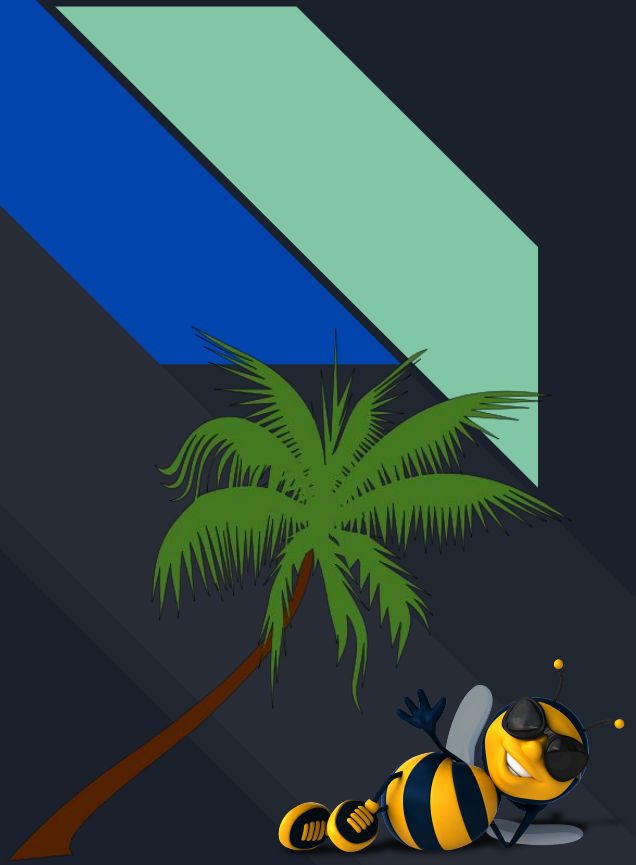


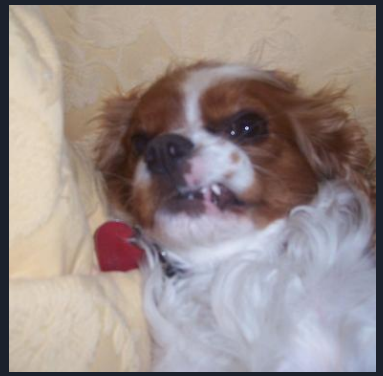
Dog Emotion Prediction Based On Transfer Learning

Team: Tree New Bee

Wei Shan, Jeff Zhuo, Xi Du, Tianrui Ye, Yuewei Wang

Introduction

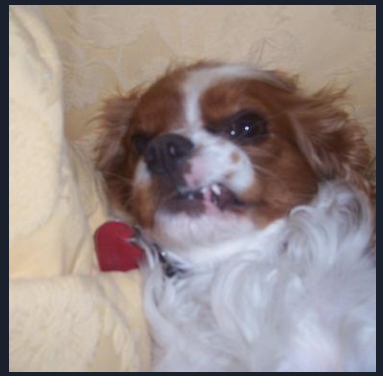
- Motivation
  - We love Dogs
- Objective
  - Image Classification
    - 4 classes
- Background
  - Transfer Learning



Introduction

- Motivation
  - We love Dogs
- Objective
  - Emotion Classification
    - 4 classes
- Background
  - Transfer Learning

Angry



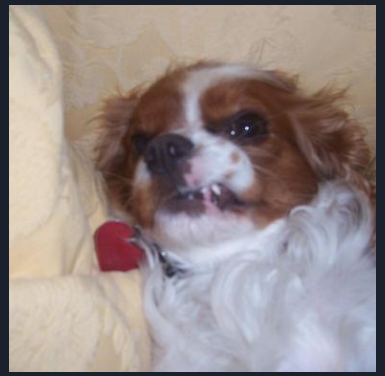
Happy

Relaxed

Sad

Introduction

- Motivation
  - We love Dogs
- Objective
  - Image Classification
    - 4 classes
- Background
  - Transfer Learning



Introduction(Background - Transfer Learning)

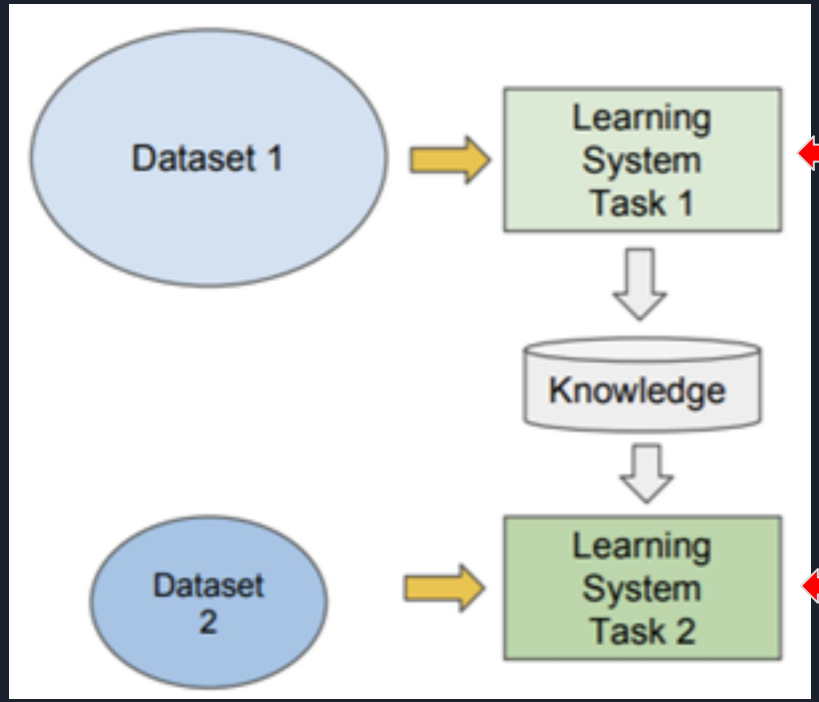
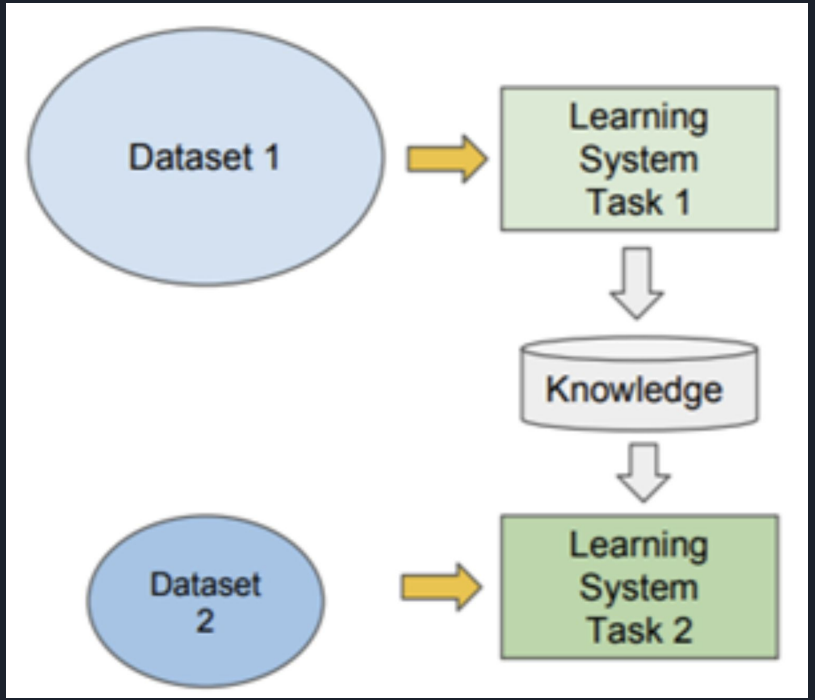


Image Credit: Prof. Li

Introduction(Background - Transfer Learning)

- Task A and B have similar input x.
- You have a lot more data for Task A than Task B.
- Low level features from A could be helpful for learning B.



Works cited: Dr. Andrew Ng, https://www.youtube.com/watch?v=yofjFQddwHE
Image Credit: Prof. Li

Introduction(Background - Transfer Learning)

- Model trained by big dataset?

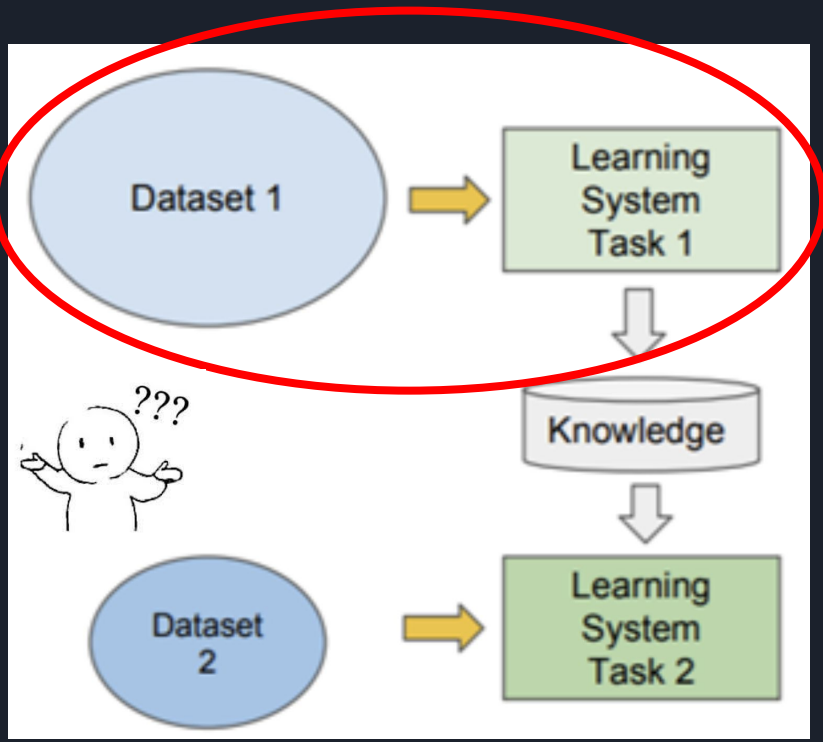


Image Credit: Prof. Li

Introduction(Background - Transfer Learning)

- Model trained by big dataset?
- How to transfer knowledge?

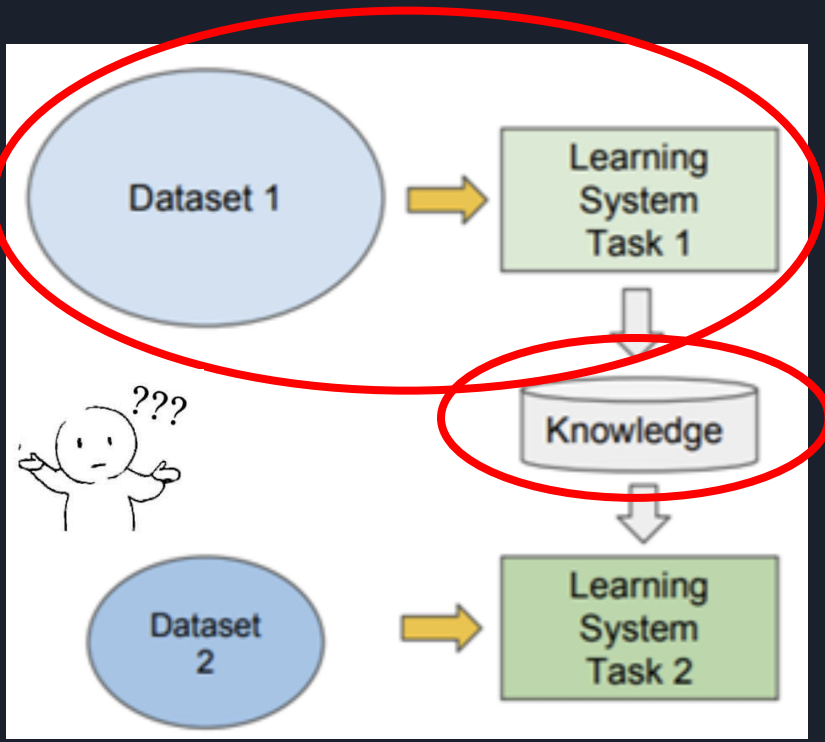


Image Credit: Prof. Li

Introduction(Background - Transfer Learning)

Q: Model trained by big dataset?

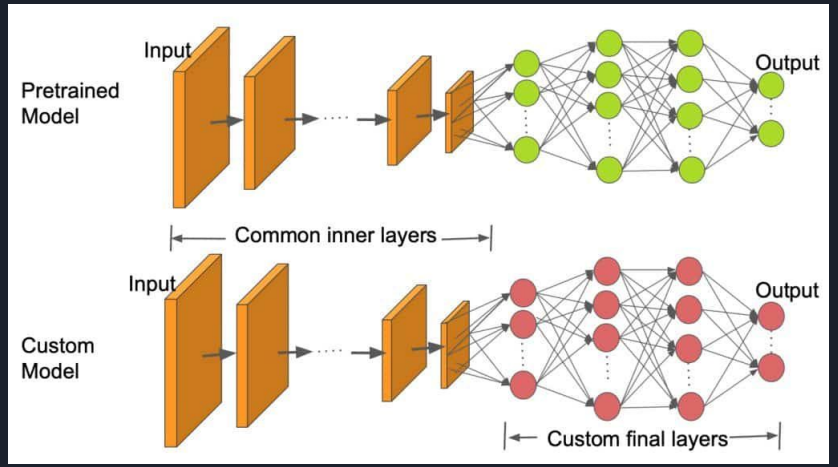


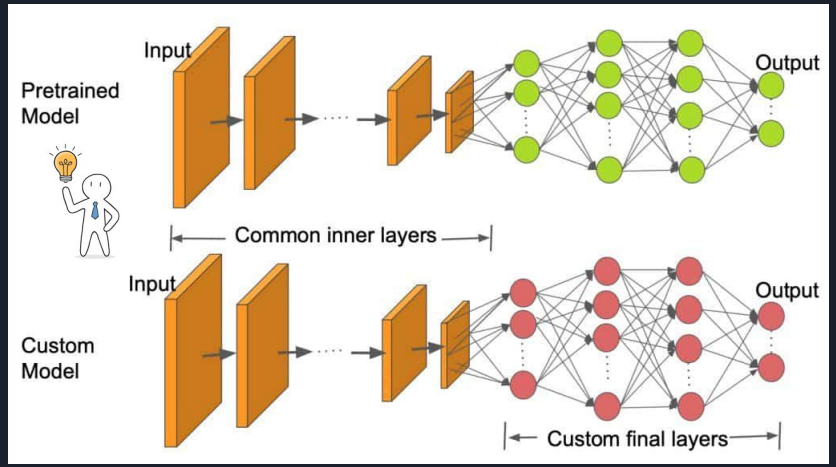
Image Credit: https://www.analyticssteps.com/blogs/how-transfer-learning-done-neural-networks-and-convolutional-neural-networks

Introduction(Background - Transfer Learning)

Q: Model trained by big dataset?

A: Pre-trained Model!

- ResNet
- VGG
- AlexNet
- MobileNet
- GoogLeNet



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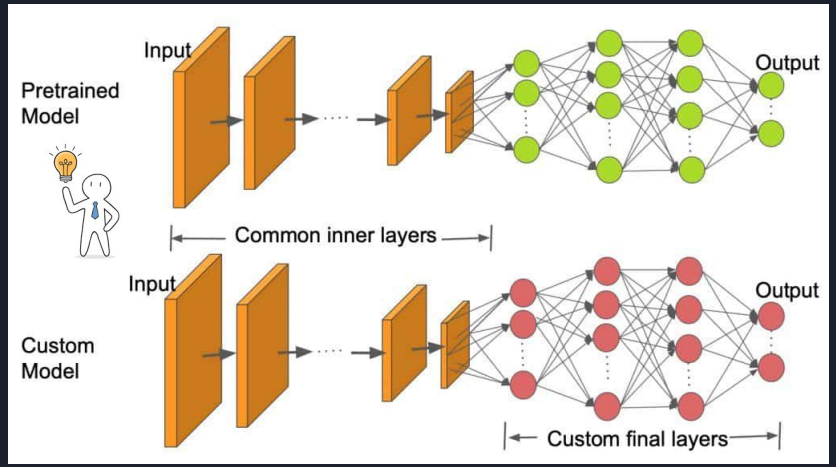
Q: How to transfer knowledge?



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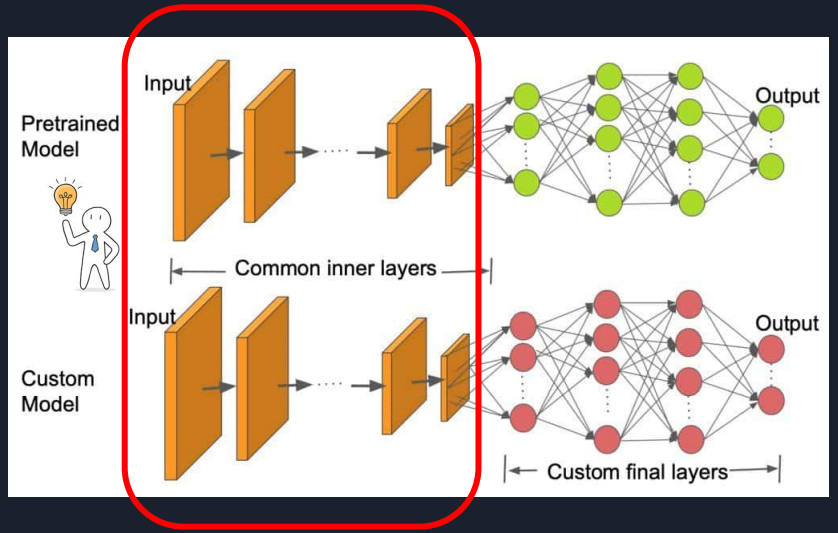

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Introduction(Background - Transfer Learning)

Q: Model trained by big dataset?

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- ResNet
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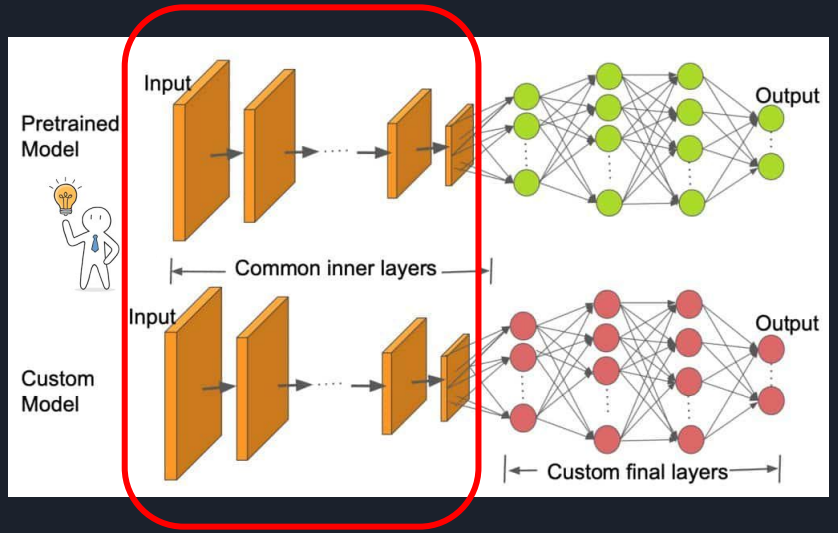
Q: How to transfer knowledge?

A: Freeze convolutional layers' parameters!



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Introduction(Background - Transfer Learning)

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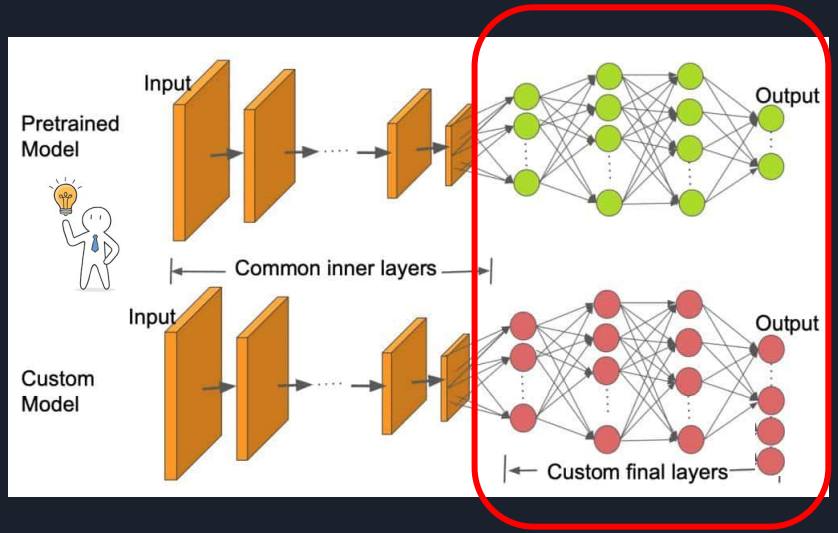

Image Credit: https://www.analyticssteps.com/blogs/how-transfer-learning-done-neural-networks-and-convolutional-neural-networks

Review of Literature

Review of Literature: Image-based Sentiment Analysis

- Lei Zhang, Shuai Wang, & Bing Liu. (2018). Deep Learning for Sentiment Analysis : A Survey.
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- Cetinic, E., Lipic, T., & Grgic, S. (2019). A Deep Learning Perspective on Beauty, Sentiment, and Remembrance of Art. IEEE Access, 7, 73694-73710.

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- Kaiming He, Xiangyu Zhang, Shaoqing Ren, & Jian Sun. (2015). Deep Residual Learning for Image Recognition.
- Karen Simonyan, & Andrew Zisserman. (2015). Very Deep Convolutional Networks for Large-Scale Image Recognition.
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- Pan, S., Tsang, I., Kwok, J., & Yang, Q. (2011). Domain Adaptation via Transfer Component Analysis. IEEE Transactions on Neural Networks, 22(2), 199-210.
- Jason Yosinski, Jeff Clune, Yoshua Bengio, & Hod Lipson. (2014). How transferable are features in deep neural networks?
- Y. Zhang and Q. Yang. A Survey on Multi-Task Learning.

Methodology (Pre-trained Model Selection)

- Pre-trained Model
  - ResNet
  - VGG
  - AlexNet
  - MobileNet
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Methodology (Pre-trained Model Selection)

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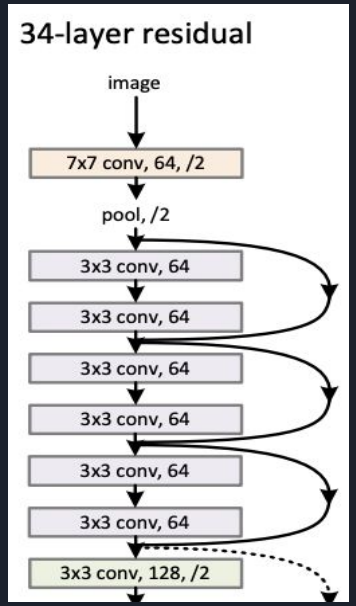

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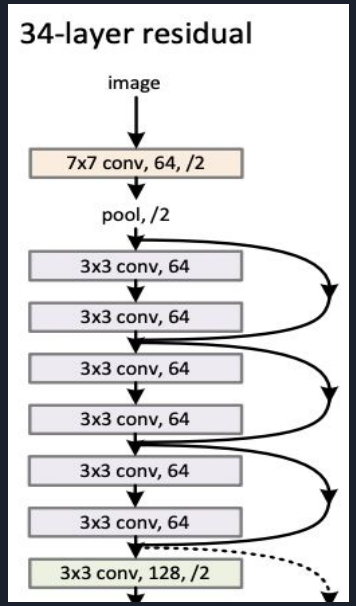
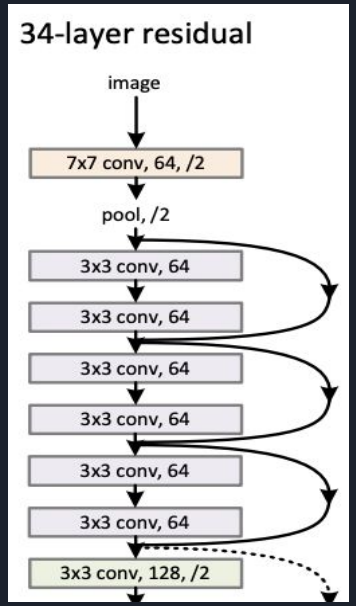


Parameters Freezed

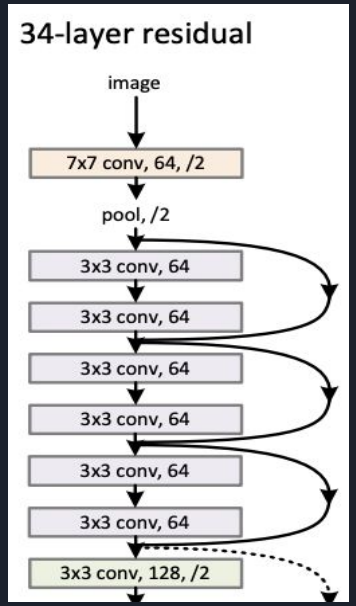
Methodology (Pre-trained Model Selection)

- Pre-trained Model
  - ResNet
  - VGG
  - AlexNet
  - MobileNet
  - GoogLeNet
- Change the last fully connected (fc) layer
  - Output size: 1000 -> 4



Methodology (Pre-trained Model Selection)

- Pre-trained Model
  - ResNet
  - VGG
  - AlexNet
  - MobileNet
  - GoogLeNet
- Change the last fully connected (fc) layer
  - Output size: 1000 -> 4
- Accuracy Comparison



Parameters Freezed

Result (Pre-trained Model Selection)

Model	ResNet18	ResNet50	VGG16	AlexNet	MobileNet	GoogLeNet
Training Accuracy	44%	54%	58%	47%	51%	46%

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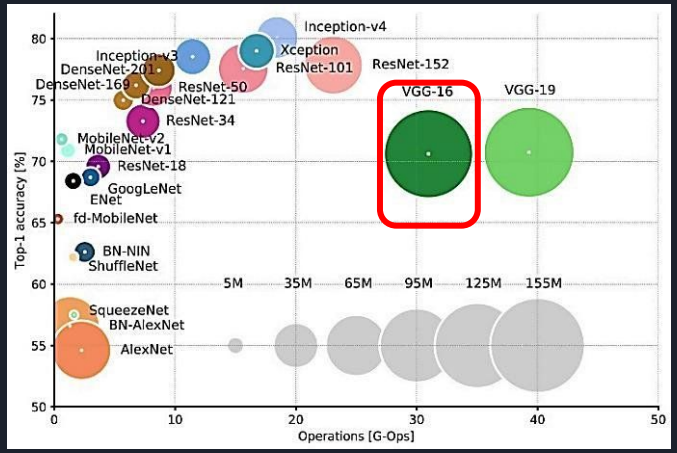

Image Credit: http://jaree.its.ac.id/index.php/jaree/article/view/191

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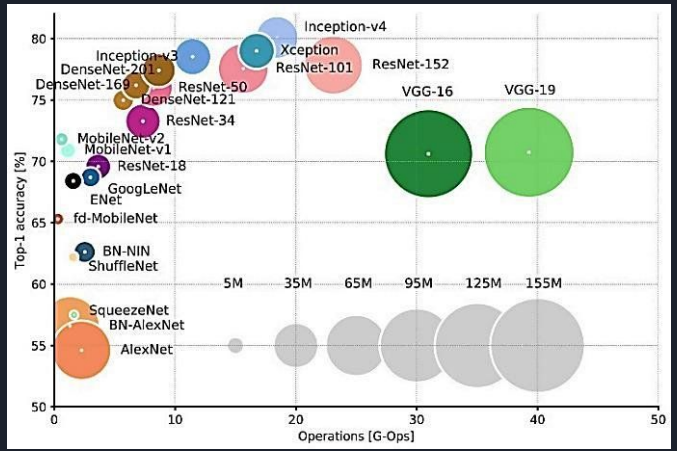

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Methodology

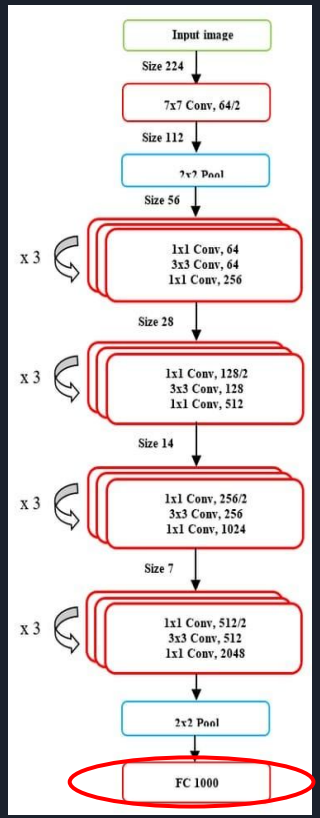
- Classifier Modification
- Multi Task Learning
- Fine-tuning
- Unsupervised Domain Adaptation

Methodology

- Classifier Modification
- Multi Task Learning
- Fine-tuning
- Unsupervised Domain Adaptation

Methodology (Classifier Modification)

- Fully Connected Layer

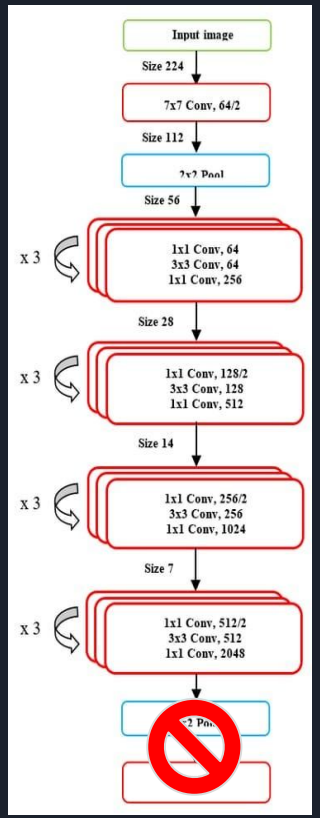


Parameters Freezed

fc 4

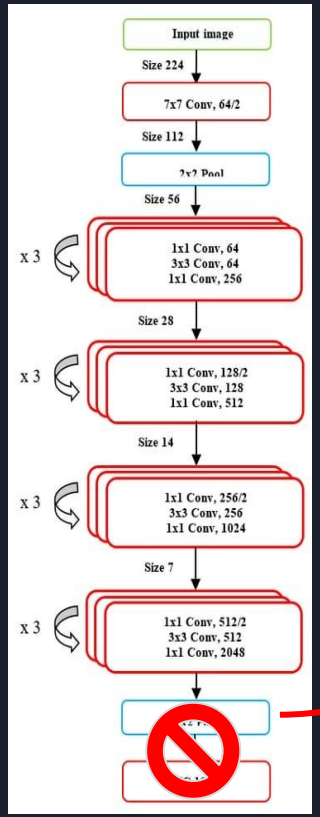
Methodology (Classifier Modification)

- Fully Connected Layer
- Naive Bayes Classifier (LDA/ QDA)
- KNN
- SVM
- Random Forest

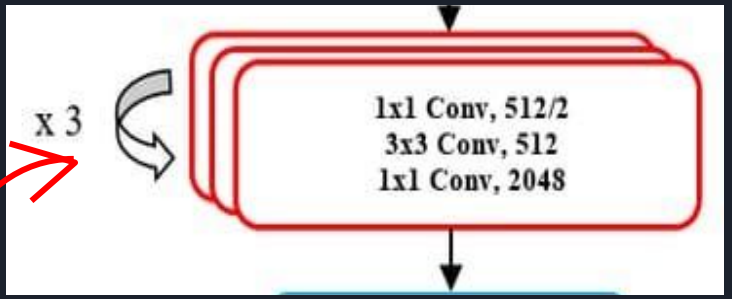


Parameters Freezed

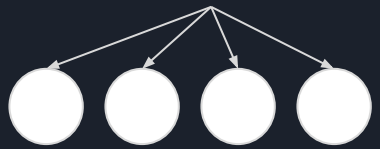
Methodology (Classifier Modification)



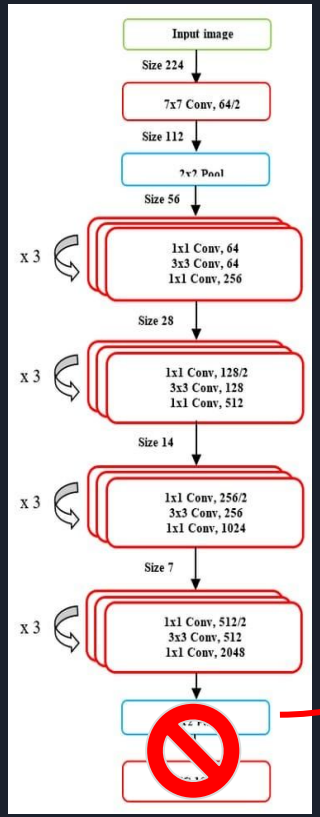
Parameters Freezed



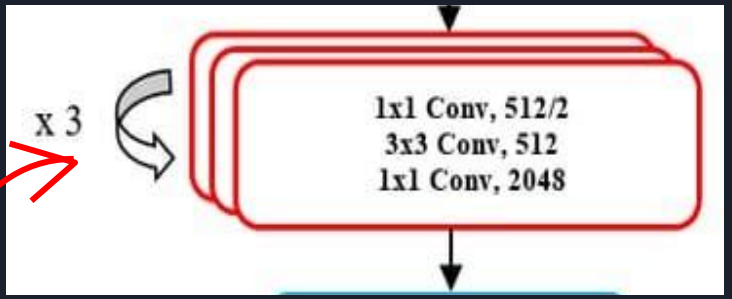
Naive Bayes Classifier (LDA/ QDA)



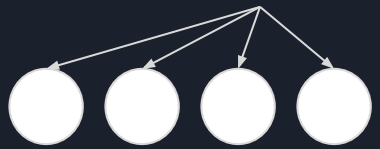
Methodology (Classifier Modification)



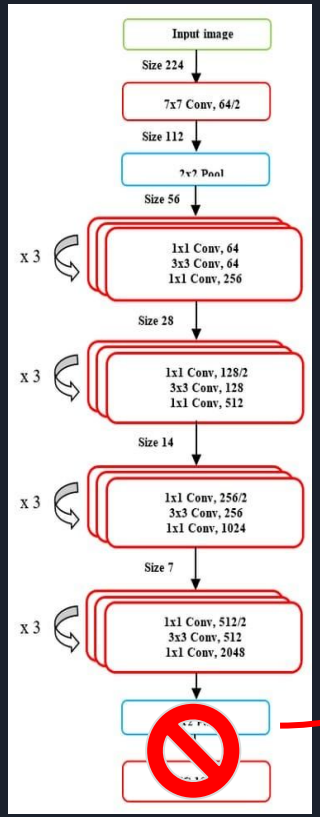
Parameters Freezed



KNN



Methodology (Classifier Modification)



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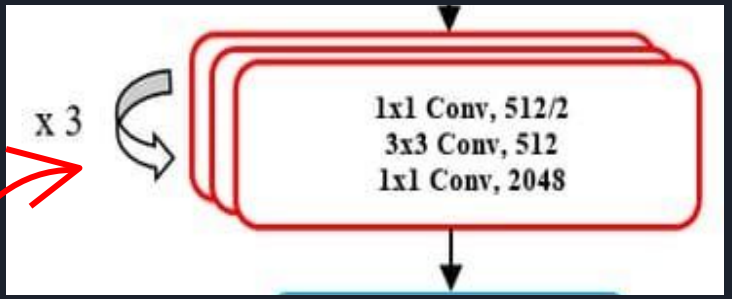
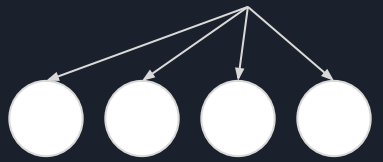
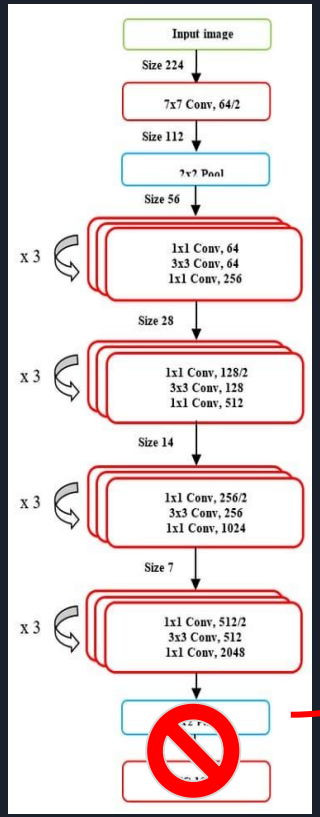


SVM



Methodology (Classifier Modification)



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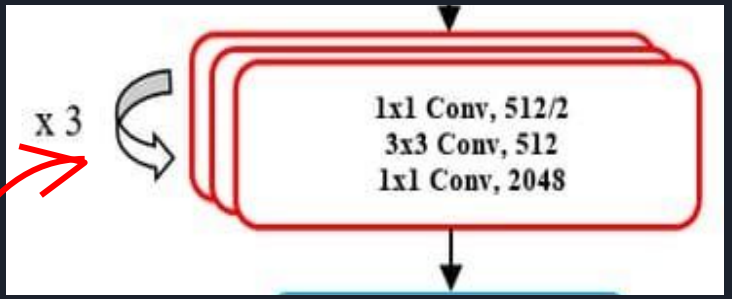
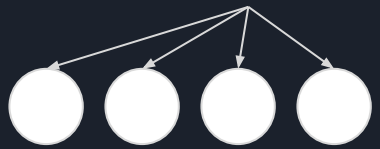


Random Forest



Result (Classifier Modification)

Model	FC	LDA	QDA	KNN	SVM	Random Forest
Training Accuracy	54%	79%	82%	48%	79%	61%

Result (Classifier Modification)

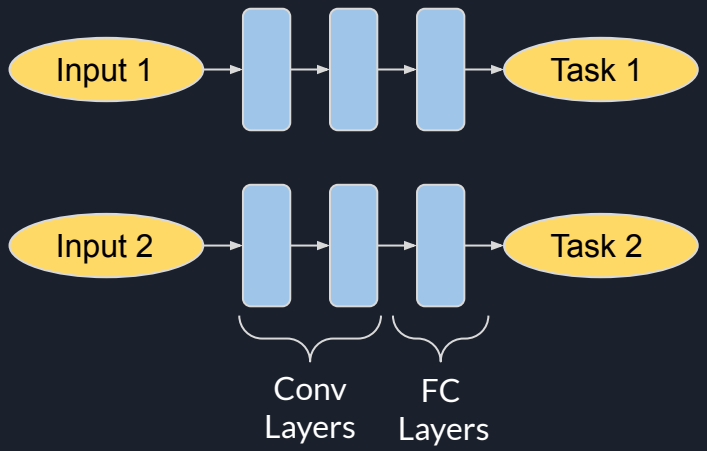
Model	FC	LDA	QDA	KNN	SVM	Random Forest
Training Accuracy	54%	79%	82%	48%	79%	61%
Testing Accuracy	53%	31%	35%	20%	59%	27%

Methodology

- Classifier Modification
- Multi Task Learning
- Fine-tuning
- Unsupervised Domain Adaptation

Methodology (Multi Task Learning)

Single Task Learning



Multi Task Learning

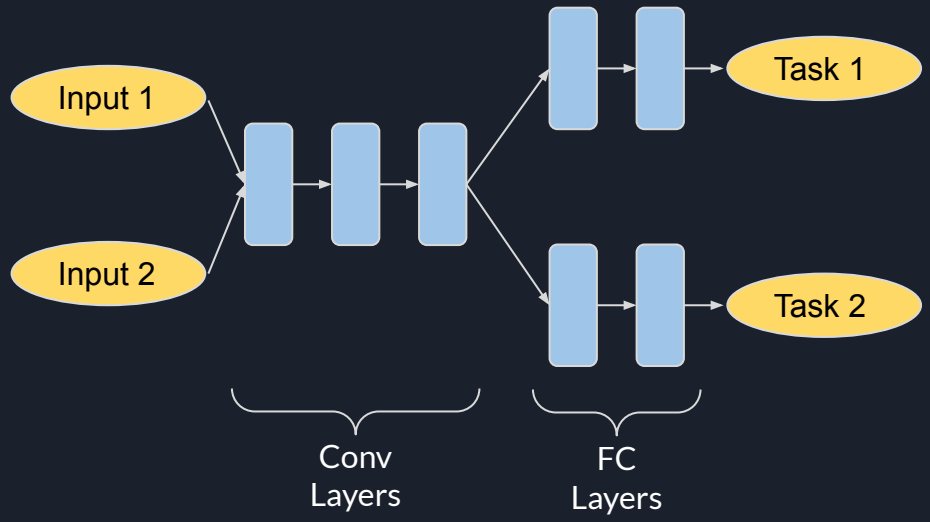
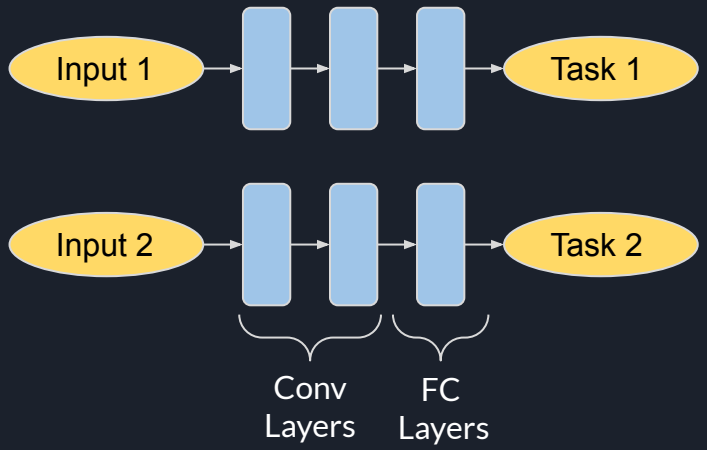


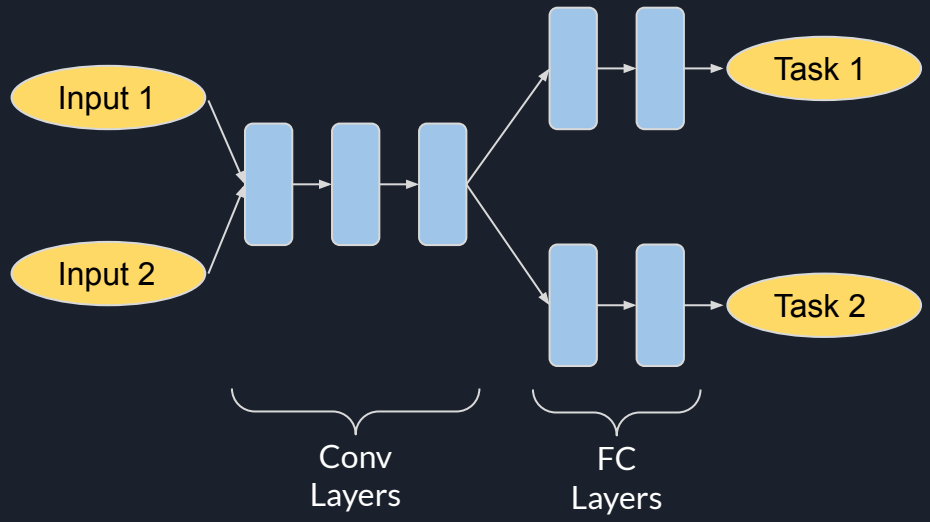
Image Credit: I made them

Methodology (Multi Task Learning)

Single Task Learning



Multi Task Learning



- Tasks should be related.

Image Credit: I made them
Works Cited: Y. Zhang and Q. Yang, "A Survey on Multi-Task Learning,"

Methodology (Multi Task Learning)

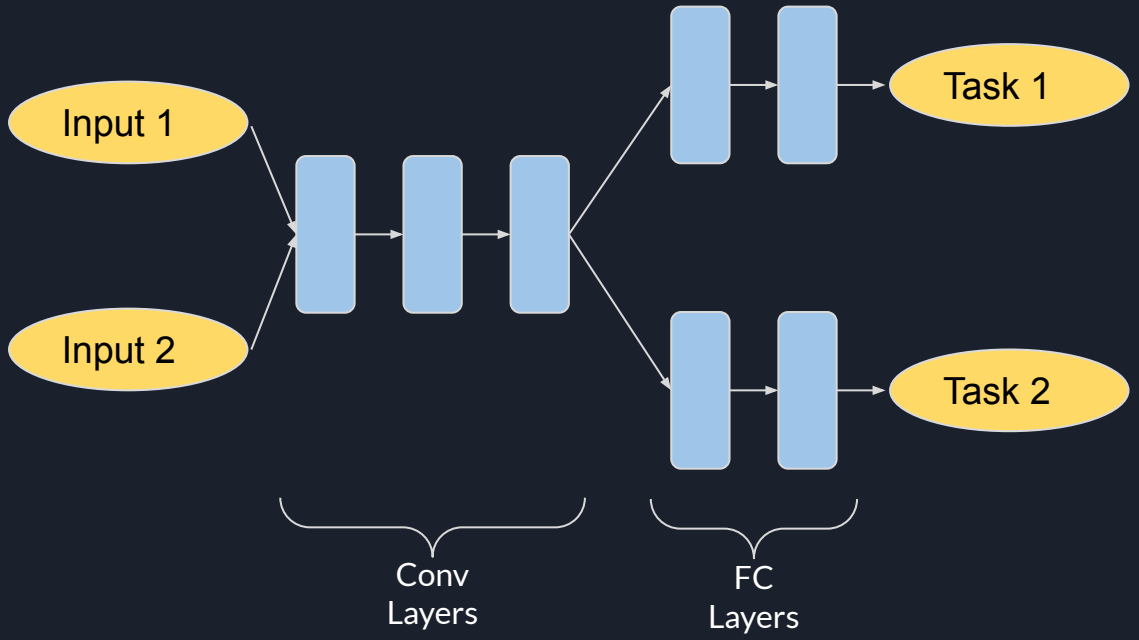


Image Credit: I made them

Methodology (Multi Task Learning)

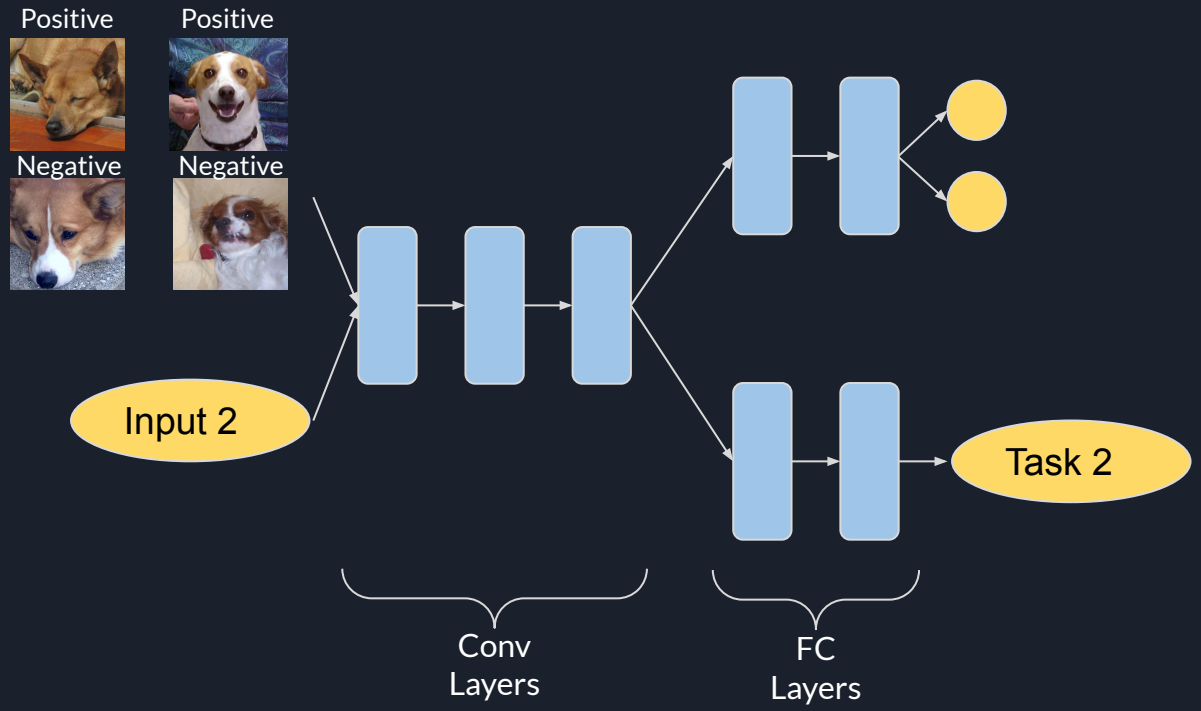


Image Credit: I made them

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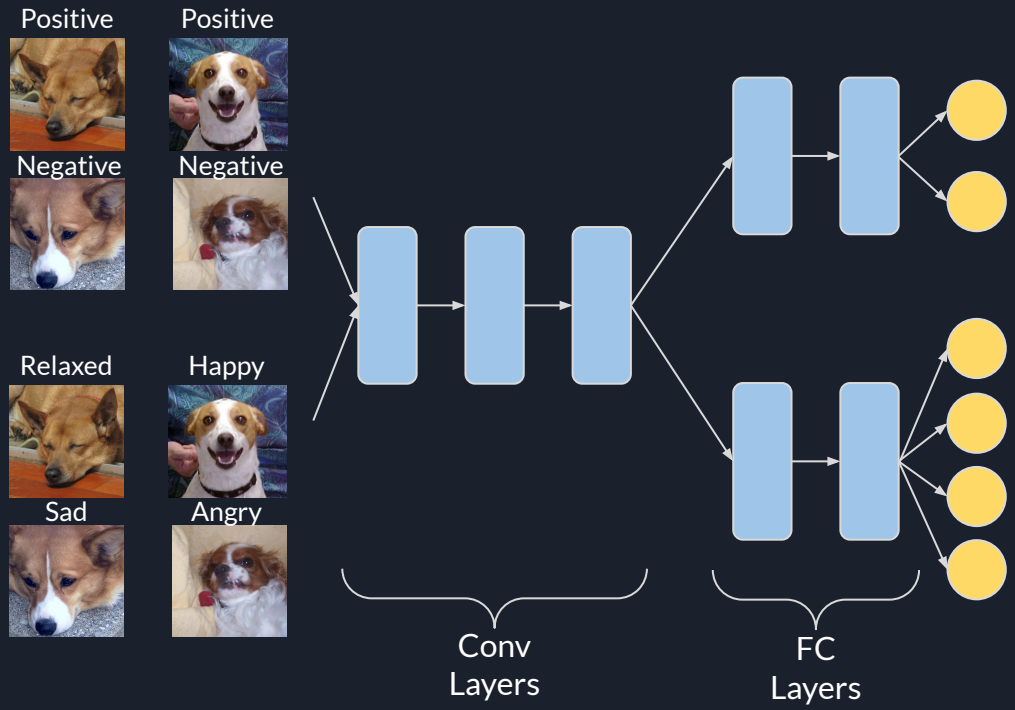

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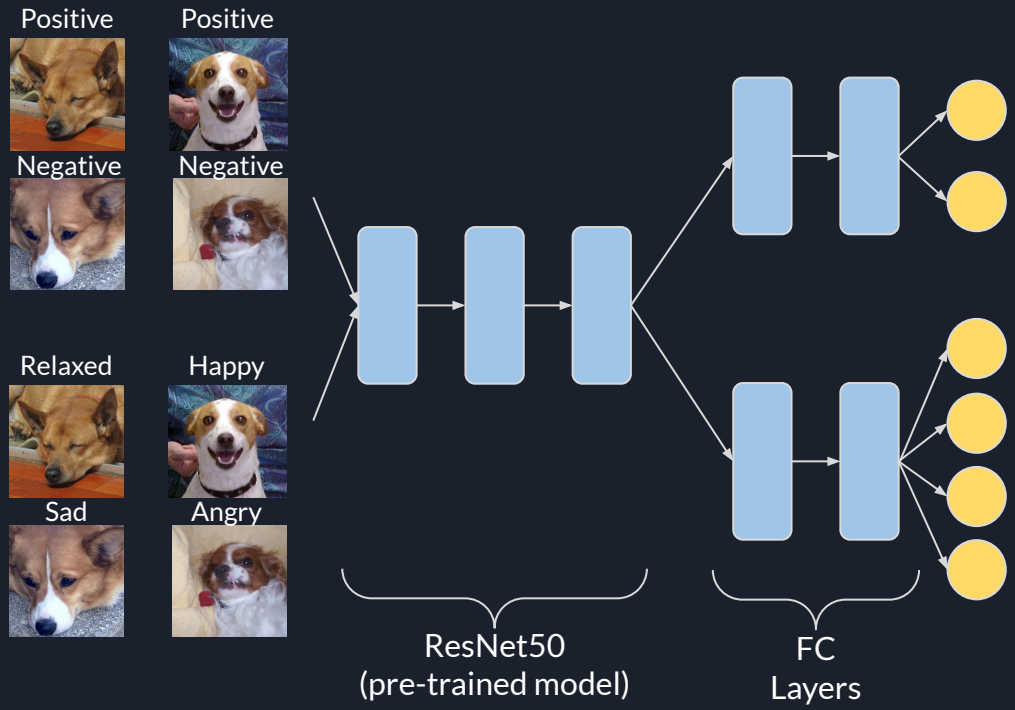


Image Credit: I made them

Methodology (Multi Task Learning)

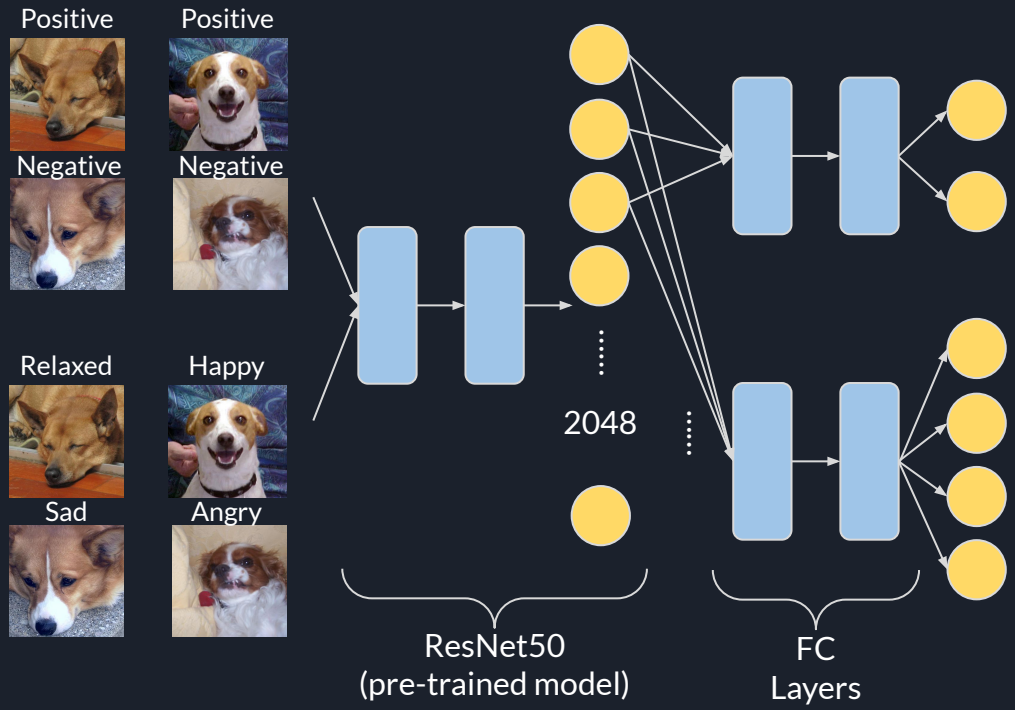


Image Credit: I made them

Result (Multi Task Learning)

- 35%

Methodology

- Classifier Modification
- Multi Task Learning
- Fine-tuning
- Unsupervised Domain Adaptation

Methodology (Fine-Tuning)

Big Idea: Low-Level features are general and High-level features are more specific.

- Low-Level features learnt are **transferable**
- Higher Layers capture features specialized to the original training tasks

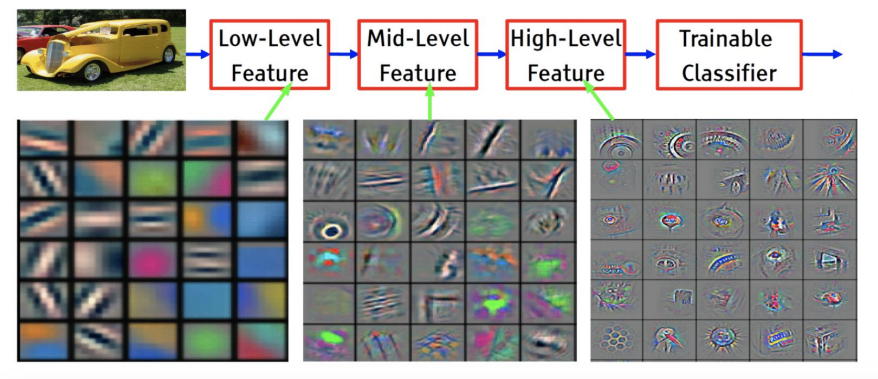


Figure 1: Hierarchy of Features in CNNs

Methodology (Fine-Tuning)

ResNet50

- Previously: freeze all feature layers
  - Train only classification layer

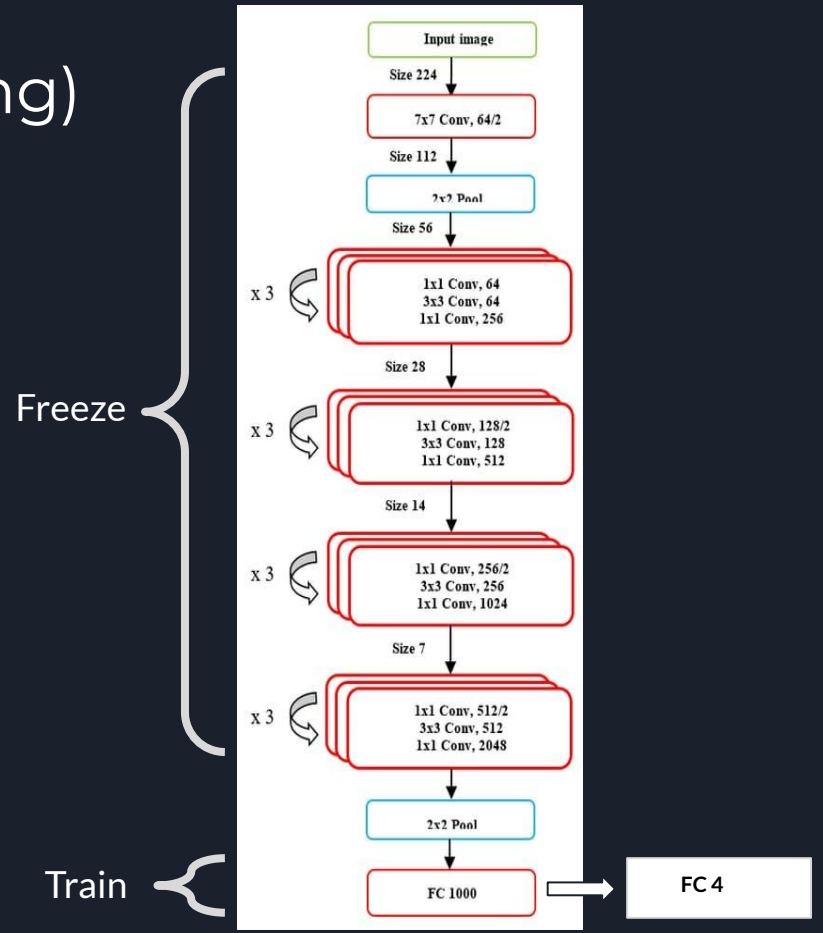


Image Credit: ResNet50 Architecture

Methodology (Fine-Tuning)

ResNet50

- Previously: freeze all feature layers
  - Train only classification layer
- Higher layer may capture features that are specialized for ImageNet task
  - Train last Feature Layer & FC Layer
- Use initial pre-train weights leads to better performance and generalization (Yosinski)

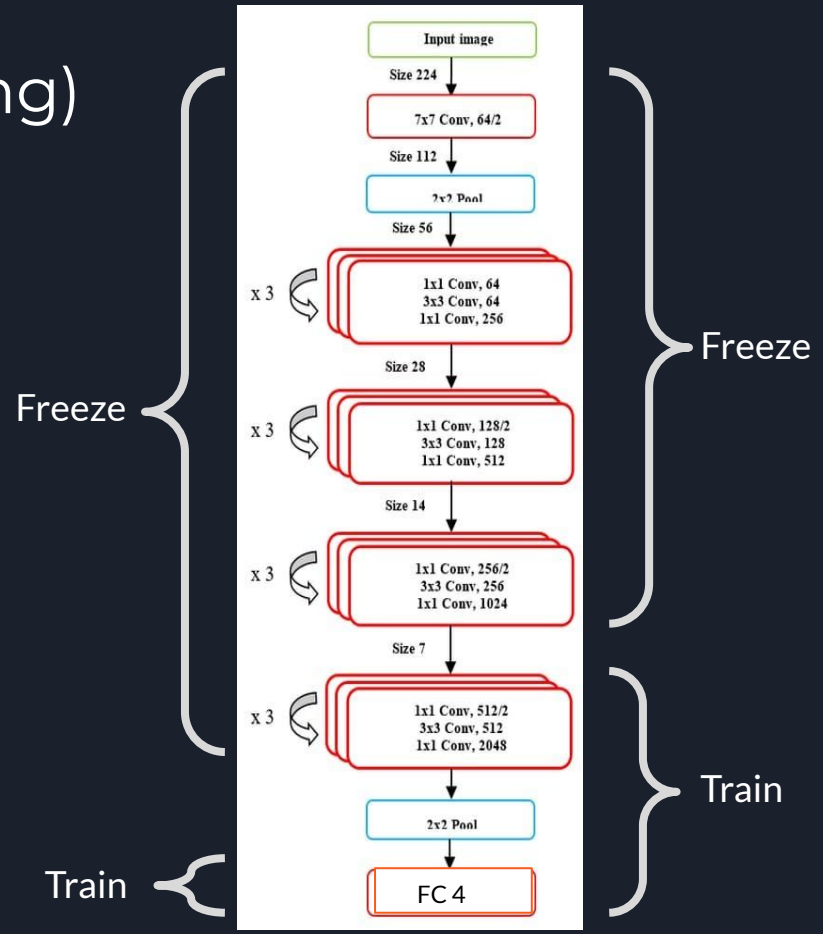


Image Credit: ResNet50 Architecture

Jason Yosinski, Jeff Clune, Yoshua Bengio, & Hod Lipson. (2014). How transferable are features in deep neural networks?

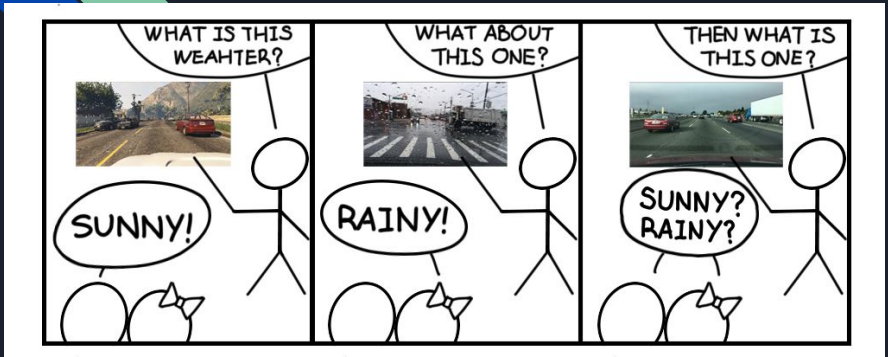
Results (Fine-Tuning)

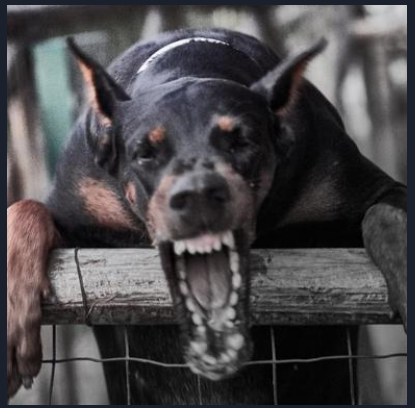
Method	Training on FC Layer	Training on FC + Stage 4	Accuracy Increase
Training Accuracy	54.5%	63.8%	9.3%
Test Accuracy	53.3%	57.6%	4.3%
Accuracy Difference	-1.2%	-6.2%	

Methodology

- Classifier Modification
- Multi Task Learning
- Fine-tuning
- Unsupervised Domain Adaptation

Methodology (Unsupervised Domain Adaptation)





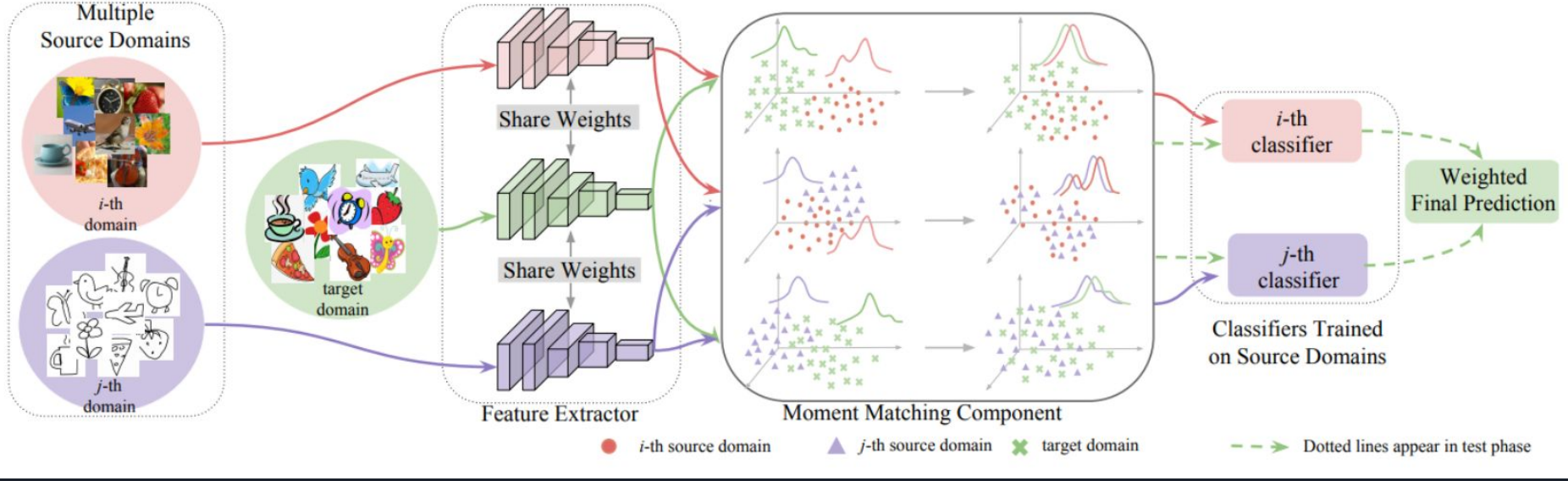
What is Domain Adaptation

- Source domain → target domain
- Two features: brightness, raindrop
- Bright + No raindrop = Sunny
- Dark + Rain drop = Rainy
- Dark + No raindrop = ?
- simple/single knowledge → complex situation

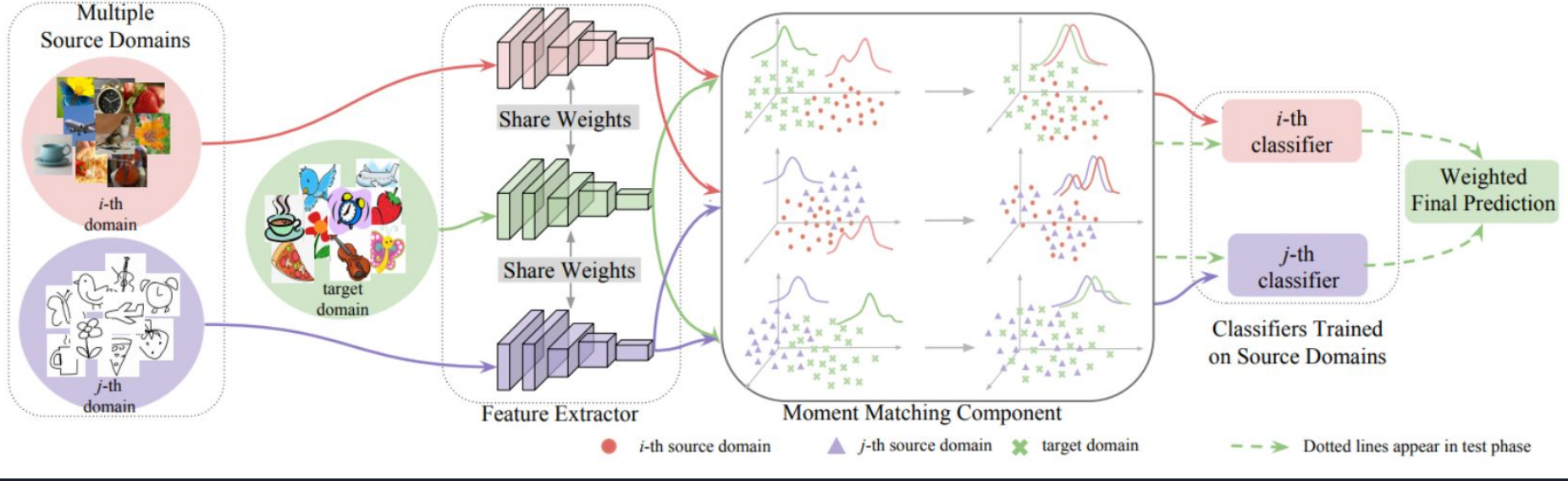
Why Domain Adaptation useful

- Pre-trained model is trained on a specific dataset
- Our dataset contains real world pictures

Methodology (Unsupervised Domain Adaptation)



Methodology (Unsupervised Domain Adaptation)



Results(Unsupervised Domain Adaptation)

ResNet50 Accuracy

Training Accuracy: 62.8%

Testing Accuracy: 53%

Training Accuracy Increase: 9.8%

Conclusion

- Introduced Pre-train Models and Transfer Learning
- Selected best Pre-train Model
- Classifier Modification
- Multi-task Learning
- Fine-Tuning
- Unsupervised Domain Adaptation