



Aalto University  
School of Science  
and Technology

# Multilabel classification through structured output learning

Hongyu Su

Department of Computer Science  
School of Science, Aalto University  
[hongyu.su@aalto.fi](mailto:hongyu.su@aalto.fi)

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# content

- ▶ machine learning
- ▶ single label classification
- ▶ multilabel classification
- ▶ structured output learning
- ▶ future work
- ▶ what can we do



# Example: dog vs. cat?

- ▶ We have 5000 pictures of dog and 5000 pictures of cat.



- ▶ Computer digitalize each picture into  $100 \times 100$  pixels.
- ▶ Given a new picture, we want to answer: is it a dog or a cat?
- ▶ Simple task for human, dog, or cat.
- ▶ Golle (2008) claimed this is a difficult task for machines with only 82.7% accuracy.
- ▶ In 2013, 98.5% accuracy was reported in a Kaggle competition (<https://www.kaggle.com/c/dogs-vs-cats>).

# Human verification system

- ▶ Is the human verification system safe from machine learning attack.
  - ▶ CAPTCHA vs. ASSIRA



Assira

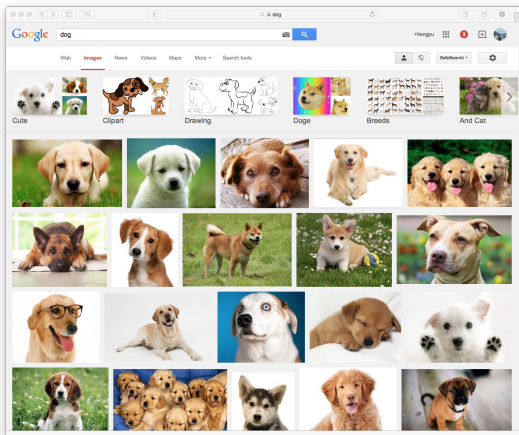
*Assira is a human interactive proof that asks users to identify photos of cats and dogs. It's powered by over two million photos from our unique partnership with Shutterstock.com. Protect your web site with Assira - free!*



- ▶ If machine can assign correct attribute to all pictures, we can search pictures by attributes.

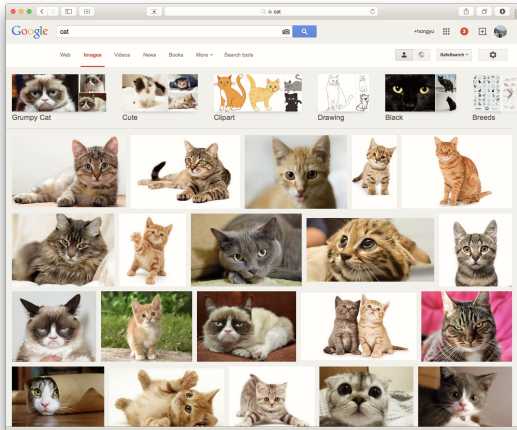
# Search engine

- Search all cat pictures.



# Search engine

- Search all dog pictures.



# Single label classification





# Future work



# To get benefit?

- ▶ Fingerprint identification
- ▶ Voice recognition
- ▶ Information assistant

# To contribute?

- ▶ SETI@home
- ▶ Rosetta@home
- ▶ Foldit

# Bibliography

Golle, P. (2008). Machine learning attacks against the asirra captcha. In *Proceedings of the 15th ACM Conference on Computer and Communications Security, CCS '08*, pages 535–542, New York, NY, USA. ACM.