

Socially Responsible Facial Recognition of Animals

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Source for both: Fred and Helen Roberts

Facial Recognition: Law Enforcement, Medicine, Commerce

- Today, video analytics is dramatically changing policing.
- Law enforcement is collecting dramatically many videos, from:
 - Dashboard cameras
 - Body-worn cameras
 - CCTV cameras placed all over cities
- In my backyard: The New Jersey State Police receives 700,000 videos each year.
- Potential for tremendous benefits.
 - Protects citizens from excessive force by police or racial profiling
 - Protects police from unfair citizen accusations

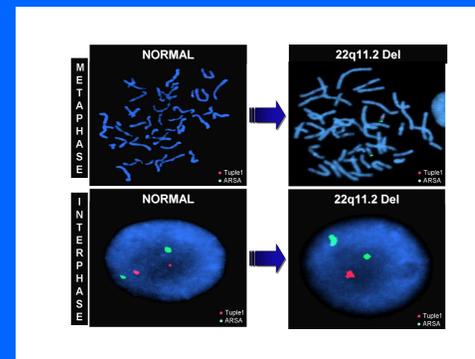


Source:
commons.wikimedia.org

Law Enforcement, Medicine, Commerce

- Tremendous benefits in policing:*
 - Police in New Delhi recently tried facial recognition technology and identified almost 3,000 missing children in four days.
- Tremendous benefits in medicine:*
 - Recently researchers used facial recognition to diagnose a rare genetic disease 22q11.2 deletion syndrome in Africans, Asians, and Latin Americans
 - Even doctors have difficulty diagnosing it in non-Europeans

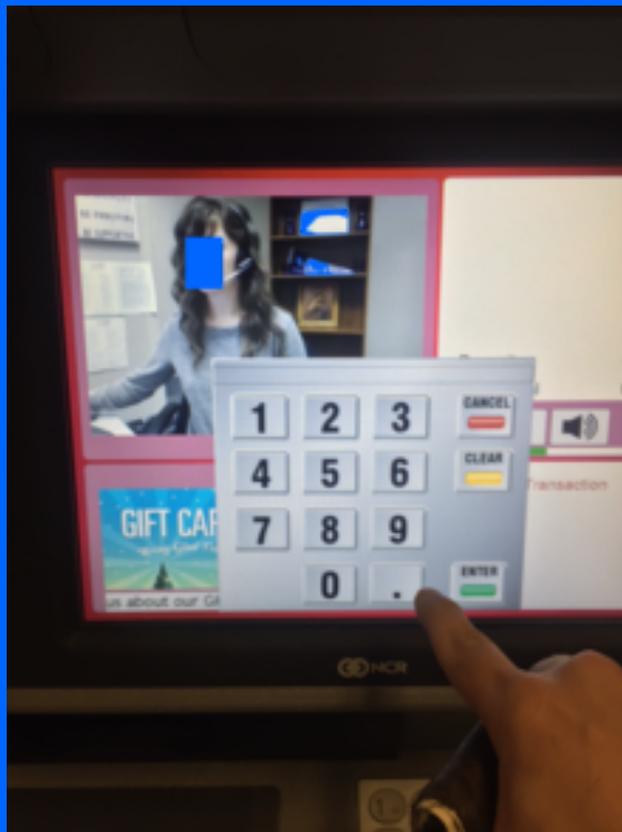
Source: Prof Victor Grech -
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<https://commons.wikimedia.org/w/index.php?curid=9836428>



Source:
commons.wikimedia.org

Law Enforcement, Medicine, Commerce

- Tremendous benefits in commerce:*
 - The National Australia Bank has piloted a system that allows customers to withdraw money from an Automatic Teller Machine with facial recognition and a pin.



Source: Wikimedia commons

Problems

- US government tests find even top-performing facial recognition systems misidentify blacks at rates five to 10 times higher than they do whites.*
 - Failure to detect dark-skinned pedestrians is of course an issue for self-driving cars



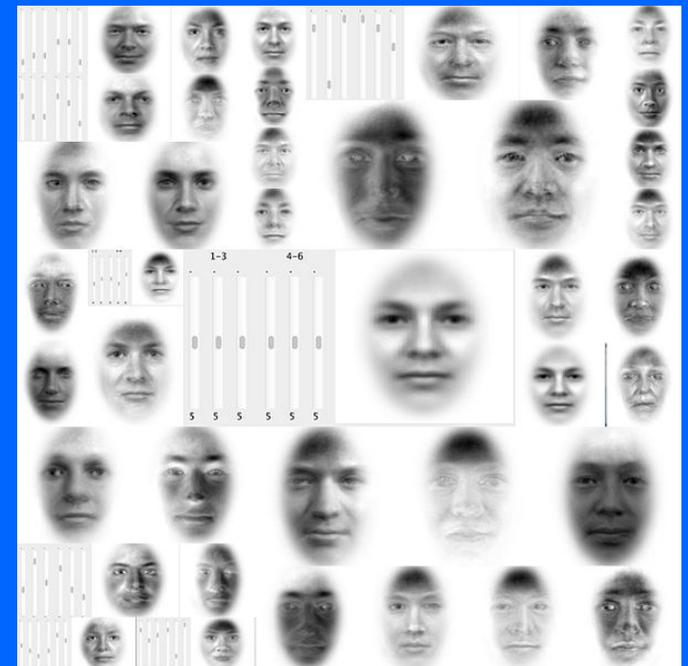
Source: https://commons.wikimedia.org/wiki/File:Google%27s_Lexus_RX_450h_Self-Driving_Car.jpg

*Wired.com: The Best Algorithms Struggle to Recognize Black Faces Equally

Problems

- French company Idemia's algorithms scan millions of faces in uses by police in the US, Australia, and France.*
- US National Institute of Standards and Technology showed that two of Idemia's latest algorithms were significantly more likely to mix up black women's faces than those of white women, or black or white men.*

*Wired.com: The Best Algorithms Struggle to Recognize Black Faces Equally



Source: https://commons.wikimedia.org/wiki/File:FaceMachine_screenshots_collage.jpg

Problems

- Machines taught by image-recognition software and photos can be sexist
 - In labeling, scenes such as cooking have tended to be associated with women and sports (or medicine) have tended to be associated with men, even when these labels were incorrect.*
- Amazon's "Rekognition" mistakenly identified 28 members of the US Congress as criminals.**

Source:

https://commons.wikimedia.org/wiki/File:3d_food_preparation_2.jpg

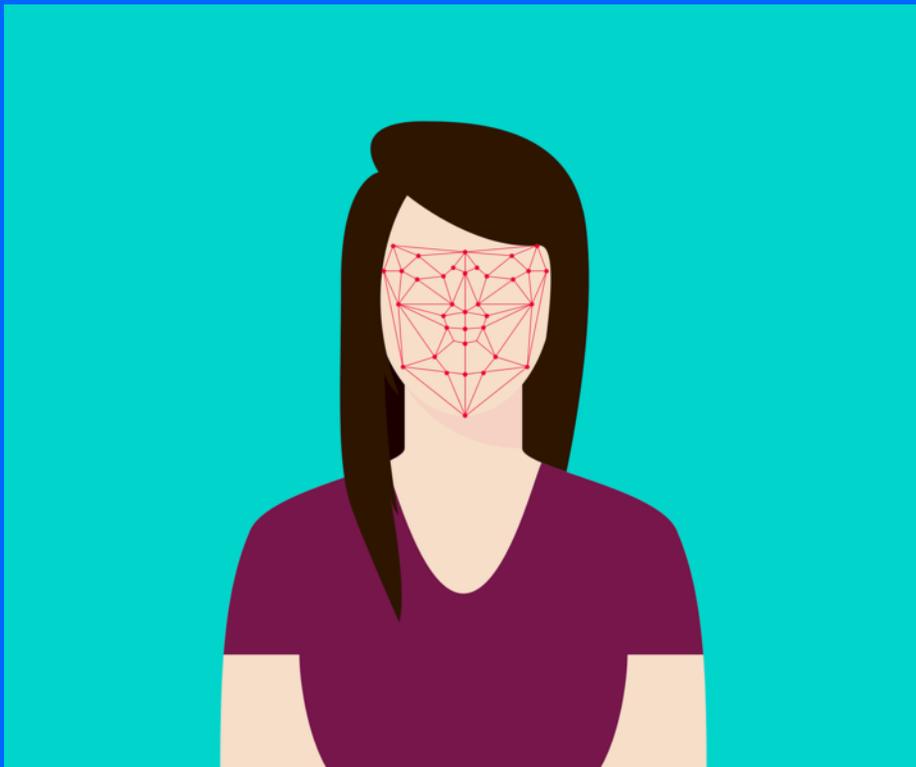


*Wired.com: The Best Algorithms Struggle to Recognize Black Faces Equally

**nymag.com/developing/2018/10/what-creatures-may-we-place-in-the-panopticon.html

Problems

- Such problems arise because the algorithms use data that may be biased, depending on racial and gender biases.
- These problems raise a variety of ethical and moral dilemmas: privacy, fairness, transparency, ...



Source: commons.Wikimedia.org

Facial Recognition of Animals

- Increasingly we are using facial recognition and video analysis to identify individual animals.
- They are used to identify diseases, protect against theft of animals, understand animal behavior, and to measure the biodiversity of ecosystems.
- Even to address world hunger.
- They have potentially major economic impact.



Source: commons.Wikimedia.com

Facial Recognition of Animals

- Do animals have rights and do those facial recognition algorithms violate those rights?
 - That is a major philosophical issue well beyond the scope of this talk.
- But could facial recognition algorithms for animals lead to injury to those animals in some way?
- Could they affect people involved with them as owners or in some other way, or as citizens of a common environment?
- Are there problems that might arise that require a socially responsible perspective?
- These are issues we will investigate.



Source: Fred Roberts

Three Problems with Face Recognition

- Microsoft* has identified three problems with regard to facial recognition that government needs to address:
 - “Especially in its current state of development, certain uses of facial recognition technology *increase the risk of decisions and, more generally, outcomes that are biased* and, in some cases, in violation of laws prohibiting discrimination.”
 - “The widespread use of this technology can lead to new *intrusions into people’s privacy.*”
 - “The use of facial recognition technology by a government for *mass surveillance can encroach on democratic freedoms.*”

The Need for Regulations

- Microsoft* has called for government regulations:
 - *Transparency*: companies offering facial recognition technology should provide documentation explaining capabilities and limitations of the technology in understandable terms.
 - *Third Party Testing*: companies should enable independent testers to test their technology for accuracy and fairness and publish their results.
 - *Privacy*: if facial recognition is being used (e.g., in a shopping mall), people need to be informed so they can “opt out.” (Europe is ahead of the U.S.)
 - *Protecting Individual Freedoms*: Governments should be restricted from ongoing surveillance of specific individuals except under specified circumstances (e.g., with court orders)
- Do such regulations make sense for animal face recognition? ¹²

Domestic Animals: Cattle Farming

- Number of farms is decreasing
- Number of cattle on each farm is growing
- Increasingly important to identify individual animals*,**
 - Health monitoring: preventing spread of disease (e.g. Bovine Spongiform Encephalopathy (BSE))
 - Adjust feeding to enhance milk production
 - Track food and water consumption
 - Tracking and registration of animals
 - Identifying missing or swapped animals (e.g., during large cattle movements)
 - False insurance claims



Cow with BSE

Source: commons.Wikimedia.org

* Kumar, et al., 2017, 2018; Jewell, et al.

**<https://www.bloomberg.com/news/features/2018-10-08/salmon-farmers-are-scanning-fish-faces-to-fight-killer-lice#skip-to-main-content>

Cattle Farming

- Ear tagging, microchip embedding are expensive and subject to damage or forgeries.
- So, enter AI.
- Cainthus, an artificial-intelligence startup based in Dublin, specializes in facial recognition for cows.
- It uses surveillance cameras, computer vision, and predictive imaging to track animals and analyze their behavior.*

Source: commons.Wikimedia.org



*New Yorker Magazine: Should we be Worried about Computerized Facial Recognition?

Cattle Farming

- But:**
 - Limited database of cattle faces (hundreds of thousands vs. millions for humans)
 - Facial recognition software for animals requires high definition photos and a variety of views
 - Animal faces require hundreds of reference points, many more than for humans



Source for both: commons.Wikimedia.org

**Wall Street Journal: Facial-Recognition Software Meets Its Match: Barnyard Animals

Cattle Farming

- So errors are more likely than for humans.
- Still: An independent component analysis (ICA) algorithm yields recognition accuracy of 86.95%*
- PCA-LiBSVM: 95.62% accuracy*
- ICA-LiBSVM: 95.87 % accuracy*
- Pretty good.
- Still: we have to weigh the accuracy with the cost of an error such as mis-identifying a cow as sick and leading to the cow being sacrificed.
- More on this later.



* Kumar, Kumar, Tiwari 2016

Source: <https://commons.wikimedia.org/wiki/File:Sweating-sickness-Zimbabwe.jpg>

Chickens

- Chinese insurance tech company ZhongAn Online is using facial recognition to identify and track organically farmed chickens.*
 - Using blockchain.
- You pre-purchase a chicken to eat.
- The software plus a GPS tracking bracelet allows you to follow the life cycle of your food.
- So far 100,000 chickens have been fitted with GPS trackers. Company expects to be up to 23,000,000 within three years.*



Source:
commons.Wikimedia.org

* <https://qz.com/1158236/the-gogo-chicken-program-in-china-is-adding-poultry-to-the-blockchain-with-facial-recognition/>

Chickens

- Thanks to facial recognition, you will be able to track your chicken and follow what they eat – so you feel safer that the chicken hasn't eaten something dangerous.*
- This became important in China after a 2014 incident in which a supplier provided spoiled meat to McDonald's and KFC.*



Source:
commons.Wikimedia.org

*<https://qz.com/1158236/the-gogo-chicken-program-in-china-is-adding-poultry-to-the-blockchain-with-facial-recognition/>

Pigs

- JD.com is China's equivalent to Amazon.com.
- It is using facial recognition to monitor large groups of pigs to quickly detect metrics like age, weight, and diet.*



Source: commons.Wikimedia.org

*<http://nymag.com/developing/2018/10/what-creatures-may-we-place-in-the-panopticon.html>

Sheep

- Assessing level of pain in animals is an important factor in assuring their welfare.
- Especially true for sheep.
 - Pain indicates potential diseases such as footrot and mastitis.*



Source:
En.Wikipedia.org



Source: teara.govt.nz

*Lu, Mahmoud, Robinson, 2017,
nymag.com/developing/2018/10/what-creatures-may-we-place-in-the-panopticon.html

Sheep

- The Sheep Pain Facial Expression Scale is a standardized measure to assess pain level based on facial expressions.*
 - Has been shown to recognize pain in sheep faces with relatively high accuracy.
 - But: training of scorers and the scoring process can be time-consuming.
 - Individual bias may lead to inconsistent scores

Source: commons.Wikipedia. org



- *Lu, Mahmoud, Robinson, 2017

Sheep

- Lu, Mahmoud, and Robinson have used computer vision techniques to automate the analysis of facial expressions in sheep.
- Their results are 67% accurate.*
- Is that sufficient?
- What if bias leads to false negatives and pain is not treated?



*Lu, Mahmoud, Robinson, 2017

Source: commons.Wikimedia.org

Farmed Salmon

- Norwegian Company Cermak Group AS has developed a 3D scanner that can tell salmon apart based on the distinct pattern of spots around their eyes, mouth and gills.*
- Goal: Prevent the spread of epidemics like sea lice that infect hundreds of millions of farmed fish and cost the industry almost \$1 billion each year.*



Salmon farm = Norway
Source: commons.Wikimedia.org

*<https://www.bloomberg.com/news/features/2018-10-08/salmon-farmers-are-scanning-fish-faces-to-fight-killer-lice#skip-to-main-content>

Farmed Salmon

- Plan: build a medical record of each individual fish.*
- Plan: If you see abnormality like lice or skin ulcer, you quarantine the fish for medical treatment.*
- The economic and food-supply implications of new “radical marine-farming methods” are great.*
- For instance, the aquaculture industry is already a \$232 billion industry.*
- And if it can become more efficient and ward off fish diseases, it could help feed the world.*

Diseased salmon
Source: en.Wikipedia.org



*<https://www.bloomberg.com/news/features/2018-10-08/salmon-farmers-are-scanning-fish-faces-to-fight-killer-lice#skip-to-main-content>

Dogs and Cats

- Facial recognition is used to find missing pets.*
 - Big problem. In US alone, over 4 million pets go missing each year.
 - Only small % are found, e.g., 2% of cats.
- Tags, tattoos, and microchips are all used for pet identification. But:
 - Tags fall off.
 - Tattoos get rubbed off.
 - Microchips move around an animal's body, making detection difficult.
- Enter facial recognition.*

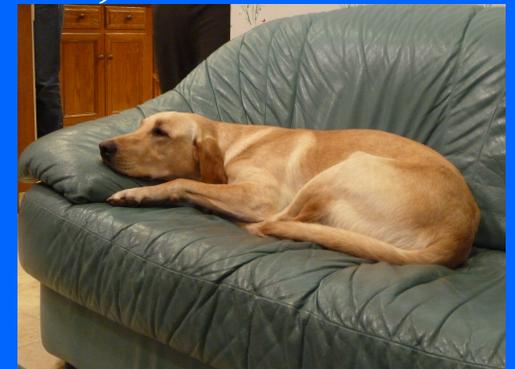
*<https://www.fastcompany.com/3020590/this-app-recognizes-your-pets-facial-features-to-find-them-when-theyre-lost>



Source: Fred Roberts

Dogs and Cats

- Facial recognition is more difficult for dogs and cats than for humans.*
 - Mouth, ears, nose are not always in same place as for humans.*
- Facial Recognition App called PiP.*
- You pay a monthly fee.
- You take a photo of your pet.
- If it goes missing, you send photo to vet clinics, animal shelters, municipal control officers, other PiP clients.
- The app does a facial match.
- The developers claim a 98% accuracy rate.



Source: Fred Roberts

*<https://www.fastcompany.com/3020590/this-app-recognizes-your-pets-facial-features-to-find-them-when-theyre-lost>

Animals: What Can Go Wrong with Facial Recognition?

- The potential dangers of using animal facial recognition algorithms include:
 - Physical injury to animals
 - Emotional injury
 - Disease spread arising from inaccurate identification
 - Miscalculation of animal population sizes
 - Economic loss from dependence on animal identification algorithms
- There is very little discussion of these potential dangers.

Source: https://commons.wikimedia.org/wiki/File:Singapore_road_sign_-_Warning_-_Danger.svg



Animals: What Can Go Wrong with Facial Recognition?

- One of the arguments for biometric identification methods for animals is that they are non-invasive and avoid the potential injuries from tagging, inserting microchips, etc.
- But could the efforts at face recognition, e.g., in the farmyard, cause some physical trauma?



RFID tag for animals
Source: commons.Wikimedia.org

Animals: What Can Go Wrong with Facial Recognition?

- What about emotional trauma?
- The literature shows that farm animals experience a wide range of complex emotions.*
- Emotions in animals lead to multiple behavioral and physiological changes.*
- Could face recognition in the farmyard lead to such changes?*



* Merino and Merskin, 2019

Angry cow

Source: [https://commons.wikimedia.org/wiki/File:Angry_Cow,_Slovenia_\(2893441048\).jpg](https://commons.wikimedia.org/wiki/File:Angry_Cow,_Slovenia_(2893441048).jpg)

Animals: What Can Go Wrong with Facial Recognition?

- Example: Fearfulness has been tested and reliably measured in sheep for decades.
- Fear in sheep is typically expressed by behaviors such as highly focused visual and auditory vigilance, immobilization (a “frozen” posture), fleeing/attempts to escape, and defecation.*
- There is even evidence that chronic stress leads to long-term fearful reactions in sheep. *



*Merino and Merskin, 2019

Source: https://commons.wikimedia.org/wiki/File:Defecating_sheep.jpg

Animals: What Can Go Wrong with Facial Recognition?

- Similarly, cows show a wide range of complex emotions, including distress and fear
 - Measured by nasal temperature, eye white visibility, ear posture, heart rate, and also defecation and vocalization.*
- Many studies demonstrate that chickens also experience a wide range of complex emotions, including fear.
 - With accompanying physiological reactions such as tachycardia and “body fever.”**



* Marino and Allen, 2017

** Marino, 2017

Animals: What can Go Wrong with Facial Recognition?

- Emotional contagion arises when emotional arousal (e.g., stress) in one animal arises from observing emotional arousal in another.
- This has been demonstrated in socially complex animals such as dogs, wolves, and great apes, but also in farmyard animals such as pigs.*
- Could the presence of cameras and people taking pictures cause distress, fear, emotional contagion or other reactions in animals?



Angry wolves

Source: [https://commons.wikimedia.org/wiki/File:Varg_fotograferad_pa_Polar_Zoo_Norge_\(32\).jpg](https://commons.wikimedia.org/wiki/File:Varg_fotograferad_pa_Polar_Zoo_Norge_(32).jpg)

Animals: What Can Go Wrong with Facial Recognition?

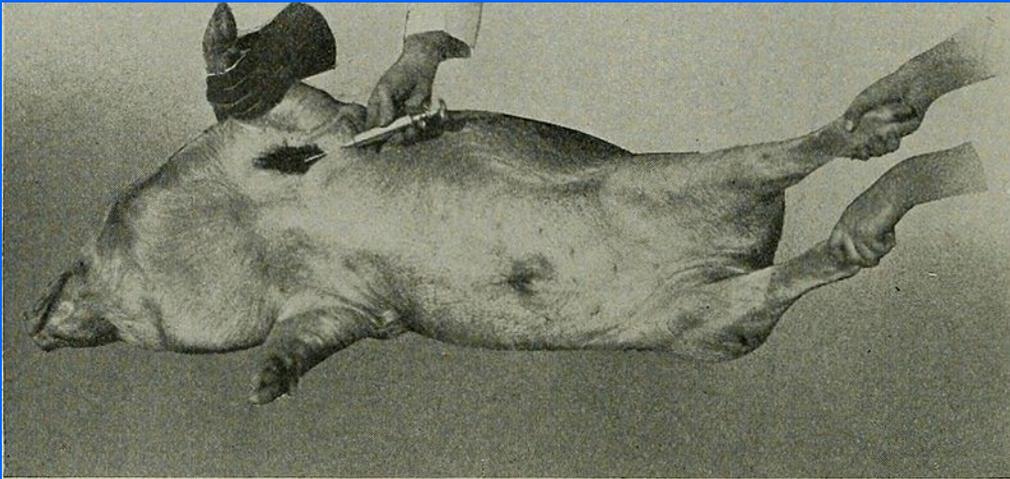
- What if a facial recognition system mis-identifies a cow, sheep, or pig as sick and the animal is sacrificed?
 - There is an economic consequence.
 - Are there fairness issues for the cows, sheep and pigs?
 - For the farmers?
 - Is this more likely to happen with certain kinds of farms than others?



Source for both:
[commons.Wikimedia.org](https://commons.wikimedia.org)

Animals: What Can Go Wrong with Facial Recognition?

- What if an algorithm identifies a cow, sheep or pig that is not growing fast enough or eating enough?
 - Could this cause you to change to a more expensive diet – in error?
 - Purchase medicine for the animal – in error?
 - Select the animal for slaughter too early – in error?



Animals: What Can Go Wrong with Facial Recognition?

- What if a facial recognition system mis-identifies a cow as yours when it is mine and I am jailed for stealing cattle?
 - What recourse do I have?
 - Is this more likely to happen with certain kinds of farms than with others?
- If you pre-purchase a chicken to eat and facial recognition software assures you it is healthy, when it is not:
 - How serious could the outcome be?
 - What is your recourse?
 - How likely is this to happen?



Animals: What Can Go Wrong with Facial Recognition?

- If a sheep is identified as not being in pain when in fact it is, what is the recourse?
 - How fair is that to the animal?
 - To the farmer?
- If it is identified as being in pain when in fact it is not, what is the recourse?
 - How fair is that to the animal?
 - To the farmer?



Animals: What Can Go Wrong with Facial Recognition?

- If you fail to identify a salmon with an infectious disease and the disease spreads rapidly, what is the recourse?
 - How fair is that to the fish that catch the disease?
 - To the fish farm owner?
 - Does this imply the need for a backup disease-ID system?
 - How we measure the expected cost of disease spread vs. cost of a backup system?



Salmon with gas bubble disease
Source: commons.Wikimedia.org

Animals: What Can Go Wrong with Facial Recognition?

- If you lose your dog or cat, what are the chances that a facial recognition algorithm will lead to the conclusion that your pet is not in a clinic when in fact it is?
- In this case, you have paid for protection for your pet and don't get it.
- *All of these issues suggest that in animal facial recognition, there are serious issues of social responsibility of algorithms.*
- *And serious roles for government regulation.*



The Need for Regulations

- Recall that Microsoft* has called for government regulations:
 - *Transparency*: companies offering facial recognition technology should provide documentation explaining capabilities and limitations of the technology in understandable terms.
 - Should apply to animal facial recognition too.
 - *Third Party Testing*: companies should enable independent testers to test their technology for accuracy and fairness and publish their results.
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The Need for Regulations

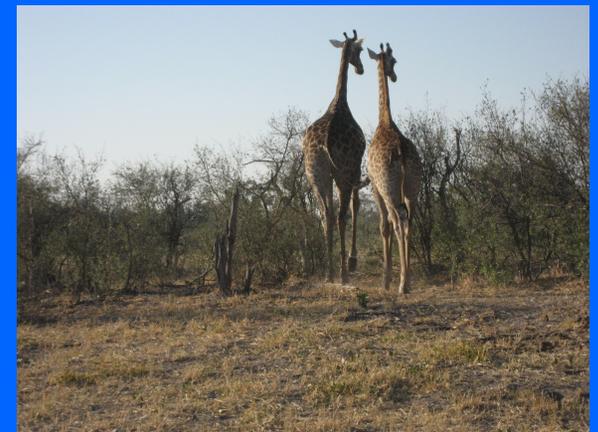
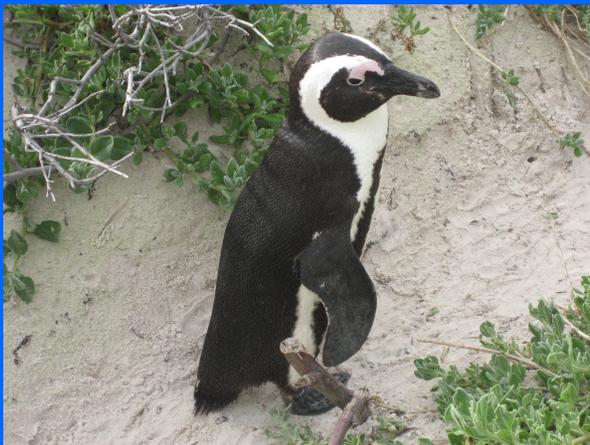
- Recall that Microsoft* has called for government regulations:
 - *Privacy*: if facial recognition is being used (e.g., in a shopping mall), people need to be informed so they can “opt out.”
 - Does this apply to animals?
 - *Protecting Individual Freedoms*: Governments should be restricted from ongoing surveillance of specific individuals except under specified circumstances (e.g., with court orders)
 - Does this apply to animals?
- But are there other regulations that would be appropriate for animal facial recognition?

The Need for Regulations

- But are there other regulations that would be appropriate for animal facial recognition?
- Probably the most important are to *ensure that methods used to get images of animals do not endanger those animals. And not frighten them.*
 - Are there physical risks to the animals?
 - Emotional risks?
 - For example: Salmon need to come up to the surface every four days or so to take a gulp of air. In salmon farming applications, the plan is to have them then go through a funnel fitted with sensors that would screen their face and body so records can be kept on each fish. Is this safe?***

What about Wild Animals?

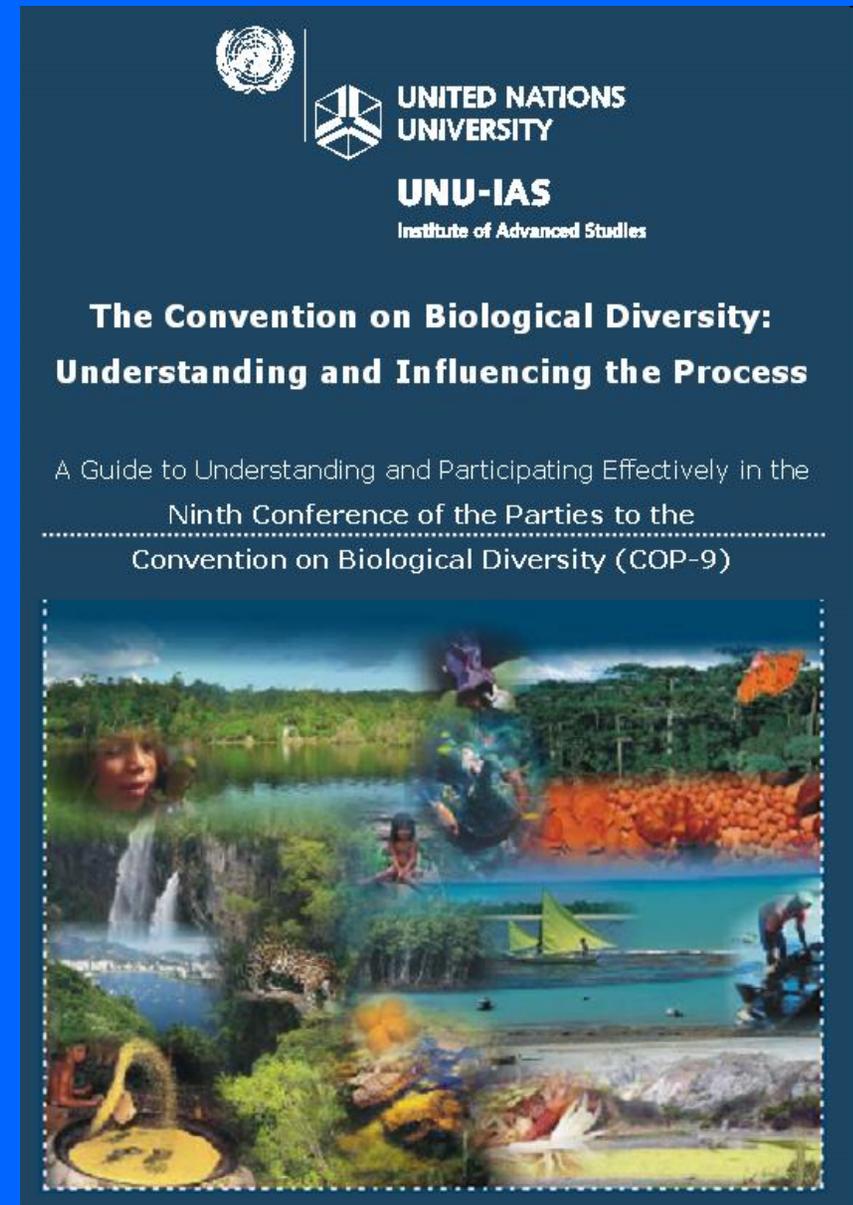
- Identifying individual wild animals is important in gaining insight into the changing biodiversity on the planet.
 - Identifying species helps determine presence or absence of certain kinds of animals in a region
 - Identifying individual animals helps in numbers and distribution of animals



What about Wild Animals?

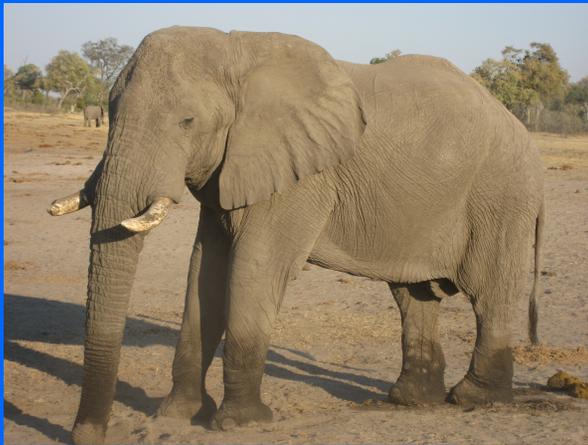
- International agencies and agreements concern regular updating in progress toward protecting biodiversity.
- But our current knowledge of both numbers and distribution of species is inadequate to support this task.
- Estimates of the total number of species on Earth range widely from around 2 million to 1 trillion.*

*Costello, et al 2012, Locey and Lemon, 2016



What about Wild Animals?

- Facial recognition and other biometric identification has started to be used.
- Mostly so far has emphasized “iconic species”:
Lions, Tigers, Elephants, the Giant Panda.



Sources:

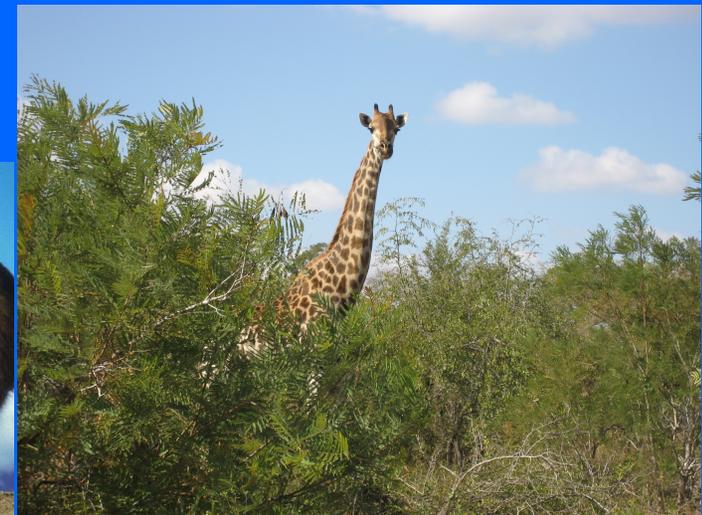
Elephants, lion: Fred Roberts

Tiger: [https://commons.wikimedia.org/wiki/File:Sumatran_Tiger_5_\(6964685356\).jpg](https://commons.wikimedia.org/wiki/File:Sumatran_Tiger_5_(6964685356).jpg)

Giant Panda: https://commons.wikimedia.org/wiki/File:Grosser_Panda.JPG

What about Wild Animals?

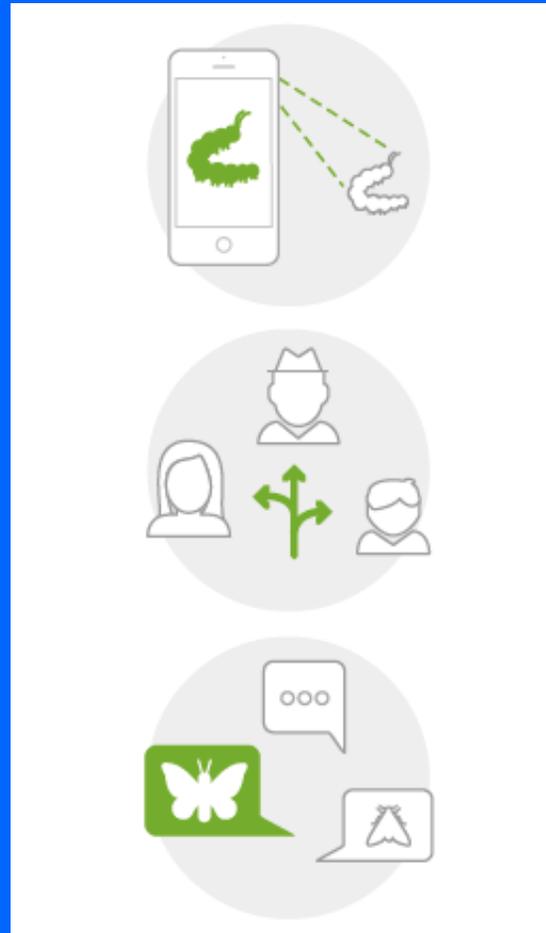
- Biometric identification has many advantages:*
 - Data can be collected without invasive intervention
 - Capture, tagging, instrumentation, ...
 - Can be collected by remote sensors, thus reducing field labor and cost
- Biometrics in use include not only face, but:
 - Body, fur, feather, or skin patterns
 - Footprint identification
 - Acoustic profiling



Source: Fred Roberts

What about Wild Animals?

- Crowdsourcing/citizen science has been widely used to identify species.*
 - *iNaturalist*: Users post pictures of plants or animals and a volunteer expert gets back with an identification.



Record your observations

Share with fellow naturalists

Discuss your findings

* Jewell, et al. to appear

Source: inaturalist.org

What about Wild Animals?

- Crowdsourcing/citizen science has been widely used to identify species.*
 - *Snapshot Serengeti*: Motion-sensor cameras (“camera traps”) have collected millions of images of lions, leopards, cheetahs, elephants. Volunteers label images manually.
 - 3.2 million images labeled by >50,000 volunteers, with 96.6% accuracy.



Snapshot Serengeti

Source: Snapshot Serengeti: www.zooniverse.org

* Jewell, et al. to appear

What about Wild Animals?

- Crowdsourcing/citizen science has been widely used to identify species.*
 - *Wildlife Spotter*: Collected millions of images of wildlife in Australia and asked citizen scientists to help analyze the images.

WILDLIFE SPOTTER

Help save threatened species and preserve Australia's iconic wildlife!

Become a citizen scientist and assist researchers by looking for animals in wilderness photos taken by automated cameras around Australia.

Anyone can join in and you can do it all online.

Source: Wildlife Spotter: volunteer.ala.org.au

* Jewell, et al. to appear

What about Wild Animals?

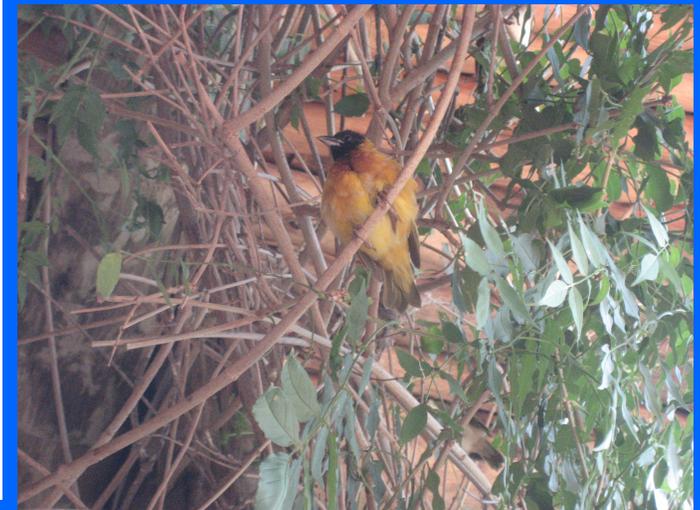
- Crowdsourcing/citizen science has been widely used to identify species.*
 - *Pi@nNET*: Uses crowdsourcing to collect images of plants and visualization software to recognize the plant photographed and link it to its plant library.
 - *Merlin Bird*: Cornell project that involves identification of more than 750 North American bird species.



Source: Fred Roberts



<https://merlin.allaboutbirds.org>



Source: Fred Roberts

* Jewell, et al. to appear

What about Wild Animals?

- Crowdsourcing/citizen science has been widely used to identify species.
- Citizens tend to take pictures in easily accessible areas and favor large, visible animals – so data are biased.
 - (Chen and Gomes developed a Shift Compensation Network that is used in machine learning; it learns the shift from scientific objectives to biased data and compensates by re-weighting the training data.)
- Social media allows people to tell others where an animal can be seen, leading to even more biased data.
- Using citizen science is slow and includes errors.

Source:

[https://commons.wikimedia.org/wiki/File:Scanning_the_cliffs_near_Logan_Pass_for_mountain_goats_\(Citizen_Science\)_\(4427399123\).jpg](https://commons.wikimedia.org/wiki/File:Scanning_the_cliffs_near_Logan_Pass_for_mountain_goats_(Citizen_Science)_(4427399123).jpg)



What about Wild Animals?

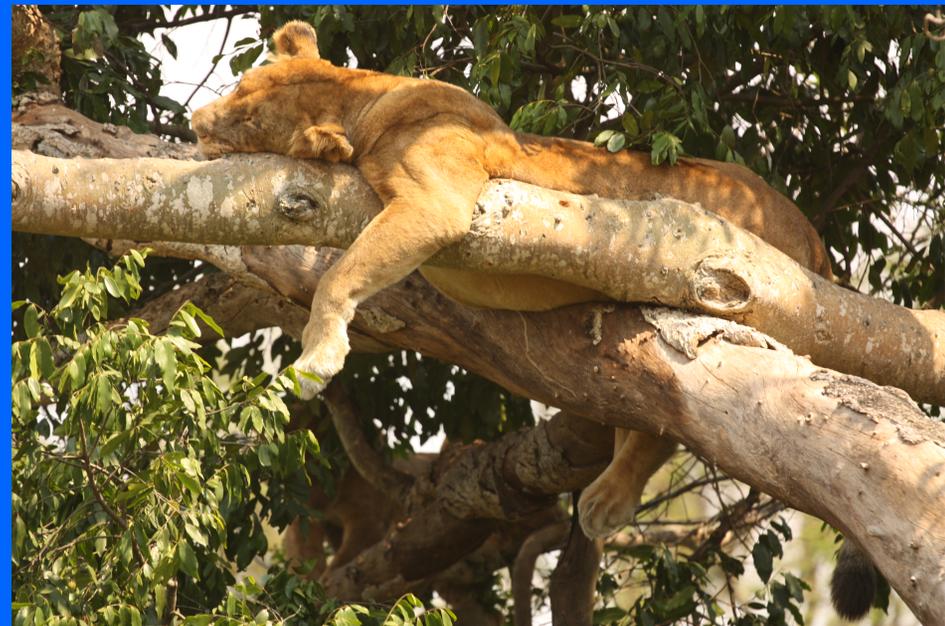
- And the data available have rapidly outpaced the number of human experts available to label it.
- Totally automated methods are needed.
- Facial recognition algorithms, and more generally biometric algorithms, are called for.
- Enter AI.
- *iNaturalist* has launched an app that uses deep learning and bypasses volunteer experts.*
 - App is trained on its huge database
 - Identifies unlabeled image.
 - Lists top 10 possible species.
 - Correct with top 10 77% of the time.

* Jewell, et al. to appear

What about Wild Animals?

- Enter AI.
- *Snapshot Serengeti* has launched an app that uses deep convolutional neural networks to identify and count species in its dataset of 3.2 million images.*
 - System is accurate 93.8% of the time.
 - (Their system also tells you what the animal is doing: eating, sleeping, etc.)

Source: Fred Roberts



* Jewell, et al. to appear

What about Wild Animals?

- *Wildlife Spotter* data have been used to automatically identify the three most common animals: bird, rat, bandicoot, from camera trap images.*
 - Used 80% of 44,536 images for training, 20% for validation.
 - 90% accuracy.

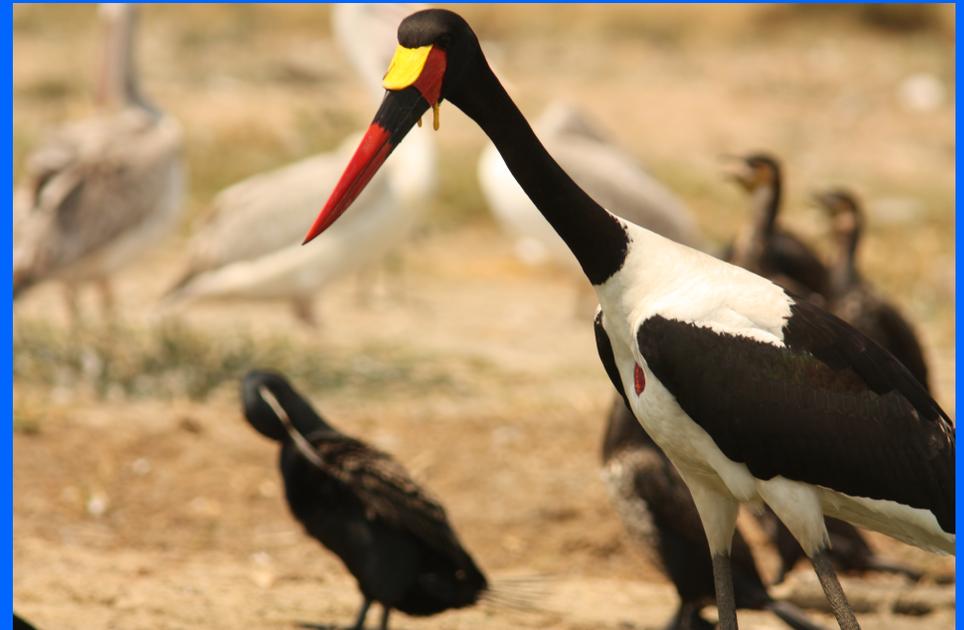


* Jewell, et al. to appear

Bandicoot Source: commons.Wikipedia. org

What about Wild Animals?

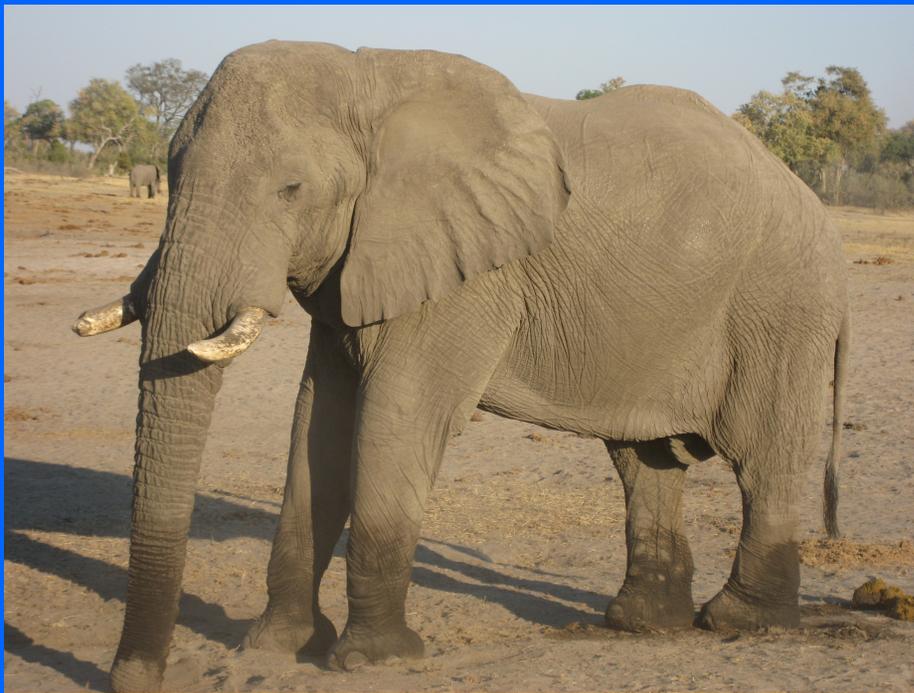
- *PI@nNet* has also developed an AI app, but it's not totally automatic: You have to show part of the flower on a plant.*
- *Merlin Bird's* AI app is also not totally automatic. You have to provide size and color of the bird.*



* Jewell, et al. to appear

Wild Animals: Elephants

- The London Zoo and Google are teaming up to use facial recognition to identify elephants in the wild and learn when they are in trouble.*
- Google's Photos app looks at human eyes, nose, and chin.
- It looks at elephant tusks, trunk, and tail.

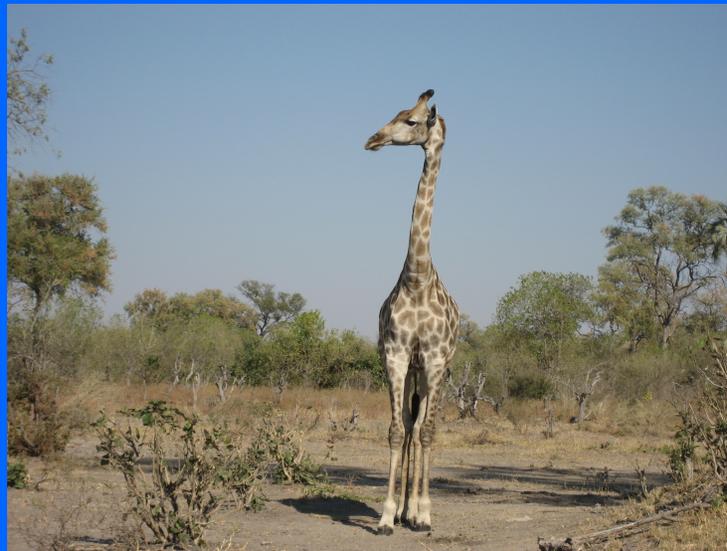
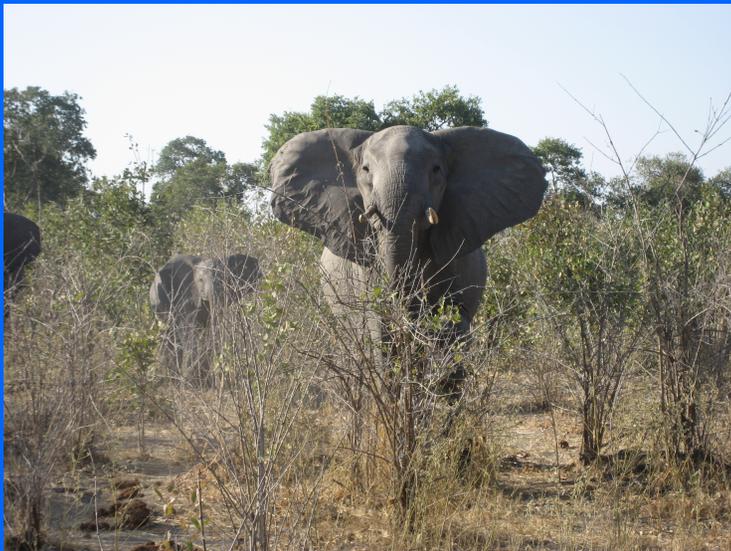


Source: Fred Roberts

*<https://www.standard.co.uk/front/london-zoo-trials-facial-recognition-technology-to-help-track-elephants-in-the-wild-a3747501.html>

Elephants

- Google's machine learning software Cloud AutoML Vision gets to "know" an elephant.
- If a human appears in a frame with an elephant, it could be a poacher, and a warning is sent out.*
- The zoo's 1.5M animal images were scanned into Google servers and aim to aid elephants, giraffes in Kenya, orangutans, stink badgers, pangolins in Borneo, etc.



Source: for both
Fred Roberts

*<https://www.standard.co.uk/front/london-zoo-trials-facial-recognition-technology-to-help-track-elephants-in-the-wild-a3747501.html>

Whales

- Deepsense.io has developed software that identifies individual “right whales”*
- You distinguish them through distinctive spots on their heads known as callosities, or “whale lice.”
- 87% accurate.*
- Even with a small dataset of 4,500 images.



Source: en.Wikipedia.org

*<https://fortune.com/2016/01/19/facial-recognition-whales/>

Whales

- Goal: Help whales tangled in nets.*
 - If crews could find out in real time what whale they're untangling, they'd know more about the individual's health, whether or not they should intervene and cut the rope.
 - Might even be able to better pinpoint problem areas in the ocean where multiple whales are getting tangled up with nets.

Source: Center for Coastal Studies



*<https://fortune.com/2016/01/19/facial-recognition-whales/>

Lemurs

- Most endangered mammal species
- Team at George Washington University developed a modified version of human facial recognition software to identify individual lemurs.*,**
- 97% accurate.
- Goal: enhance tracking and understanding of endangered species.*
- Previous efforts to track wild lemurs usually required researchers to trap and individually tag the animals.*



*<https://www.bbc.com/news/technology-39038939>

**Crouse, et al., 2017

Source: commons.Wikimedia.org

Lions

- The Kenya-based Lion Guardians has launched the Lion Identification Network of Collaborators.*
- Its database of ~1,000 lion profiles was built with facial-recognition software.
- Goal: Help conservationists better understand where lions find mates, water and prey; and changes to population dynamics caused by human expansion.



Source: Helen Roberts

Lions

- Previously, tracking efforts have used GPS transmitters:*
 - Expensive
 - Run out of batteries every one to three years.
 - Can be fitted only when an animal is sedated.
- Lion identification is harder than identification of tigers, leopards, cheetahs.*
- Spots and stripes make identification easier.*



Source for both: Fred Roberts

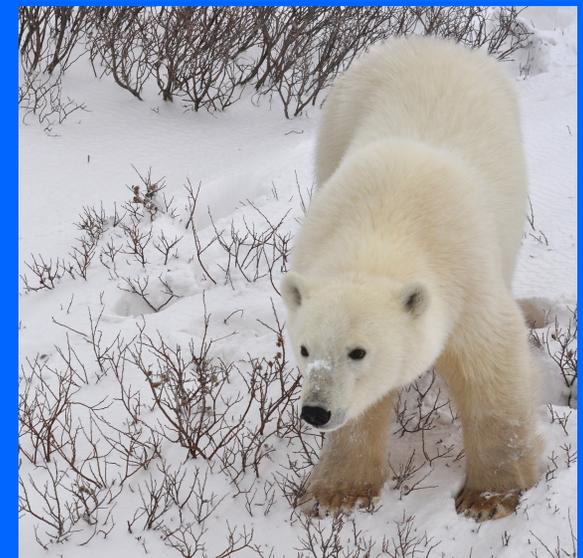
*<https://www.scientificamerican.com/article/lion-facial-recognition-debuts-in-africa/>

Sea Lions, Polar Bears

- Whisker pattern identification has been used for identification of individual large carnivores.
 - Australian sea lions *
 - Polar bears **
- Accuracy of identification depends on getting detailed images from suitable angles.
- This is a much more stringent requirement than demanded of regular camera trap images.

* Osterrieder, et al. 2015

** Anderson, et al. 2010



Source for both: commons.Wikimedia.org

What about Wild Animals: Problems

- For animal images collected by motion-sensor cameras:
 - Species or individuals tend to appear in similar habitats.
 - Computer-vision systems can fall into the trap of classifying by background rather than object of interest.
 - Some approaches, e.g., co-segmentation, aim to avoid this by automatically isolating the object of interest without manual input and before classification.

What about Wild Animals: Problems

- For animal images collected by motion-sensor cameras:
 - Faces or coats can be distorted by blood or mud.
 - Animals sometimes move rapidly, making images blurry.
 - Animals may be partly hidden by vegetation.
 - Lighting and time of day can affect camera images.

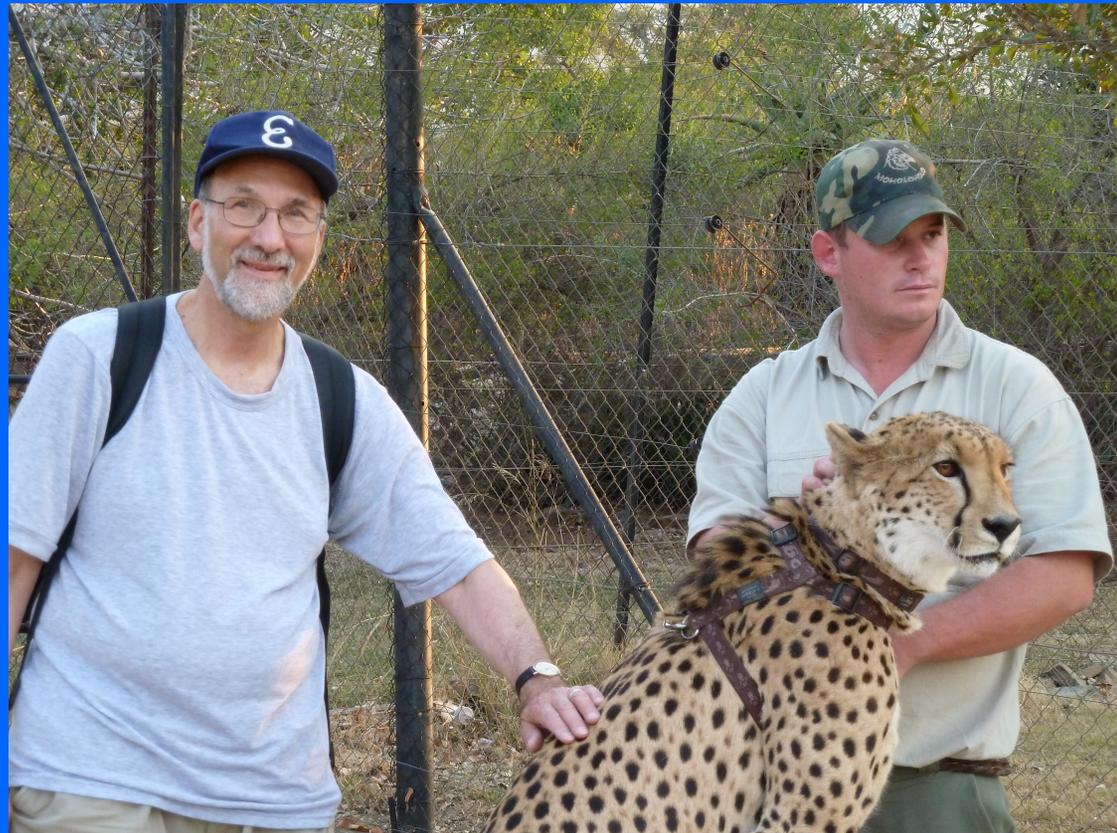
Source for both: Fred Roberts



What about Wild Animals: Problems

- Accuracy might be helped by studying animals in a private reserve, where we “know” the individuals.
 - Could lead to more reliable training data.
- Development of data quality indices will help rule out poor quality images.

Source: Fred Roberts



What about Wild Animals: Problems

- Accuracy in machine learning depends upon being able to obtain a sufficiently large training set.
- For some of the species of particular interest such as leopards and cheetahs, the number of individuals is relatively small.
- And they are distributed over a large area.
- So we just may not have enough data for training purposes.



Source: Fred Roberts

What about Wild Animals: Problems

- Identification of species or of individual animals of a given species is often aimed at understanding the population.
- But the count depends on the “sampling” procedure: the area sampled, the intensity of the sampling. (The distribution of motion-sensor cameras).*

*Boulinier, et al. 1998, Gotelli and Colwell, 2001, Soberon and Llorente 1993

Wild Animals: What Can go Wrong with Facial Recognition?

- Are there risks to animals from widespread use of motion-sensor cameras in the wild or entry into wildlife habitat where a sensitive species lives, in order to take photos?
- No cameras go completely unnoticed by animals, as the camera's flash is seen and the camera's ultrasound is heard.*

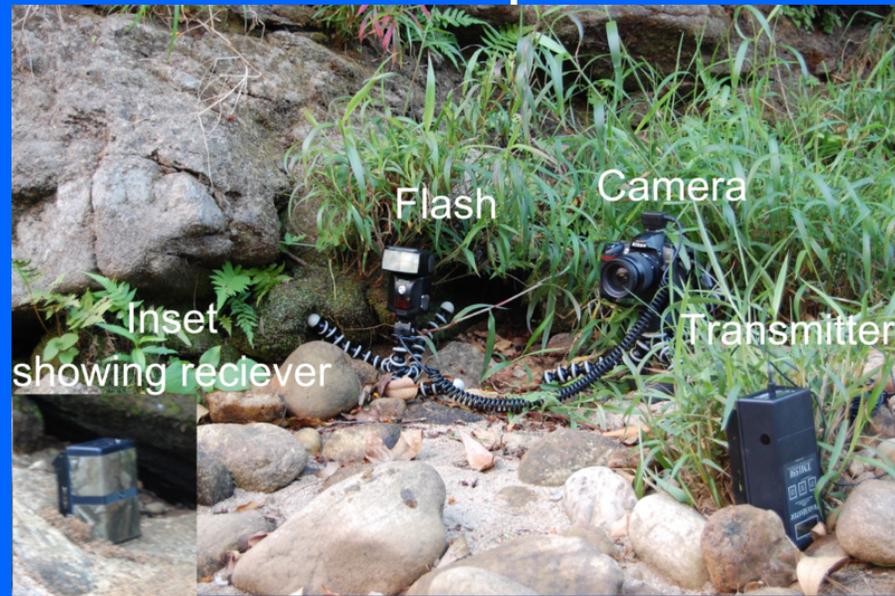


* Rovero, et al. (2013)

Source: https://commons.wikimedia.org/wiki/File:Camera_trap.jpg

Wild Animals: What Can go Wrong with Facial Recognition?

- Human presence to set camera traps, or simply walking along trails in undisturbed habitat, can change the behavior and distribution of sensitive species.*
- Is there the possibility of physical injury of some sort as a result of the use of camera traps?
- Emotional injury?

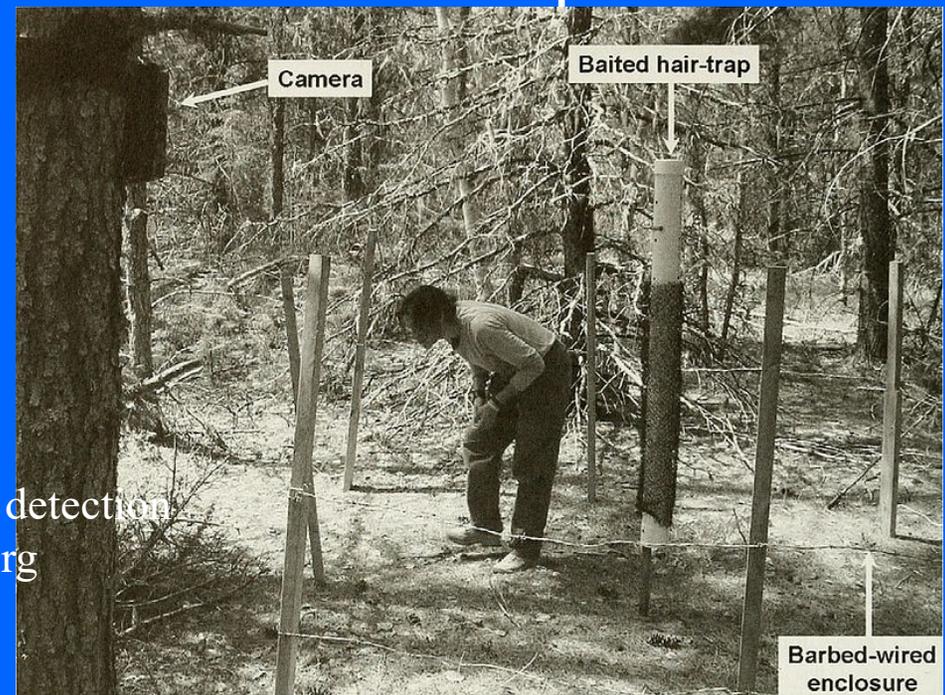


* Baker & Leberg, 2018

Wild Animals: What Can go Wrong with Facial Recognition?

- While many camera traps are placed randomly or at water holes or wildlife trails, some are placed at baited stations.
- Could the baited stations affect the health of animals in the wild?
- We know that just the presence of camera traps can attract or repel different species.*
- And surely presence or absence of bait does the same.

Baited Camera Trap for cougar detection
Source: commons.Wikimedia.org



*Meek et al 2016

Wild Animals: What Can go Wrong with Facial Recognition?

- If you miscount the population of leopards or lemurs in a given region because of human emphasis on certain areas or because of baited sites for camera traps or because of faulty algorithms, what are the implications?
 - Is there an impact on an endangered species?
 - Is there damage from an inaccurate assessment of biodiversity?
 - How do we minimize errors?



Source: Fred Roberts

Source: commons.wikimedia.org



Wild Animals: What Can go Wrong with Facial Recognition?

- If you are looking for elephant poachers and misidentify the elephant, what are the implications?
 - The poacher could kill the elephant.
 - Same if you identify the elephant correctly but miss the poacher.
 - This suggests backup systems.



Source: Fred Roberts

Wild Animals: What Can go Wrong with Facial Recognition?

- If a whale gets tangled in a net and you mistakenly identify it as a very healthy whale that should be able to untangle itself, what are the implications?
 - The whale could hurt itself
 - Are backup systems needed?
 - How do we measure the negative impact vs. the cost of such a backup system?
 - How do we design algorithms to minimize the probability of such errors?

Source:
[https://commons.wikimedia.org/wiki/File:Marine_organisms_entangled_in_a_ghost_net_with_in_the_Maldives_\(Olive_Ridley_Project\).jpg](https://commons.wikimedia.org/wiki/File:Marine_organisms_entangled_in_a_ghost_net_with_in_the_Maldives_(Olive_Ridley_Project).jpg)



Wild Animals: The Need for Regulations

- *All of these issues suggest that in wild animal facial recognition, as in domestic animal facial recognition, there are issues of social responsibility of algorithms.*
- *And roles for government regulation.*

The Need for Regulations

- Recall that Microsoft* has called for government regulations:
 - *Transparency*: companies (organizations) offering facial recognition technology should provide documentation explaining capabilities and limitations of the technology in understandable terms.
 - Should apply to wild animal facial recognition too.
 - *Third Party Testing*: companies should enable independent testers to test their technology for accuracy and fairness and publish their results.
 - Should apply to wild animal facial recognition too.

The Need for Regulations

- Recall that Microsoft* has called for government regulations:
 - *Privacy*: if facial recognition is being used (e.g., in a shopping mall), people need to be informed so they can “opt out.”
 - Does this apply to wild animals?
 - *Protecting Individual Freedoms*: Governments should be restricted from ongoing surveillance of specific individuals except under specified circumstances (e.g., with court orders)
 - Does this apply to wild animals?
- But are there other regulations that would be appropriate for wild animal facial recognition?

The Need for Regulations

- But are there other regulations that would be appropriate for wild animal facial recognition?
- Probably the most important are to *ensure that methods used to get images of wild animals do not endanger those animals. And not frighten them.*
 - There are risks from applying tags or microchips.
 - Risks are physical and emotional.
 - Are there similar risks from motion-sensor cameras?
 - From entering a given wildlife habitat where a sensitive species lives, in order to take photos?

Closing Comment

- Research on social responsibility of algorithms is taking off.
- The topic is of great interest in academia, government, and industry.
- *However, issues of social responsibility of algorithms related to animals, both domesticated and wild, is only in its most primitive state.*
- *These issues relate to possible injuries of various kinds to the animals.*
- *But more broadly to fair treatment of people interacting with the animals as owners or in other roles, or just as co-inhabitants of the same environment.*
- Much more thought needs to be given to the issues we have raised.