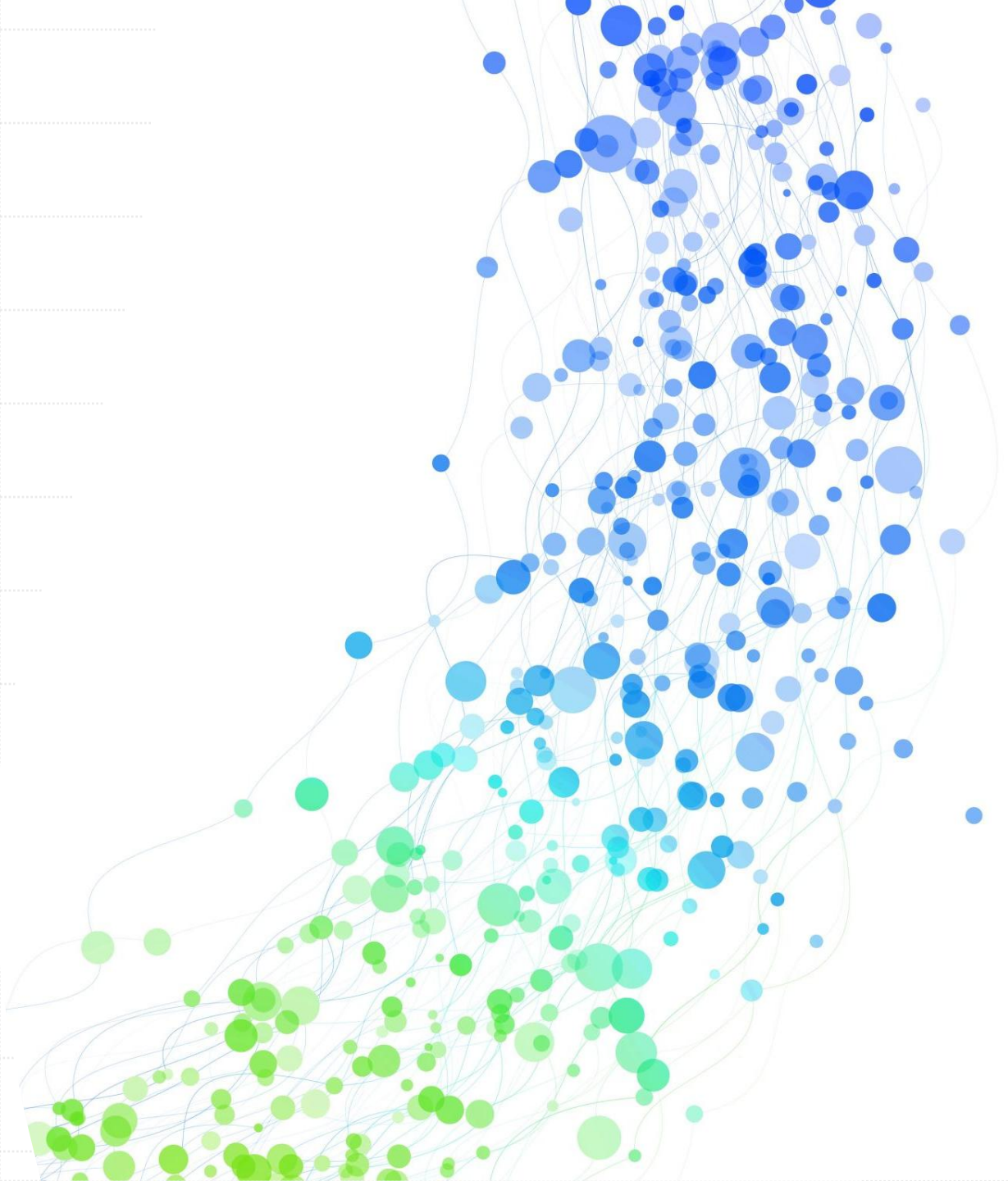


# ME536 FINAL PROJECT

Kemal Barış Tanrıverdi  
2578995



# What to Talk About

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Main Problem

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General Look at the Solution

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Dataset

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Image Pre-processing

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Convolutional Feature Extractor

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Statistical Calculations

---

User Interface (UI)

---

Algorithm Workflow

---

Demonstration

---

Possible Improvements

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# Main Problem

Can we cluster aircrafts by using statistical methods? Can we detect novelty and cluster accordingly?

What happens if we had data for a single type of aircraft, but suddenly data from other aircraft types starts to come. This project aims to decide that the new data is not from the previously known cluster and create a similarity metric so that similar data will be clustered accordingly.

# General Look at the Solution

Image  
Preprocessing

Feature Vectors  
from CNN

Statistical Methods  
for Clustering

Detecting and  
Learning Novelty

# Dataset

- FGVC (fine-grained visual classification) Aircraft Benchmark
- Multiple aircraft types labelled properly

EF2000





# Image Pre-processing

- Resize to scale
- Gray scale conversion
- Background-Foreground masks
- Image augmentation
  - Noise
  - Gaussian Blur
  - Horizontal and Vertical Flip



# Convolutional Feature Extractor

24 layers

Maxpooling  
every fourth  
layer

7x7 and 3x3  
kernels

64 and 128  
filters

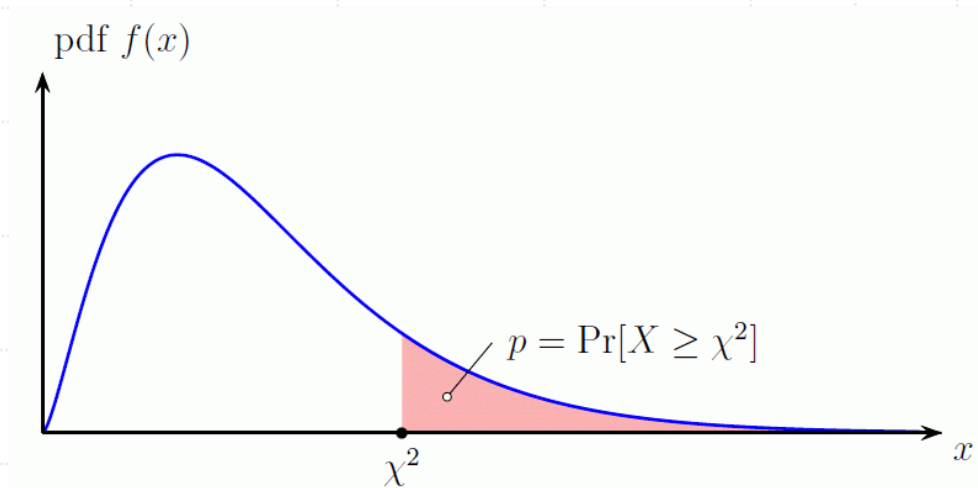
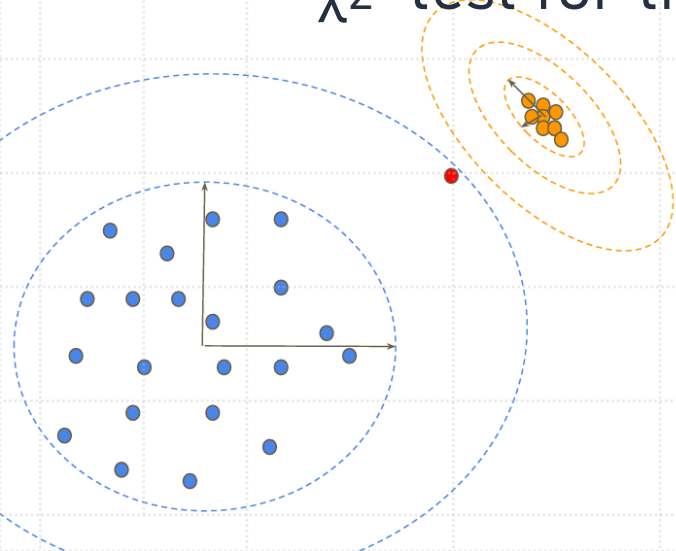
Leaky ReLU  
activation

2048  
dimensional  
vector

# Statistical Calculations

- Mean
- Standard deviation
- Mahalanobis distance
- $\chi^2$  test for threshold determination

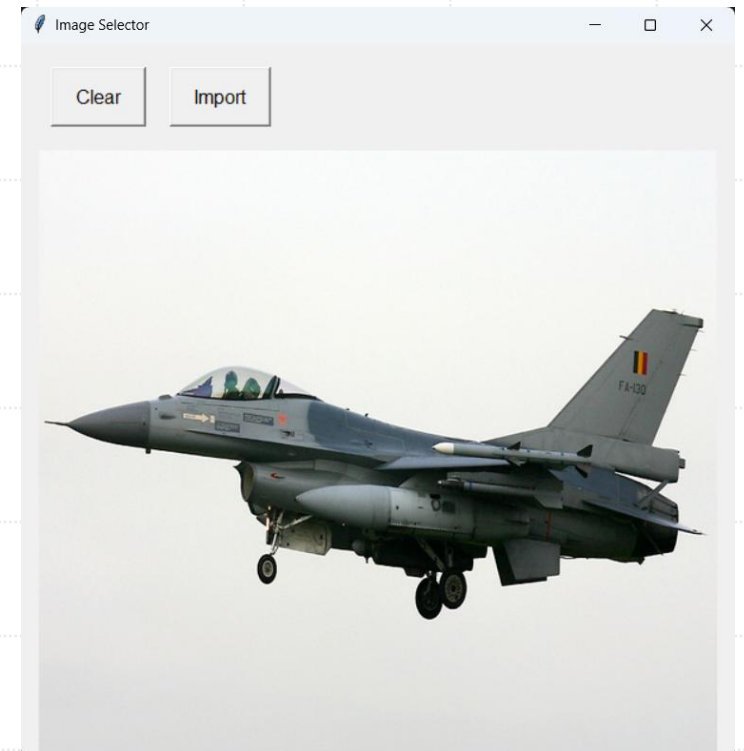
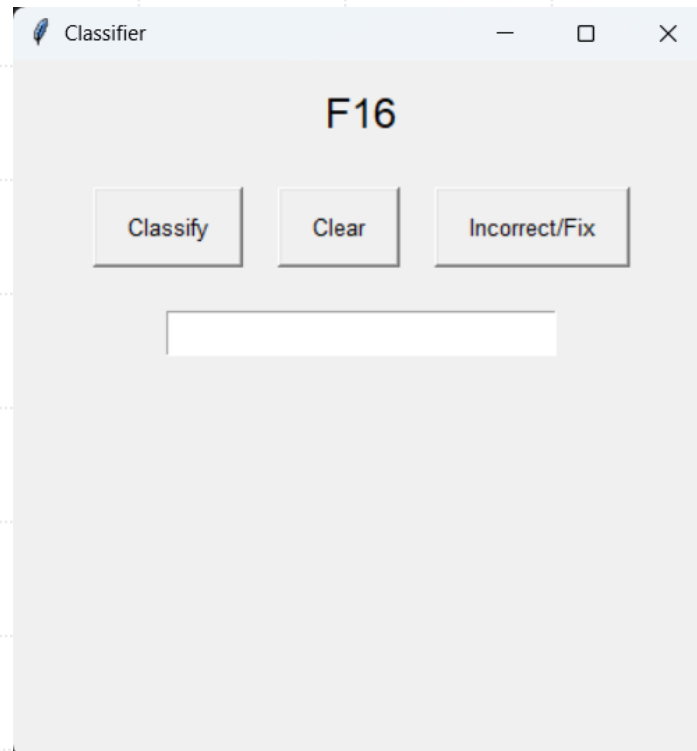
$$d_M(\vec{x}, Q) = \sqrt{(\vec{x} - \vec{\mu})^\top \Sigma^{-1} (\vec{x} - \vec{\mu})}.$$





# User Interface (UI)

Easy interaction with code



# Algorithm Workflow

---

Process F16 images to yield  
mean/deviation vector

---

Save training vector as a cluster

---

Process different image to get feature  
vector

---

Calculate mean and standard deviation

---

Calculate Mahalanobis distance to  
clusters

---

Decide closeness from chi-square test

---

If doesn't exist => new cluster



How About a Demonstration?



# Possible Improvements

- Better dynamic limit instead of chi-square
- Trying different CNN architectures
- Adding correctly clustered data into cluster parameter calculations
- Better image filtering and processing

Thank You for Listening







# References

- *Fine-Grained Visual Classification of Aircraft*, S. Maji, J. Kannala, E. Rahtu, M. Blaschko, A. Vedaldi, [arXiv.org](https://arxiv.org/abs/1306.5151), 2013
- *Lecture Notes*, A. B. Koku, [www.odtuclass.metu.edu.tr](http://www.odtuclass.metu.edu.tr), accessed in 2025
- *"Reprint of: Mahalanobis, P.C. (1936) "On the Generalised Distance in Statistics.", A. Sankhya, 80 (1): 1–7. 2018-12-01, doi:10.1007/s13171-019-00164-5, ISSN 0976-8378"*