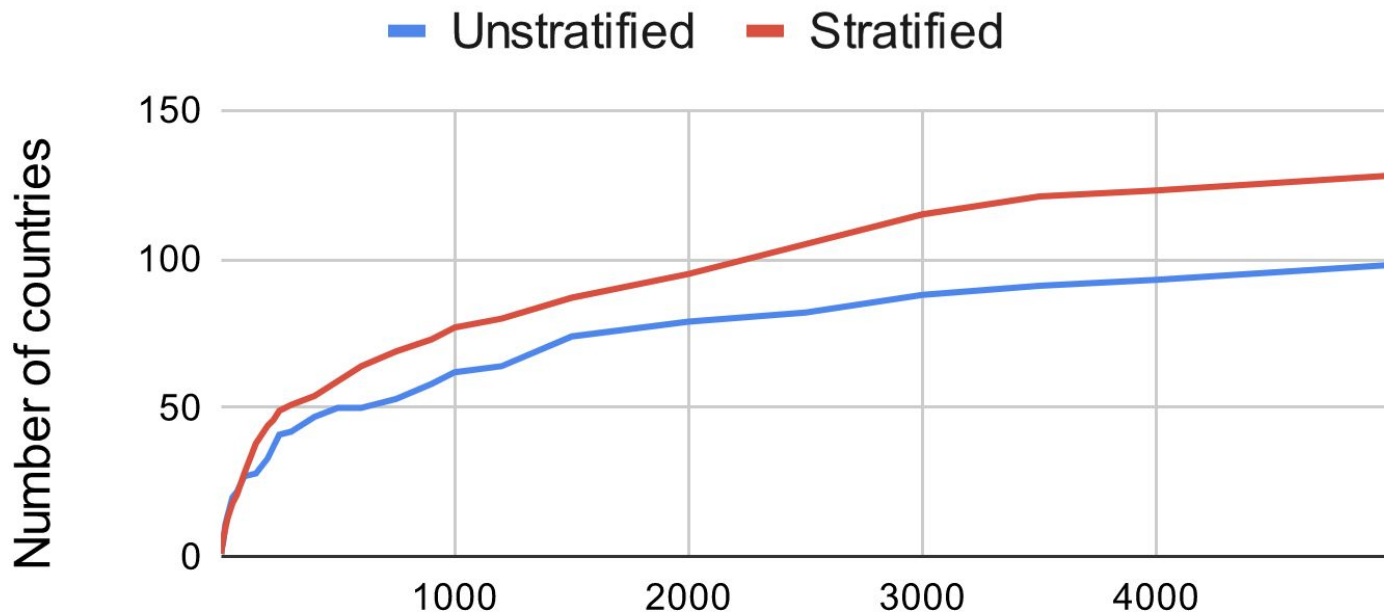
Relevance (e.g., user
contribution) by
demographic group

Prior (representation)



Effect of the Stratification

Landmarks from more countries in top N:



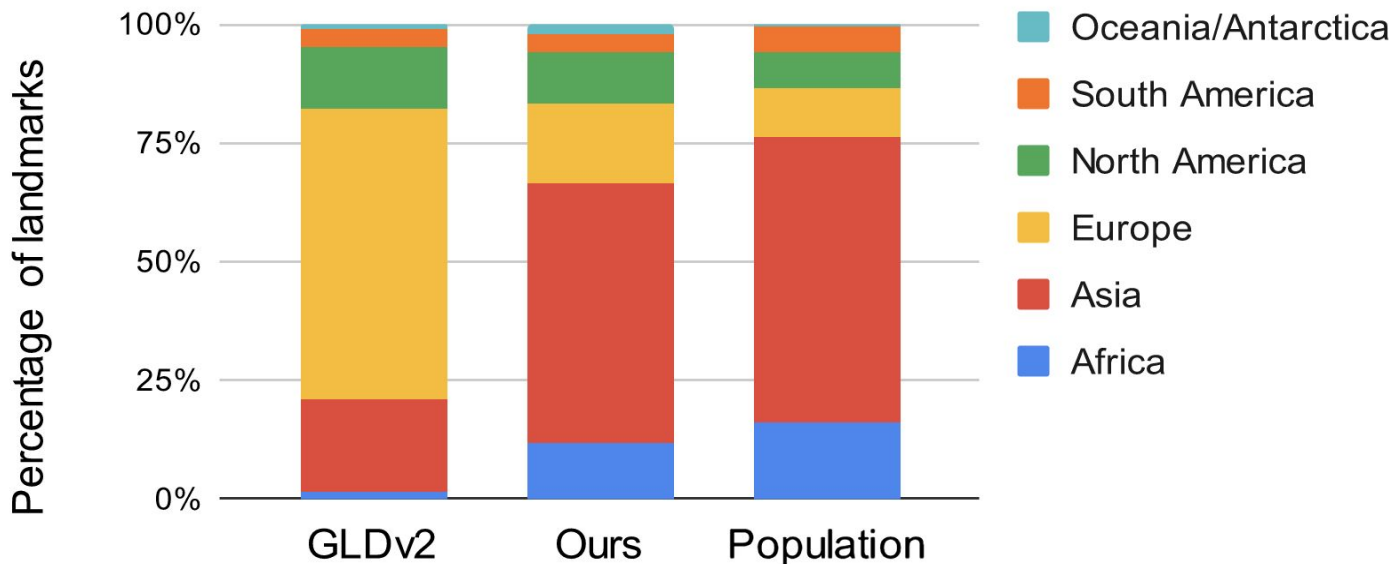
Effect of the Stratification

| Rank | Top-10 landmarks (Unstratified) | Top-10 landmarks (Stratified) |
|------|--|------------------------------------|
| 1 | Eiffel Tower (France) | Eiffel Tower (France) |
| 2 | Colosseum (Italy) | Masjid al-Haram (Saudi Arabia) |
| 3 | Trevi Fountain (Italy) | Taj Mahal (India) |
| 4 | Taj Mahal (India) | Al Masjid an Nabawi (Saudi Arabia) |
| 5 | Louvre Museum (France) | Louvre Museum (France) |
| 6 | Gateway Of India Mumbai (India) | Gateway Of India Mumbai (India) |
| 7 | Masjid al-Haram (Saudi Arabia) | The Dubai Mall (Arab Emirates) |
| 8 | Central Park (US) | Mysore Palace (India) |
| 9 | Mysore Palace (India) | Giza Necropolis (Egypt) |
| 10 | Walt Disney World [®] Resort (US) | Colosseum (Italy) |



Effect of the Stratification

Top-5000 landmarks: results are more aligned with the actual population



Datasets for Landmark Challenges

- Randomly resampled GLDv2 index and evaluation datasets using the landmark relevance as a sampling distribution
 - More images for more relevant landmarks
 - Long-tails are preserved
 - Additional images were downloaded from Wikimedia for underrepresented landmarks

| Landmark name | Relevance score | # of images in the eval dataset* |
|------------------------------|-----------------|----------------------------------|
| Giza Necropolis (Egypt) | ~0.000827 | 28 |
| Srikalahasti Temple (India) | ~0.000070 | 0 |
| Acuario de Veracruz (Mexico) | ~0.000056 | 3 |

*: example

Limitations

- Some of the potential sources of bias (e.g., internet proficiency, income level, ability to travel) were not addressed or only implicitly addressed through correlated variables (gender, age, and country)
- We may still not have enough landmarks in some of the underrepresented regions due to a lack of internet access and/or users in the region
- Relevance score may not be available for a highly relevant landmark due to various reasons including the incompatibility between Google Maps and Wikimedia

Future Work

- Arxiv paper: [Towards A Fairer Landmark Recognition Dataset, Kim et al, https://arxiv.org/abs/2108.08874v1](https://arxiv.org/abs/2108.08874v1)
 - Preparing for another publication with full details
- Generalize and apply the approach to generic object recognition

Thank you!
(Q&A?)

[Towards A Fairer Landmark Recognition Dataset](#)

[Z. Kim, A. Araujo, B. Cao, C. Askew, J. Sim, M. Green, N. F. Yilla, and T. C. Weyand](#)

<https://arxiv.org/abs/2108.08874v1>