Images-as-data:
An Intro to Computer Vision for Political Research

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Overview

- **Images and political research**
- **Studying images at scale: images-as-data**
  - Neural networks overview
  - Convolutional Neural Networks
  - Autotaggers
- **Applications of computer vision**
  - Transfer learning using social media data
  - Autotagger example
- **Conclusions**

Images-as-data

Why study images?

https://www.smithsonianmag.com/smart-news/woman-iconic-v-j-photo-died-age-92-heres-her-story-180960435/

https://www.npr.org/2010/01/18/122701268/i-have-a-dream-speech-in-its-entirety


Saul Loeb | AFP | Getty Images

https://www.cnn.com/2019/04/12/us/crying-girl-john-moore-immigration-photo-of-the-year/index.html

https://www.washingtonpost.com/national/biden-administration-directs-border-officials-to-suspend-horse-patrols-in-del-rio-migrant-camp/2021/09/23/dcfb30c2-1c93-11ec-914a-99d701398e5a_story.html

https://unsplash.com/photos/jSKjkV4Oc5Q

TL;DR:

Images are powerful tools that convey significant amounts of information

On the power of images...

- They convey messages in a powerful and immediate way (e.g. Barry 1997)
- People pay more attention to images (Dahmen 2012) and are processed more quickly than text (Graber 1990, 2012, Whitehouse et al 2006).
- Images evoke emotions that influence evaluations (e.g. Wright and Citrin 2011, Renshon et al 2015)
- Images can increase attention and online diffusion of political movements (e.g. Casas and Webb Williams 2018) and offline mobilization (Geise et al 2021).
- In multimodal environments, images and text have a symbiotic, mutually-amplifying relationship (Geise and Baden 2015; Lee and Ho 2018)

Previous limitations on studying images…

- **Image-based analyses are absent from political academic research, particularly on disinformation (Bucy and Joo 2021)**
- **Images are not easily studied quantitatively, but it's now possible**
    - Previous techniques for content analysis relied on hand-coding
    - With the growth in computing power, however, it is possible to use computational methods to analyze them at scale.

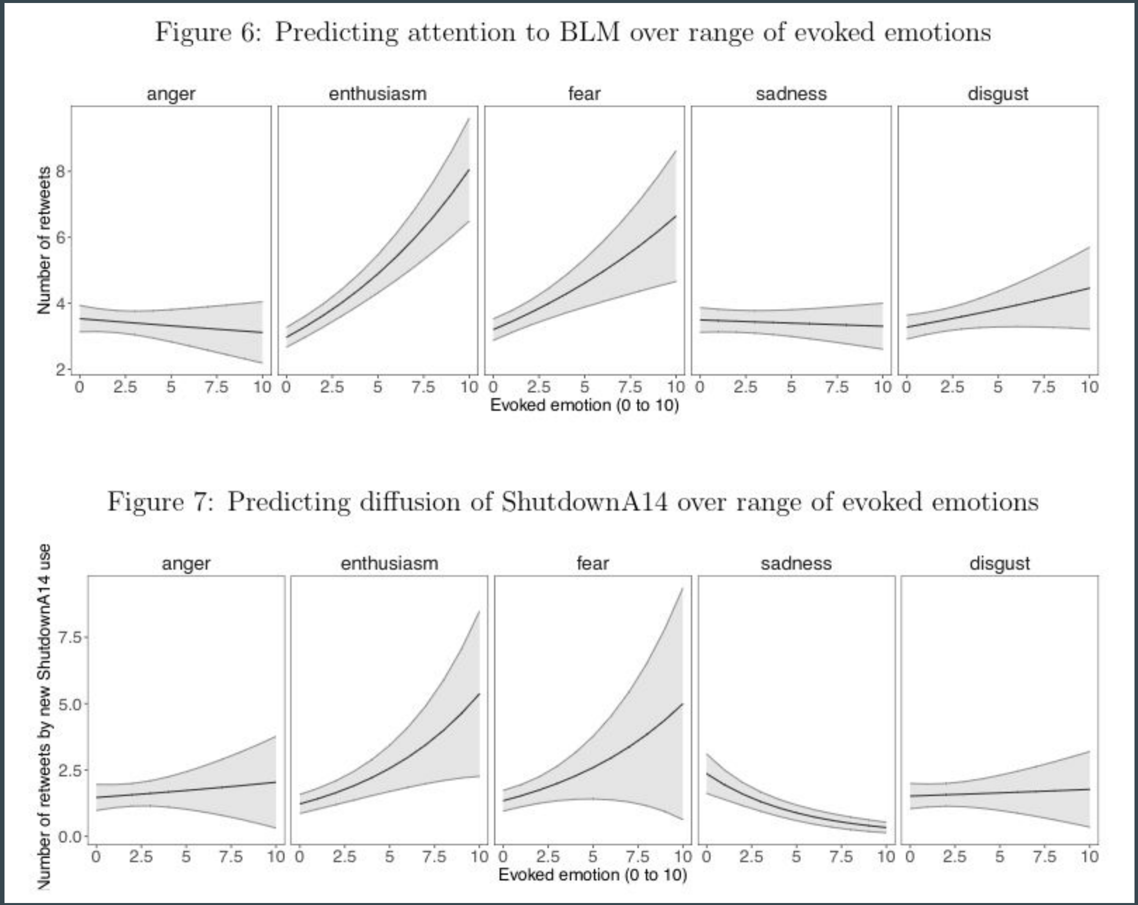
How can we study images at scale?

- **Images are easily accessible and collectable through APIs**
  - Using APIs allows users to collect data (example: Twitter)
  - One of the pieces of information that the old Twitter API provides is whether a Tweet contains an image and, if so, it provides a link through which the image can be downloaded.
  - Disclaimer: check with IRB before collecting any data!

Example on images: Casas and Webb Williams (2018)

- Study diffusion of Black Lives Matter online and the role of images
- They argue that images evoking anger, fear, and enthusiasm are mobilizing for online engagement
- But how do the authors get there?
    - Combining Twitter data with images-as-data strategy!
    - Authors coded ~9,500 images using undergrads and AMT workers to get labels based on emotions of interest, then analyzed the data

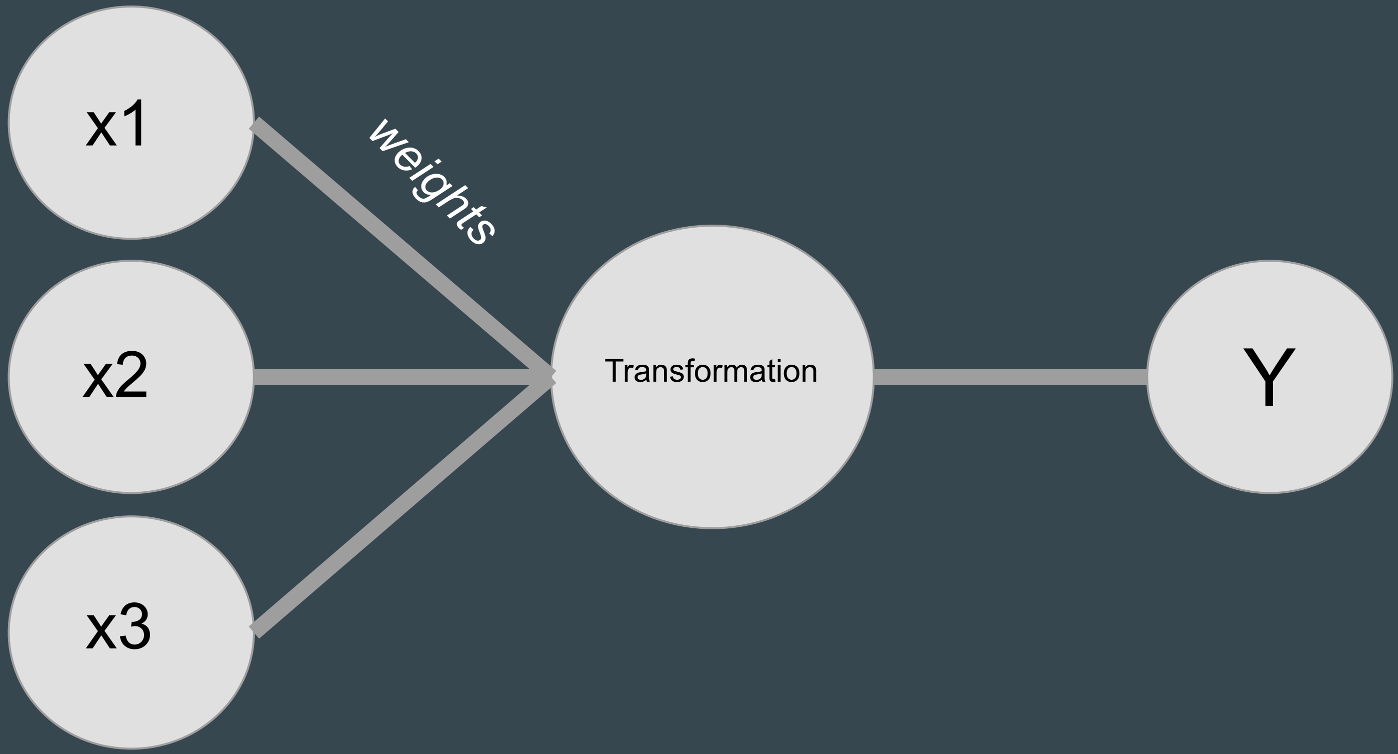
Example on images: Casas and Webb Williams (2018)



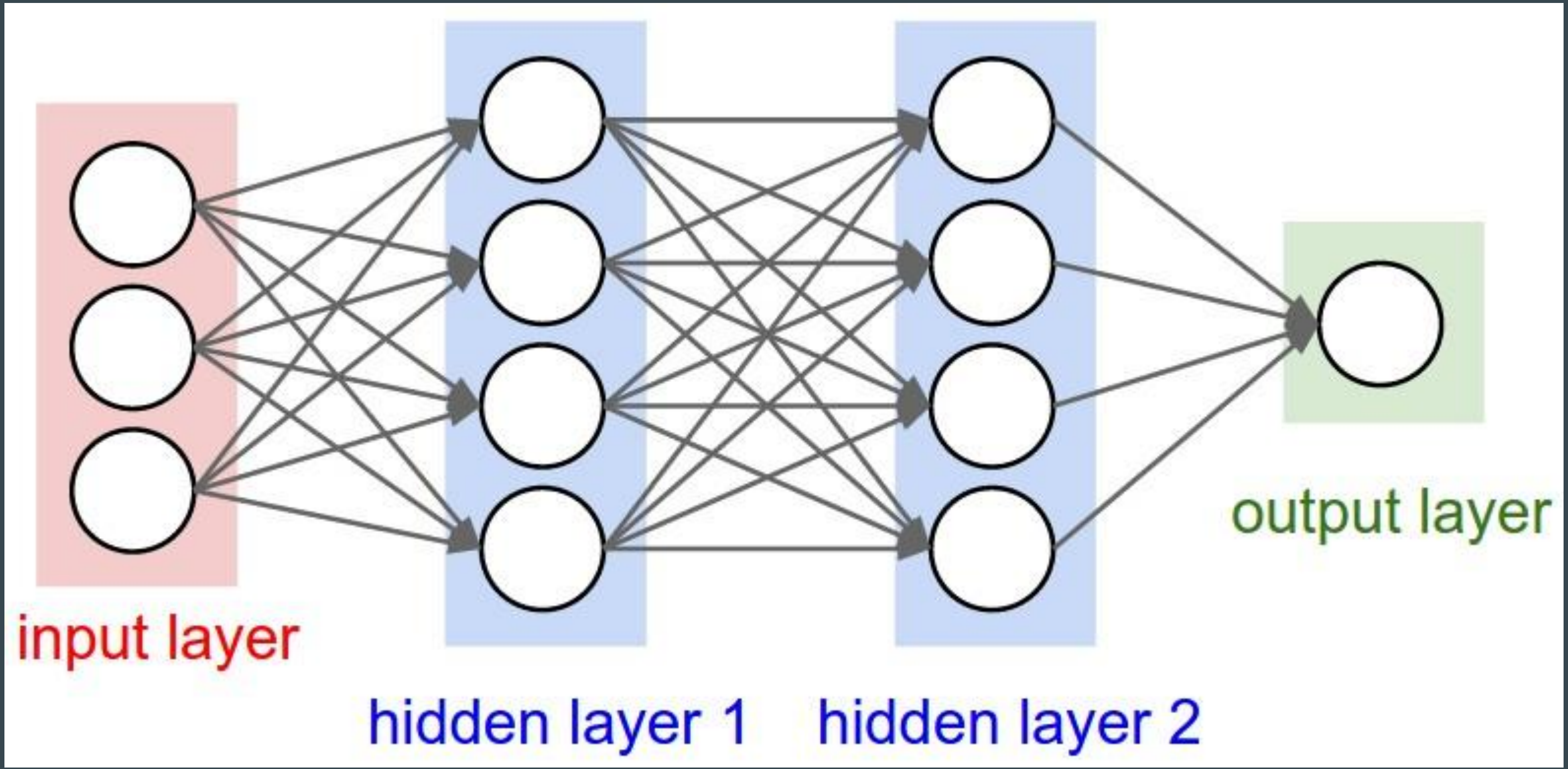
https://journals.sagepub.com/doi/10.1177/1065912918786805

Images at scale: Computer Vision Methods

Neural Nets Explained



Neural Nets Explained



http://cs231n.github.io/convolutional-networks/#layers

Neural Nets Explained

- **Neural networks use matrix algebra, with each layer being a vector that gets transformed until its final output.**
  - I'm not going to go deep into the math today, but more into the intuition and examples.
- **<u>Black Box</u>: The coefficients and results of internal layers are *not interpretable*, only the final prediction is interpretable**
- **These networks works like a human brain, learning from the data it is fed through a process called <u>training</u>.**

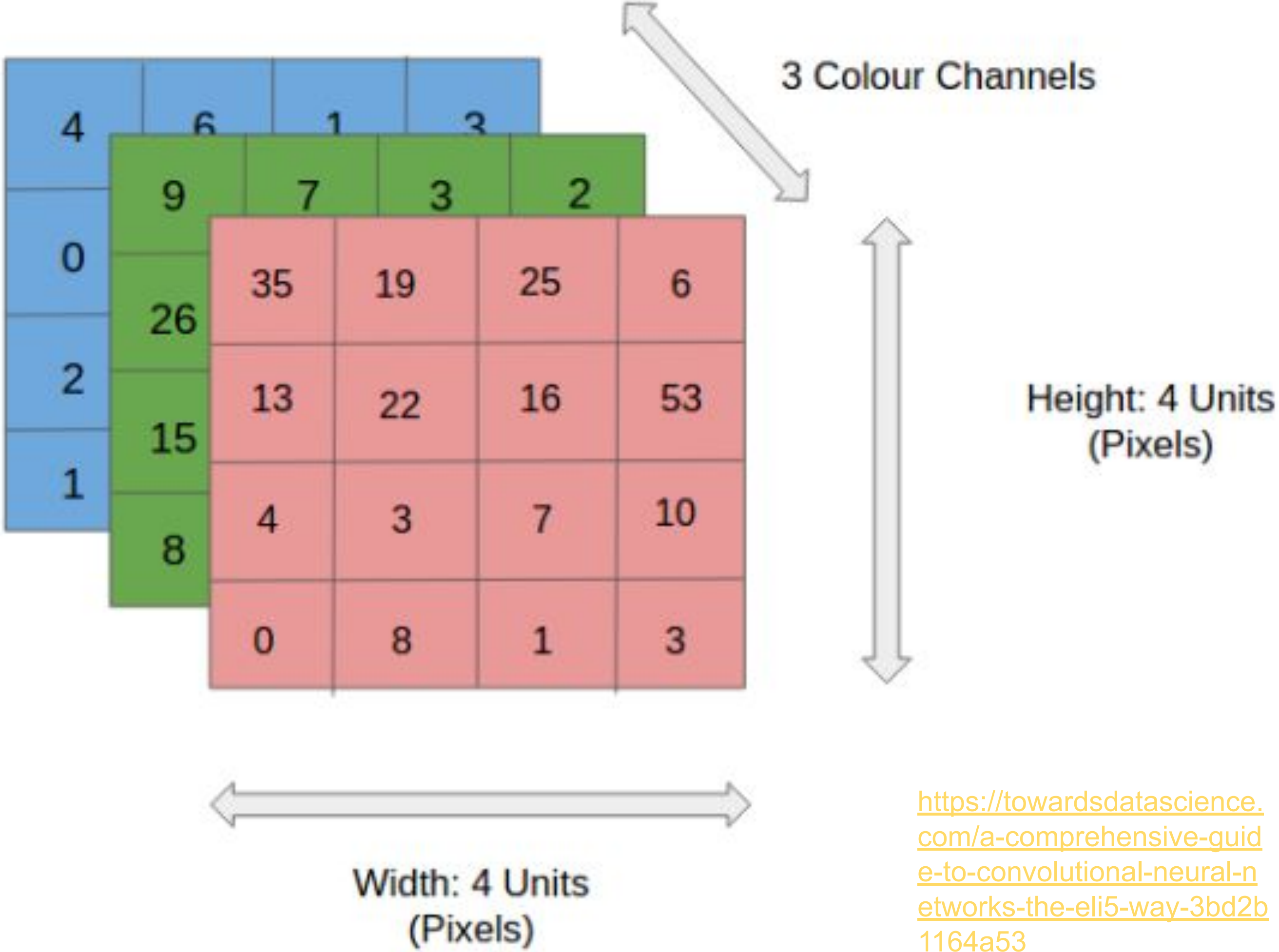
Training a neural net

- **Phases:**
  - Training
  - Testing
  - Validating
- **You will need:**
  - Training data that comes with labels
  - Testing data that comes with labels, held off from the network while it's being trained.

Example: Classifier about dog/cat text

- Let's say you have a classifier (neural net) that has been trained to recognize whether the subject of a text is a dog or a cat.
- A neural network accurately trained on enough textual data will be able to predict whether the following sentences fall into each of those categories:
  - *The dog ran through the backyard.*
  - *Free from his masters, the feline sits on his throne in the room.*
- This can also apply to pictures!

But images are a bit more complicated...



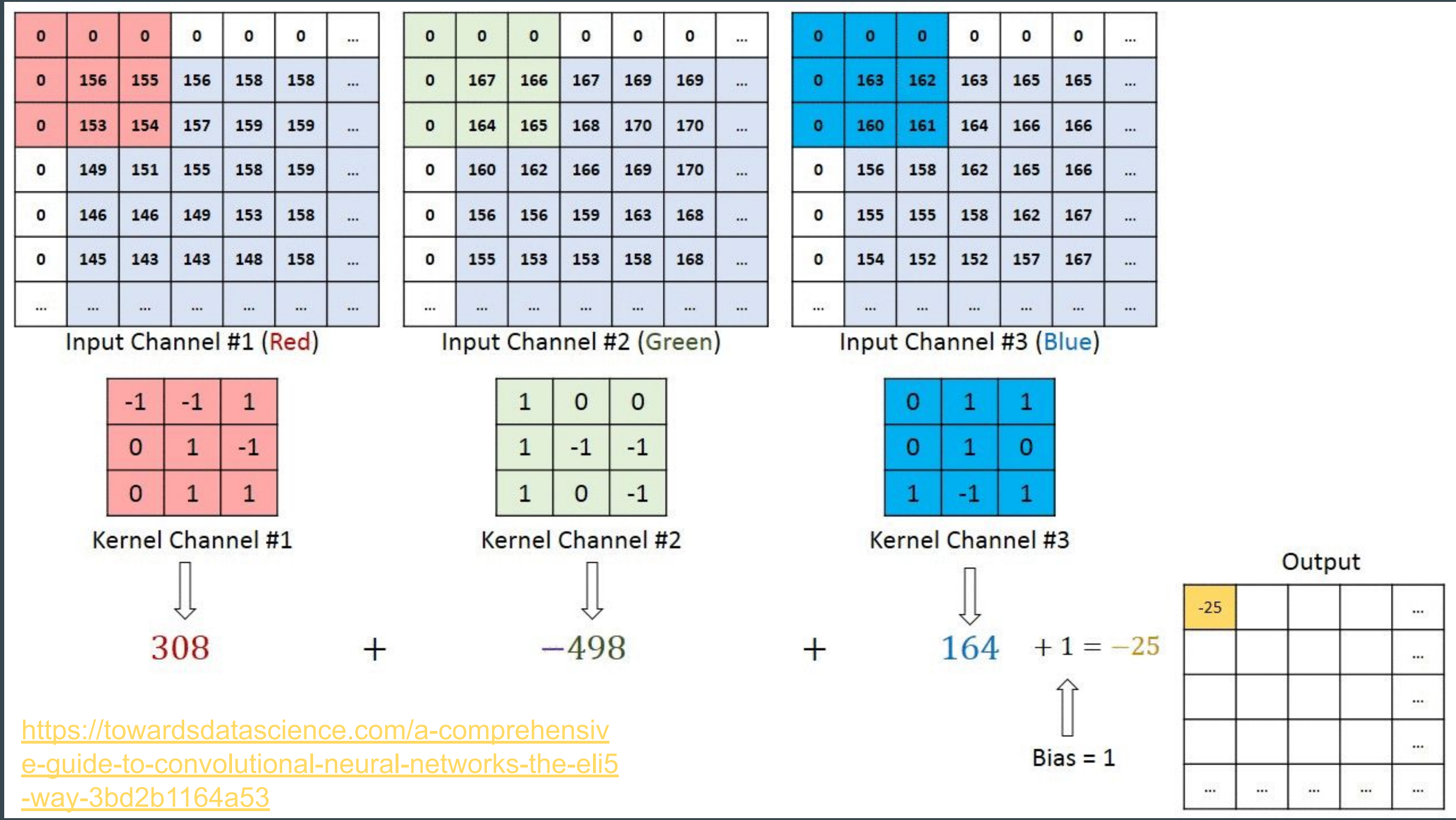
https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

Computer Vision

It's been applied before in academic research, and it is extensively used in industry

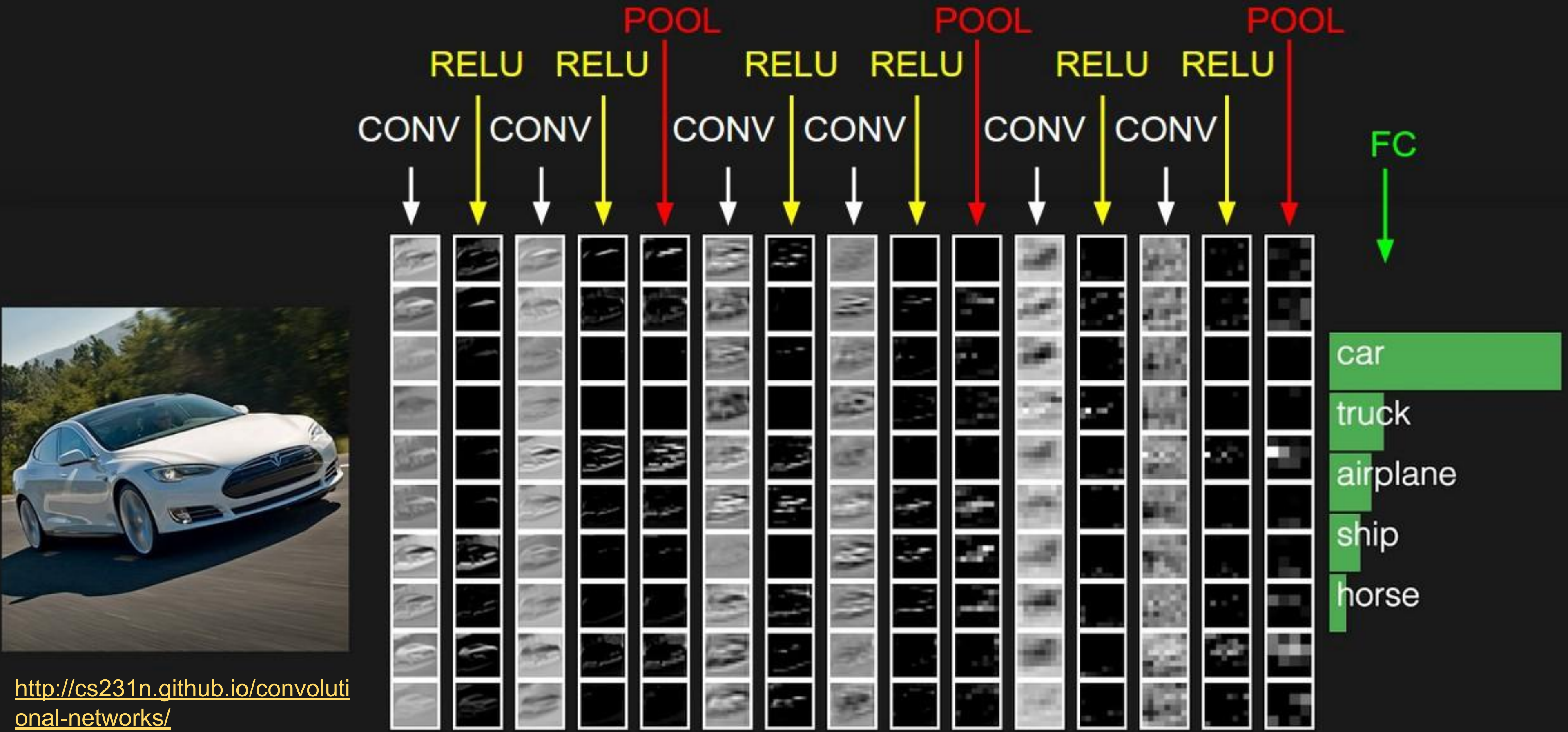
- Convolutional Nets are most often used!

Convolutional Neural Network: ReLu example



https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

Convolutional Neural Network



http://cs231n.github.io/convolutional-networks/

Tools that allow automatic analysis of images

- **Machine learning: convolutional neural networks (CNN)**
  - They are very hard to train and calibrate from scratch, need a lot of coded data to create a new one, and are time-consuming.
  - However, we can do transfer learning and re-train the last layer of a CNN that has already been trained so you don't have to do the entire process from scratch(e.g. ResNet18 or VGG16).
    - There are various tools -- pytorch, keras, tensorflow.

Application 1: Transfer learning on pictures from Venezuelan public officials’ Tweets*

* Proof of concept

Transfer Learning: Retraining ResNet 18 on political figures

- Tweets from 145 Venezuelan MCs in May 2019
- Randomly selected 1,000 pictures from these tweets.
- Retrained ResNet18 to recognize Nicolas Maduro, Juan Guaido, and crowds in these 1,000 pictures.

Transfer Learning: Retraining ResNet 18 on political figures

- Retrained ResNet18 to recognize Nicolas Maduro, Juan Guaido, and crowds.
- Training data (yes, hand-coded)
  - Maduro = 40 images
  - Guaido = 15 images
  - Crowds = 80 images

Transfer Learning: Retraining ResNet 18 on political figures

- Retrained ResNet18 to recognize Nicolas Maduro, Juan Guaido, and crowds.
- Testing data (yes, hand-coded too...)
  - Maduro = 10 images
  - Guaido = 10 images
  - Crowds = 10 images

Transfer Learning: Retraining ResNet 18 on political figures

- Retrained ResNet18 to recognize Nicolas Maduro, Juan Guaido, and crowds.
- Applying this retrained CNN on 1,000 pictures off Twitter.

Findings: The CNN became highly accurate in test data! (though I used very little test data, should have had more)

- Correctly recognized Guaido 10/10 times
- Correctly recognized Maduro 10/10 times
- Correctly recognized crowds 10/10 times

Examples: Guaido test data

Prediction = 0.9997

Prediction = 0.7103

Examples: Maduro test data

Maduro = 0.9978

Prediction = 0.9905

Findings: Retrained CNN processes 1,000 pictures

- Recognized Guaido 32% of the time
- Recognized Maduro ~ 1% of the time
- Recognized crowds as top category 67% of the time

Examples: OK predictions

Crowd = 1.00

Guaido = 0.42
Crowd = 0.54

Examples: Need more training!

INFORMACIÓN — EL NUEVO PAÍS — DOMINGO 02 de Abril de 2017 -- /3

Gracias Venezuela

HENRY RAMOS ALLUP

Sin Censura

***** El régimen inventó la artimaña de validar a los partidos políticos para obstaculizar las elecciones de gobernadores que ya debieron haberse realizado.**

Gracias, conciudadanos sin militancia partidista, por haber confiado en nosotros y participado en torrente validando a Acción Democrática que no es sólo de quienes militamos en este partido indestructible, sino pertenencia de la mejor Venezuela. Gracias a quienes, una vez más, depositaron en nosotros su fe por creer que somos un instrumento eficiente para salir de esta tragedia y lograr el futuro grande que nos merecemos. Gracias por su aliento y sus mensajes a los fraternos compañeros y queridos amigos de la diáspora que desde todo el mundo sienten y padecen la tragedia de la Patria adolorida cuya sanación depende de todos nosotros. Gracias a las mujeres y hombres de toda condición que hicieron filas interminables y pacientes en nuestra validación para expresar sus deseos de cambio democrático y progreso, iguales a las que hacen cotidianamente para adquirir los menguados alimentos y medicinas que se pueden encontrar. Gracias a nuestros críticos severos y de buena fe que hicieron un alto en sus reparos y vinieron a validarnos entregándonos una incomparable lección de respaldo y solidaridad. Gracias a quienes ni remotamente creíamos que podían validar por Acción Democrática y nos sorprendieron con su apoyo desinteresado. Gracias a los hijos, nietos y parientes de nuestros queridos fundadores desaparecidos que suplieron el vacío y multiplicaron su presencia. Gracias a nuestra maquinaria, silenciosa y eficiente, que sin recursos materiales pero con energía infinita, esparcida a lo largo y ancho de toda Venezuela, fue capaz de entusiasmarse y entusiasmar millares por encima de todas las desventajas y adversidades y sobre todo convencer que su bien ganada fama de equipo imbatible con mística, activismo, disciplina y organización hoy es capaz de repetir los prodigios que la hicieron mítica. Gracias a los activistas y sobre todo a los de la Juventud del Partido por haberse hecho cargo de lo más pesado y agobiante de la faena y haberle contagiado al evento la alegría y energía que los distinguen. Gracias a Venezuela que aceptó nuestro llamado a validar nuestro partido que es patrimonio nacional. Gracias a la inmensa mayoría de nuestros conciudadanos creyentes en la solución constitucional, democrática, pacífica y electoral a este inmenso drama que agobia a Venezuela y que por lo mismo rechazan las salidas de violencia a las que el gobierno nos quiere desviar.

De lamentar que se quedara sin validar una cantidad de personas quizás igual o mayor a la que pudo hacerlo, ya por el limitado número de máquinas captahuellas, por su forma de distribución, por las pocas existentes en los sitios en que eran presumibles mayores afluencias, por interrupciones en su funcionamiento por diversas causas y por los limitados horarios sin prórrogas. Quienes validamos por AD tuvimos disponibles menos máquinas y horarios más restringidos. No obstante, ahí están los resultados. Y ese es uno de los aspectos que demuestra la vocación antidemocrática del régimen: cuando se trata de ejercicios que le desagradan restringe, limita y complica todo.

Con este invento de la validación, el gobierno quiso por partida doble crear un obstáculo para diferir las elecciones de gobernadores ya vencidas desde hace cuatro meses y colocársela difícil a los partidos de oposición para, aunque parezca un contrasentido, ilegalizarlos legalmente. Pero el tiro va a salirle por la culata. Gracias Venezuela.

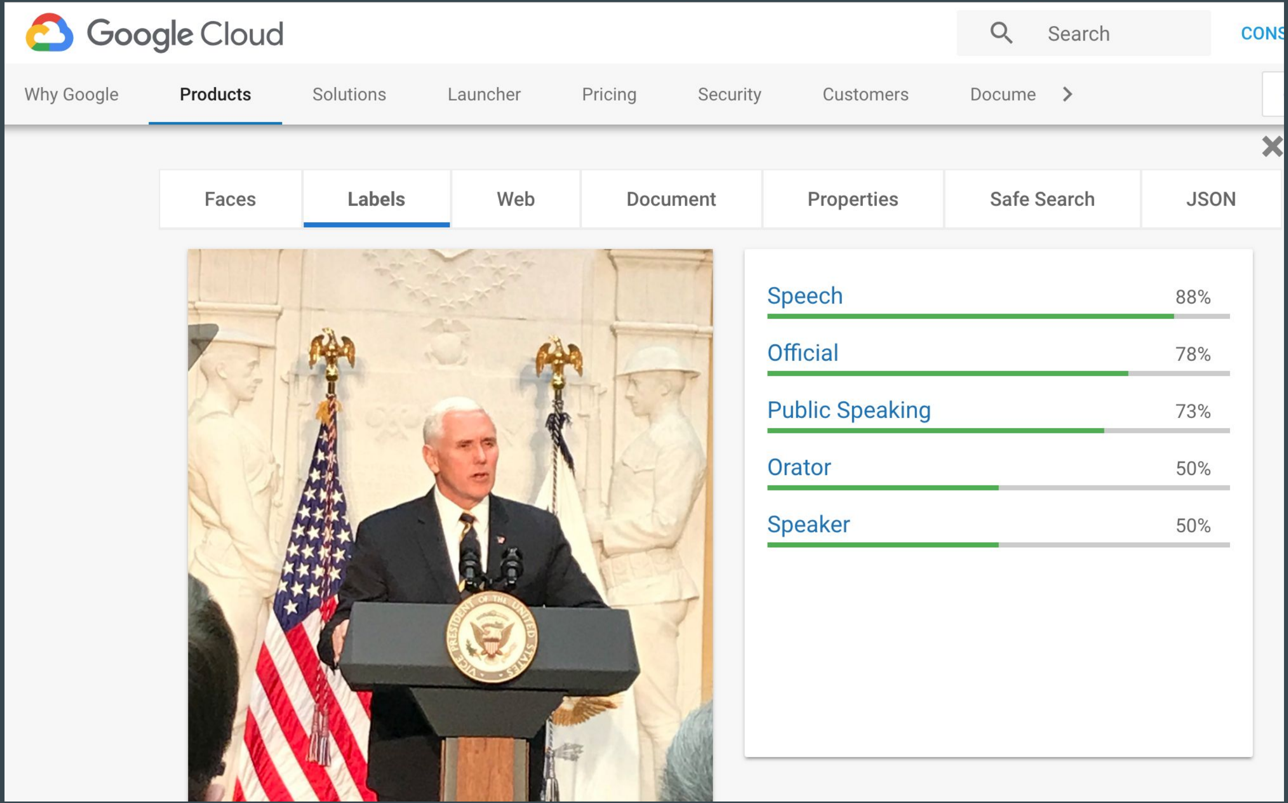
Guaido = 0.45

Guaido = 0.7029

Commercial Auto-Taggers: Potentials & Limitations

Tools that allow automatic analysis of images

- **Machine learning: convolutional neural networks (CNN)**
- **Commercial platforms like Google Cloud Vision API allows to**
    - Upload a picture,
    - Have the platform analyze it, and
    - Obtain labels (and more information) for the image.



An example of the Google Cloud Vision API (GUI)

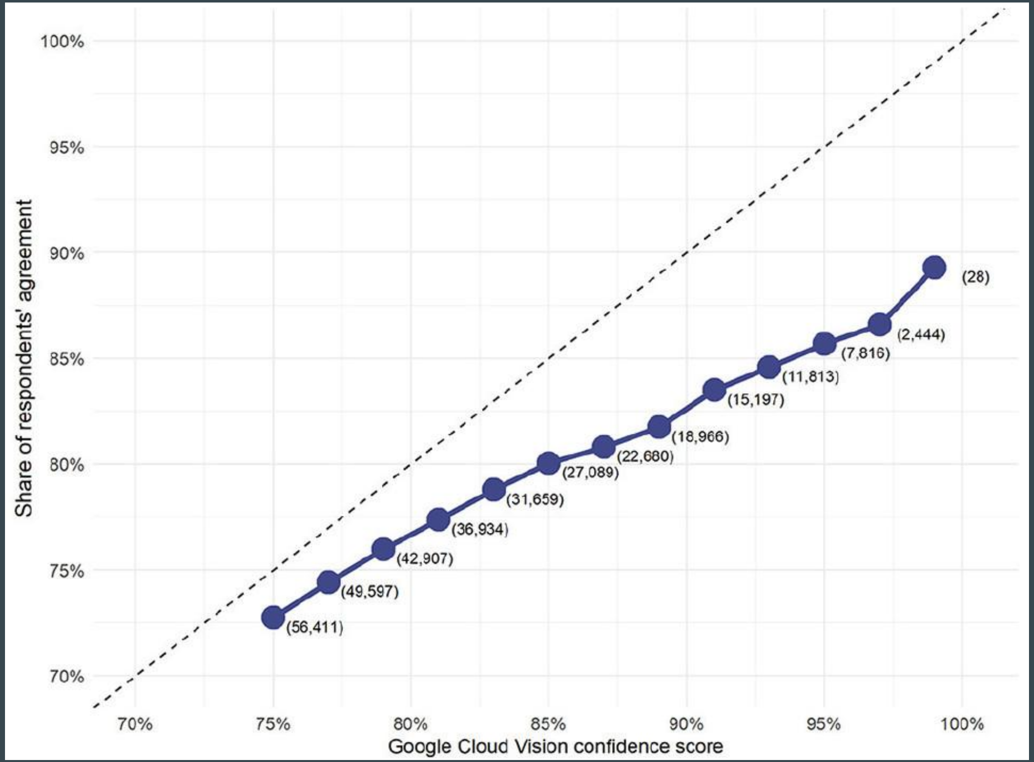
When you do this programmatically via API, you get usable data

	img_labels	img_values
1	senior_citizen, official, event, interaction, fun	0.9065596461296082, 0.7297561764717102, 0.71...
2	infrastructure, tree, walking, road, recreation, street...	0.8797321319580078, 0.8417906165122986, 0.70...
3	room, standing, furniture, electronic_device, technol...	0.8771613240242004, 0.7967374920845032, 0.79...

Google Cloud Vision in research

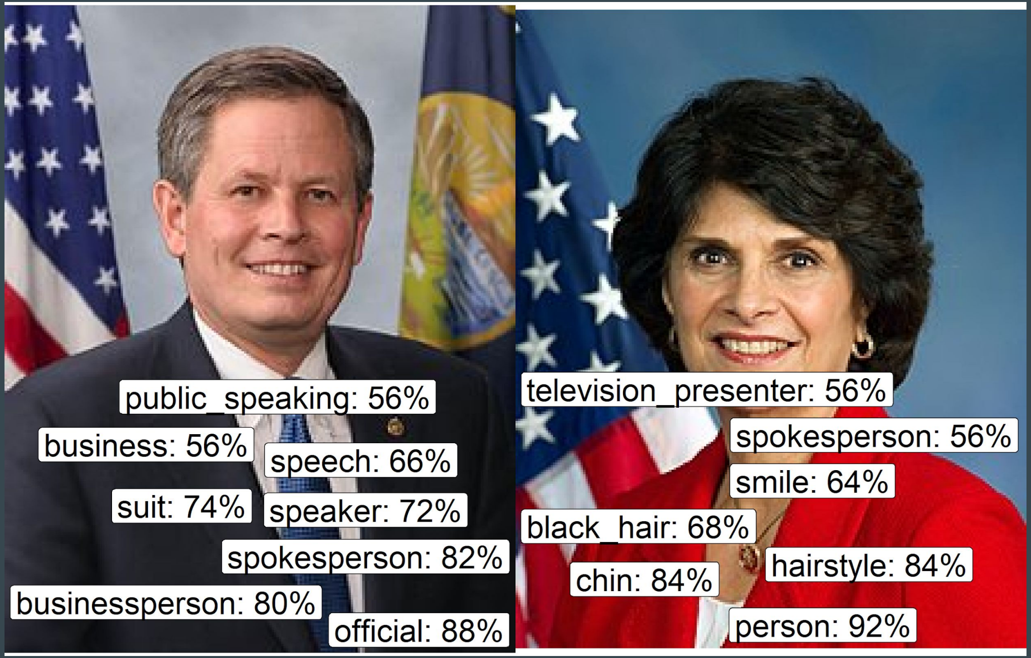
- **Few studies have looked into using Google Cloud Vision in research and found its accuracy being relatively close to that of human coders**
- **Bosch, Revilla, Paura (2018):**
  - Between 52.4% and 65.0% of the images were similarly codified by the Google Vision API and the human coder.
  - The API codified 1,818 images in less than 5 min, whereas the human coder spent nearly 35 hours to complete the same task.
- **Could political images also be accurately coded by the API?**

The good news: can agree with human coders quite a lot



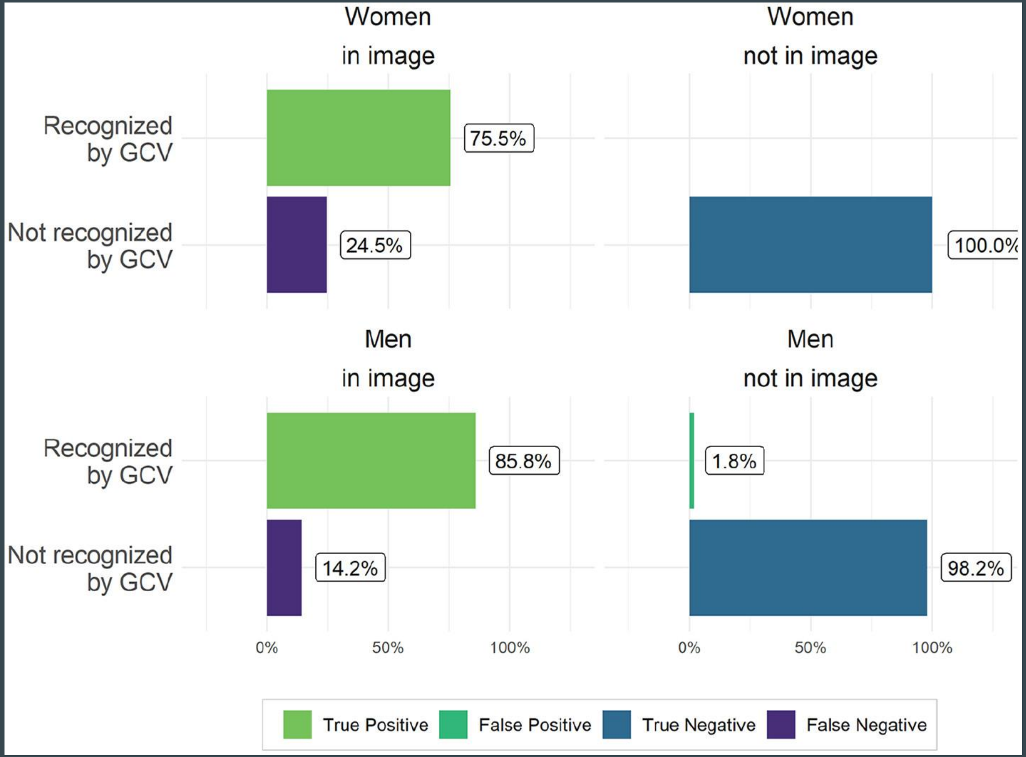
Analysis from Schwemmer, C., Knight, C., Bello-Pardo, E. D., Oklobdzija, S., Schoonvelde, M., & Lockhart, J. W. (2020). Diagnosing gender bias in image recognition systems. *Socius*, *6*, 2378023120967171.

The bad news: they can amplify biases that are hard-coded into the data to an extent that can be difficult to quantify



Example: headshots for Steve Daines (R, MT) and Lucylle Royball-Allard (D, CA-40), from Schwemmer, C., Knight, C., Bello-Pardo, E. D., Oklobdzija, S., Schoonvelde, M., & Lockhart, J. W. (2020). Diagnosing gender bias in image recognition systems. *Socius*, *6*, 2378023120967171.

The bad: GCV "sees" women in images at different rates...



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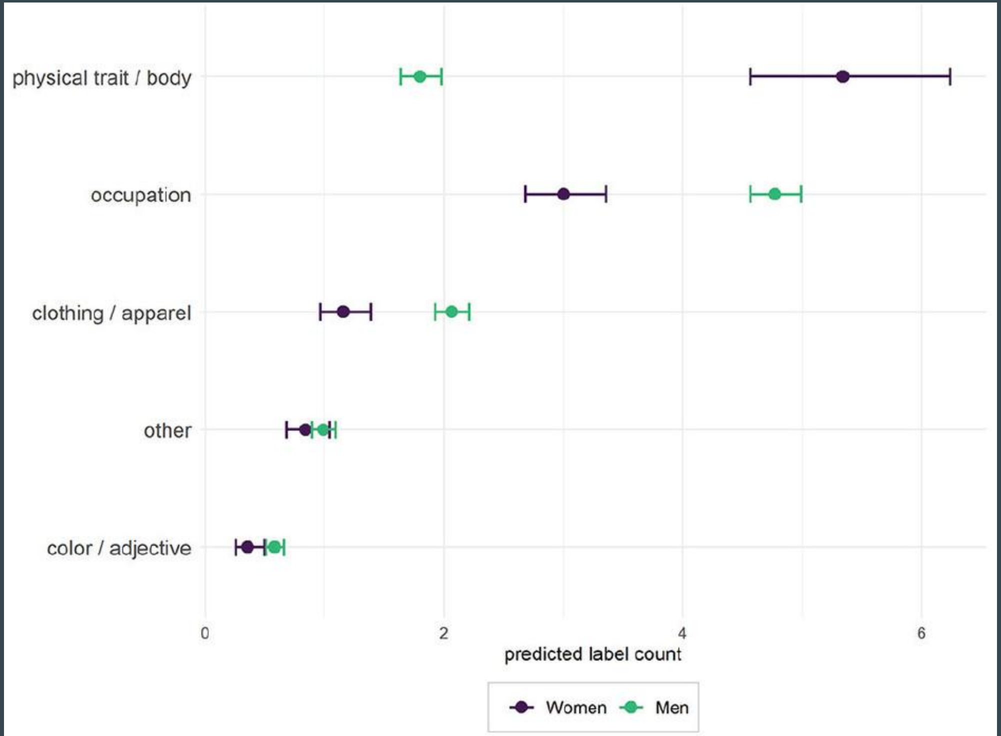
The bad: GCV is biased in the type of labels it gives images…



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<u>TL;DR:</u>

Use commercial auto-taggers at your own risk depending on your own goals and ideally understanding the kind of biases that could be baked into it

Conclusions

Recap

- Images-as-data is a very exciting new frontier in research with many interesting theoretical applications.
- You can use convolutional neural networks (especially transfer learning) to code images at scale
- You can also use commercial autotaggers but please be careful with those, as research has shown these could prone to significant biases.
- Think of the ethics of big data analysis before doing any of this (see *Bit by Bit* by Matt Salganik for further discussion)

More info...


Cambridge Elements
Quantitative and Computational Methods for the Social Sciences
Images as Data for Social Science Research
Nora Webb Williams, Andreu Casas and John D. Wilkerson

Thank you!

Questions? Feedback?

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