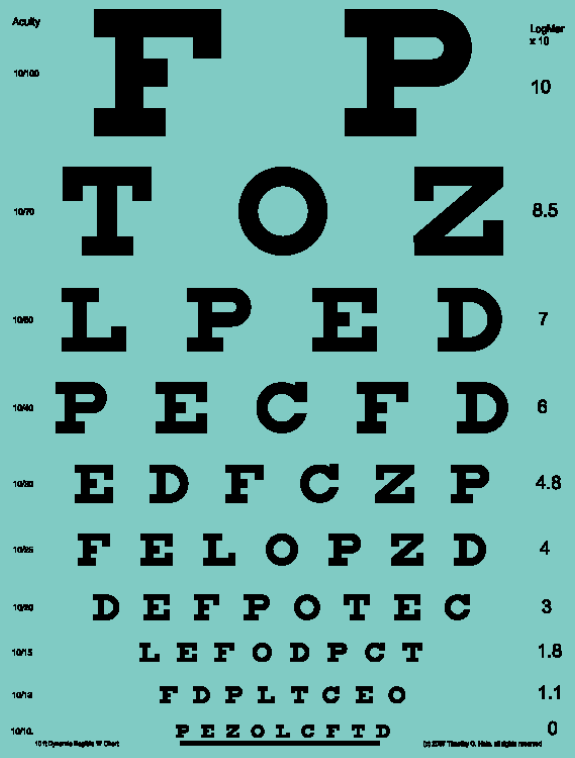
Machine Visual Acuity

Brooke Ryan and Andreana Chua

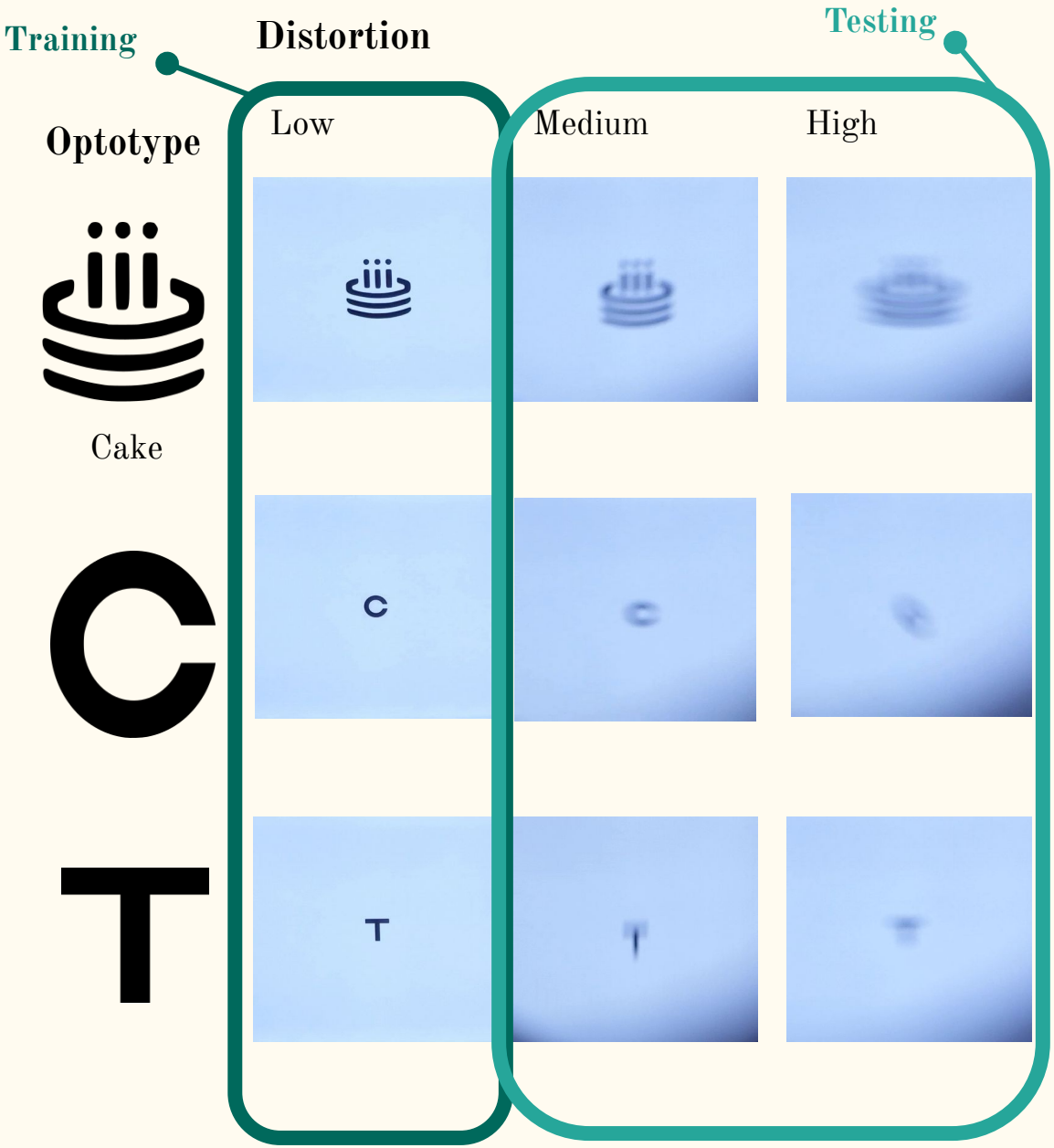


Key Question

What insights can we gain about human visual acuity by applying these tests to machines?

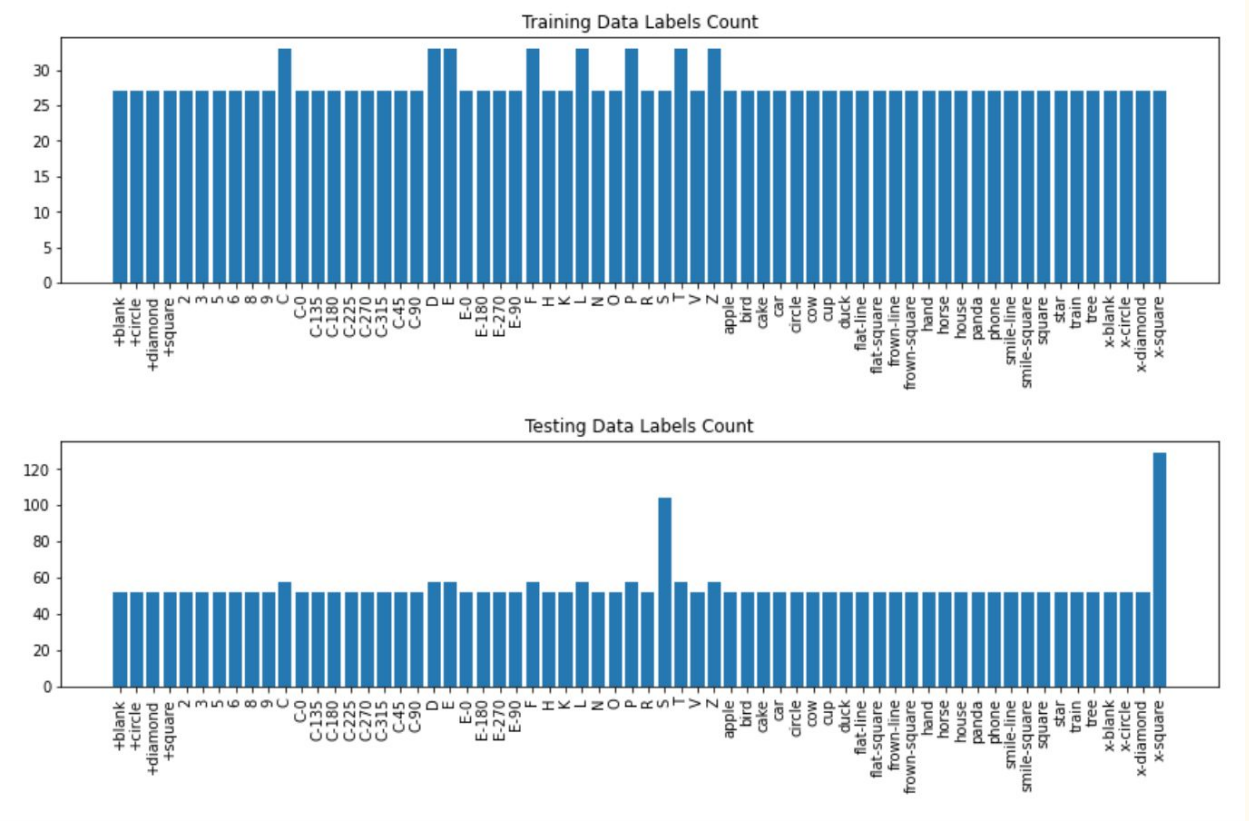
Problem to Solve

- **Which "Optotypes" are hardest for humans to solve?**
  - Browne Lab of Ophthalmology
- **What about machines?**
  - Brooke and Andreana!
  - + Baldi Lab
- **What can we learn about both through this project?**
  - More accurate Acuity tests
  - Literacy affecting test
  - Administer Acuity tests remotely



Data Exploration

- All images
  - 400 x 400 x 3
- 64 distinct classes (Optotypes)
- Three levels of distortion:
  - Low
  - Medium
  - High
- Balanced classes

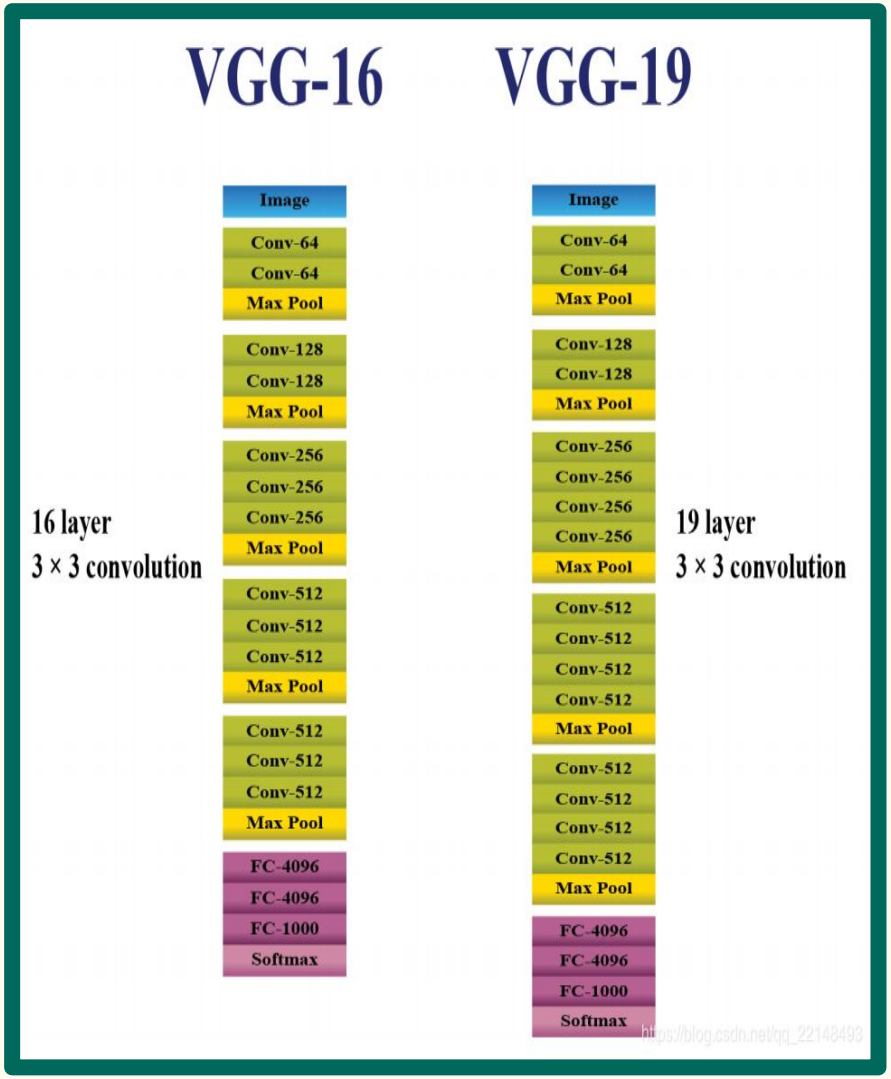


Implementation

Deep Learning

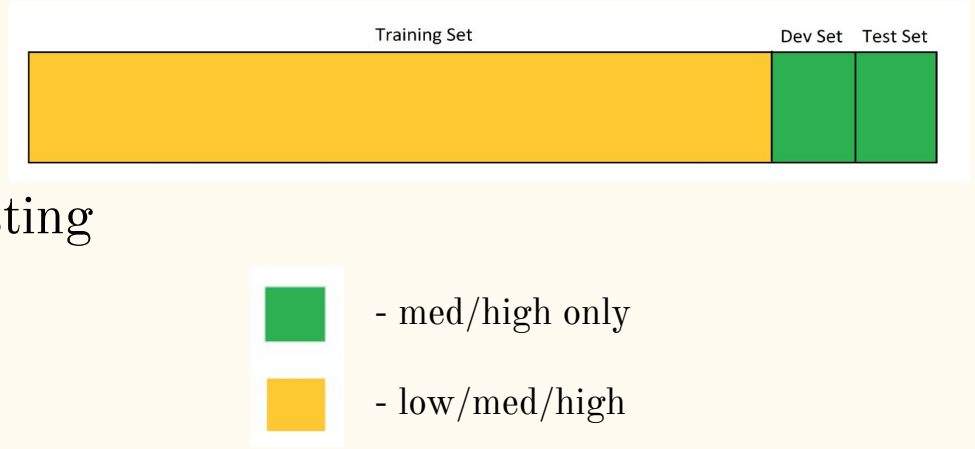
Transfer Learning

- **Models**
  - Used VGG networks
    - VGG-16
    - VGG-19
- **Hyperparameter tuning**
  - # of layers to freeze
  - # of epochs to train
  - # of layers to use (VGG-16 vs VGG-19)

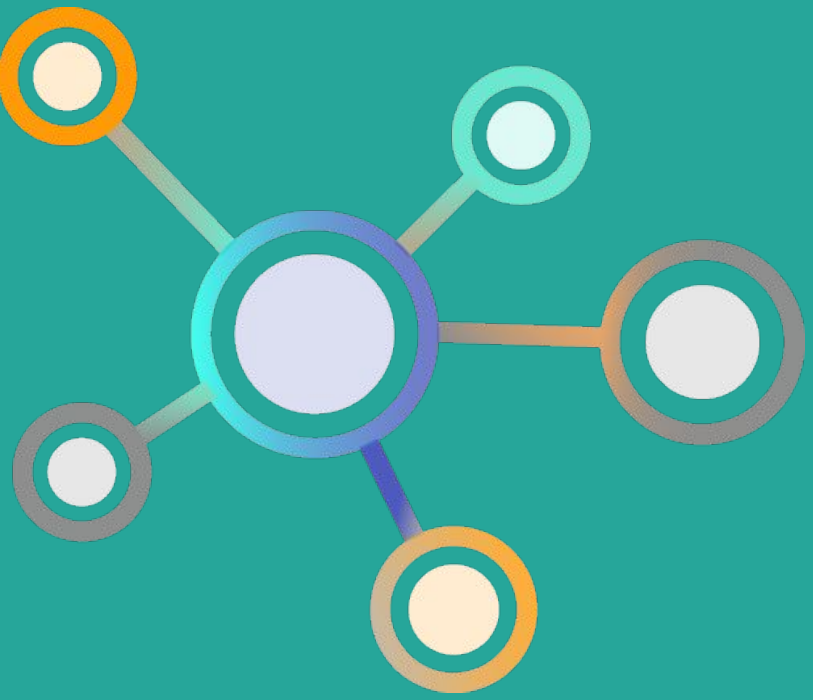


Mismatched Training/Testing Sets

- Training data and testing data come from two different distributions
  - Ex. High resolution images for training vs low resolution images for testing
- Two ways to approach
  - Intermix training/testing sets
  - Mix only a part of testing set into training set
- Second option better
  - 50% of testing into training
  - 25% of testing for valid/dev
  - 25% of testing for actual testing

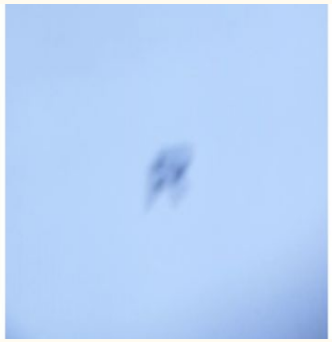


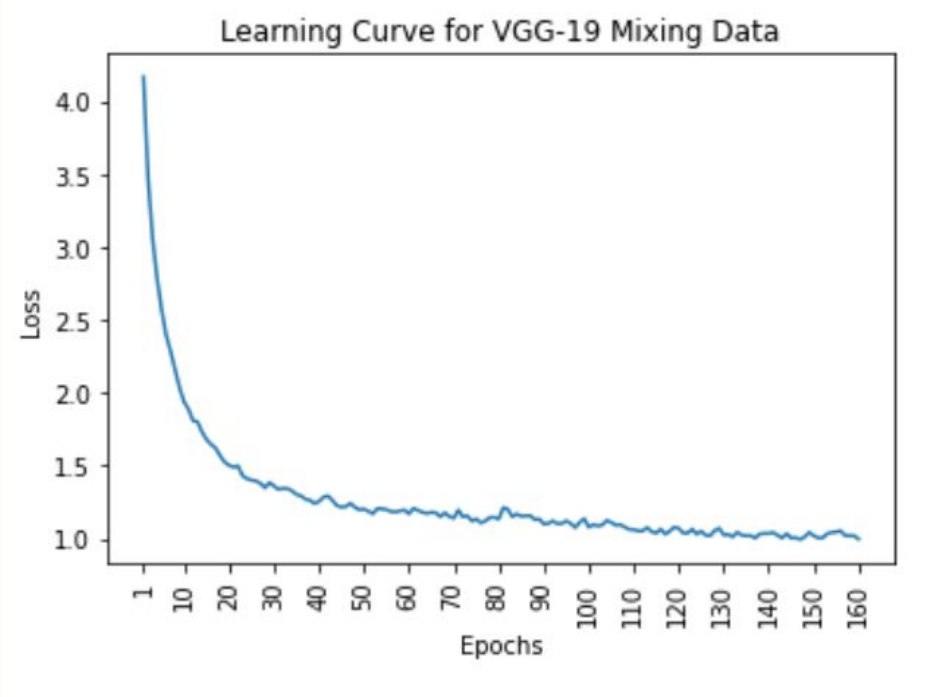
Best Results



Mismatched Data Results and Visualization

- After hyperparameter tuning:
  - VGG-19
  - Froze ¼ of the first layers
  - Train for 160 epochs
- Training accuracy: **63.23%**
- Testing accuracy: **62.88%**
- Test example:
  - R





Conclusions

Most proud of...

- Successfully building a model with transfer learning
- Given the wide range of distortions, getting results that are higher than random guessing

Most challenging...

- Having the model generalize well to the distortions
- Training images takes up a lot of computational time
- Could try a deeper network, such as ResNet50, if time wasn't an issue

Lessons learned...

- Having data in the same distribution is better
- A GPU is essential for training models like these

Questions?