# Classification of X-ray images using different models

LifeSavers
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CSCI 5523 - Spring 2021

# Motivation

1. Machine learning (ML) model can quantify the progress the how far pneumonia has progressed

2. ML model as an assistance tool can prevent a mistake from the human expert.

3. ML model can capture the pneumonia from the x-ray image for other disease.


Figure 1. Illustrative Examples of Chest X-Rays in Patients with Pneumonia

# Data & Data pre-processing

Original

| | Normal | Pneumonia |
|---|---|---|
| Train | 1341 | 3875 |
| Validation | 8 | 8 |
| Test | 234 | 390 |

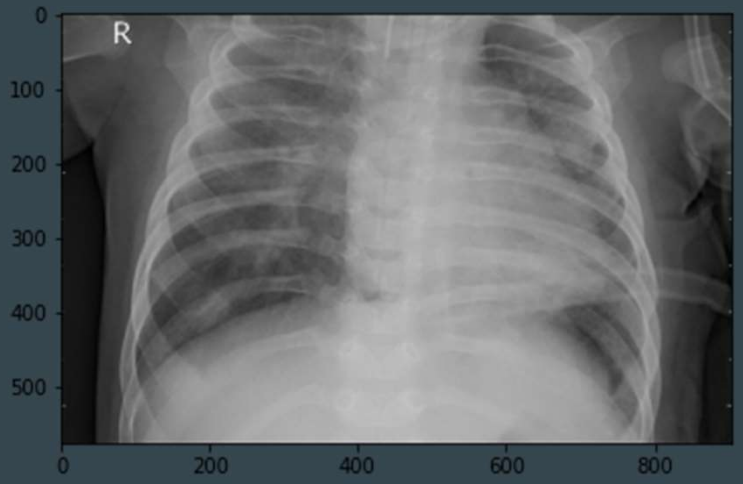
Balanced

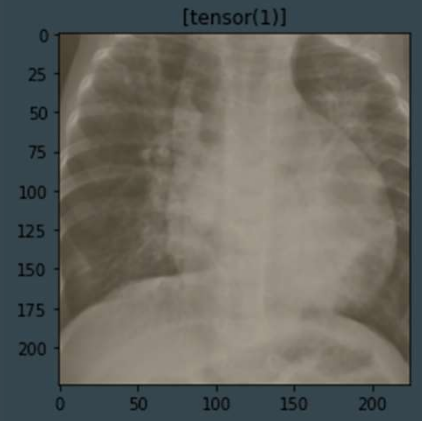
| | Normal | Pneumonia |
|---|---|---|
| Train | 1241 | 1241 |
| Validation | 108 | 108 |
| Test | 234 | 234 |

Unbalanced

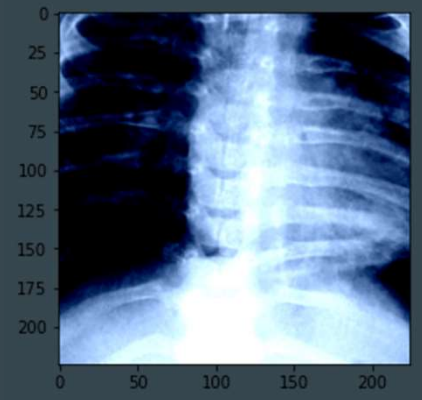
| | Normal | Pneumonia |
|---|---|---|
| Train | 1239 | 3773 |
| Validation | 110 | 110 |
| Test | 234 | 390 |

# Example of the original and transformed image




SVM and ANN

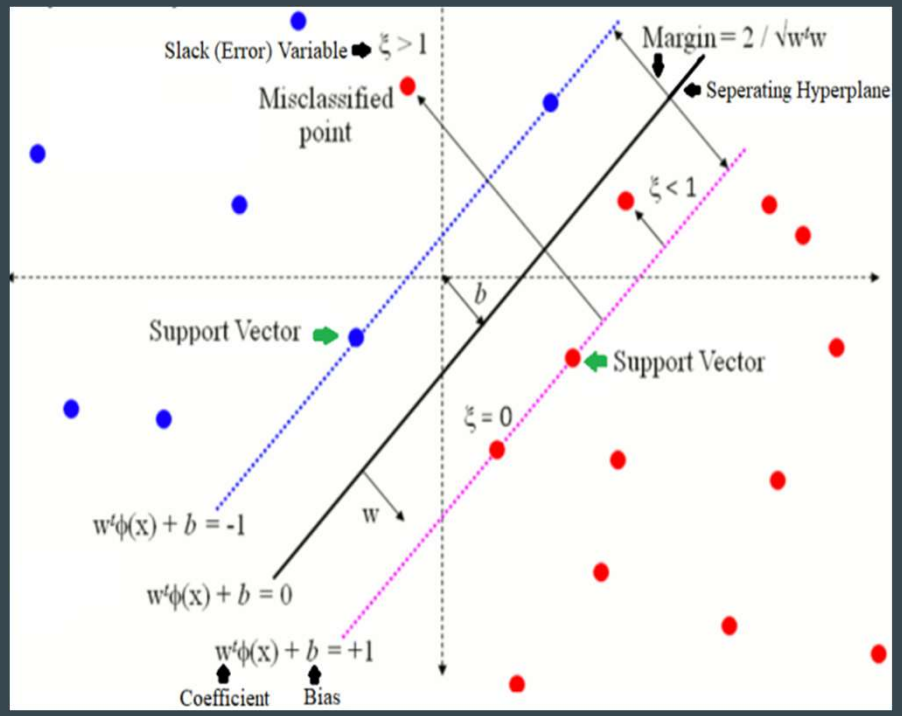



CNN and
Transfer learning

# Support Vector Machine (SVM)

- SVM complexity
  - Kernel (Gaussian RBF)
  - Parameters C (1), Gamma (0.005)

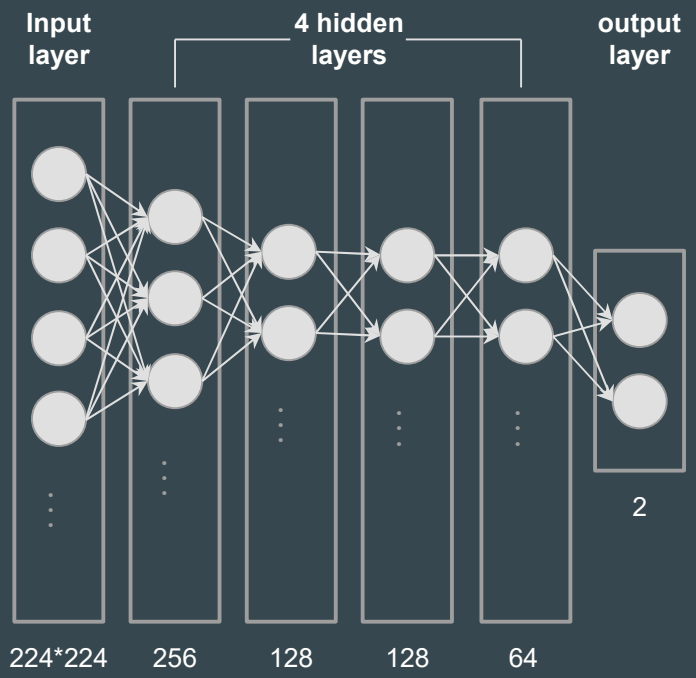
- SVM Advantages and disadvantages
  - Highly accurate & Less overfitted
  - Expensive computation & classification



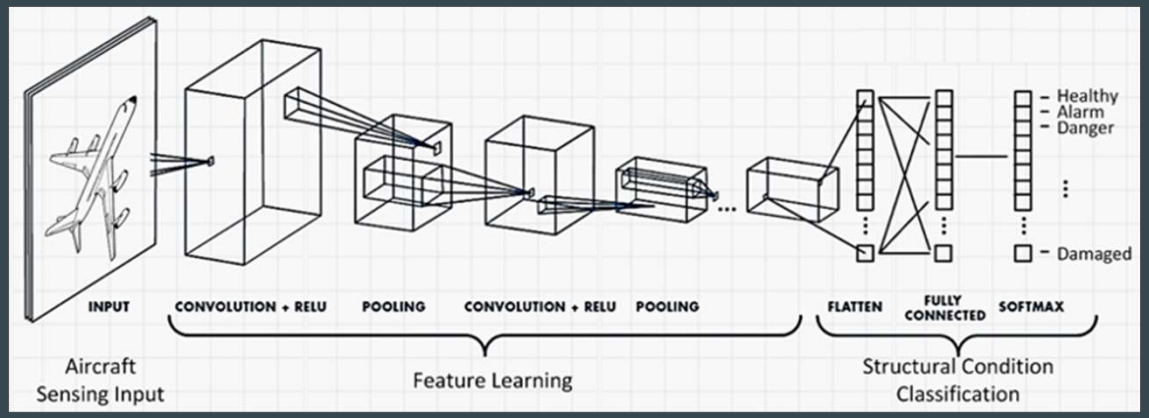
# Artificial Neural Network (ANN)

- Time, computational complexity
  → Grayscale (vs. RGB)

- Activation function: RELU
- Batch size = 1
- Epochs = 15
- Learning rate = 0.001
- Forward propagation & backpropagation



# Convolutional Neural Network (CNN)




- CNN can reduce the size of image data while keeping important features.
- Combination of 2d convolutional layer and pooling is a key point.

# Convolutional Neural Network (CNN)

- Model specification

  Batch size = 16; Dimension of data = 3; Number of epoch = 5

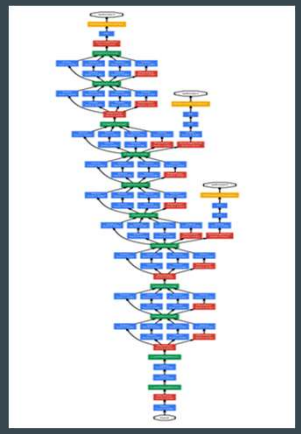
1. 2D convolutional layer (input dimension = 3, output dimension = 3, kernel size = 4)
2. 2D Max pooling (kernel size = 4)
3. 2D convolutional layer (input dimension = 3, output dimension = 3, kernel size = 4)
4. 1st Linear transformation (input size = 507, output size = 128)
5. 2nd Linear transformation (input size = 128, output size = 64)
6. 3rd Linear transformation (input size = 64, output size = 2)

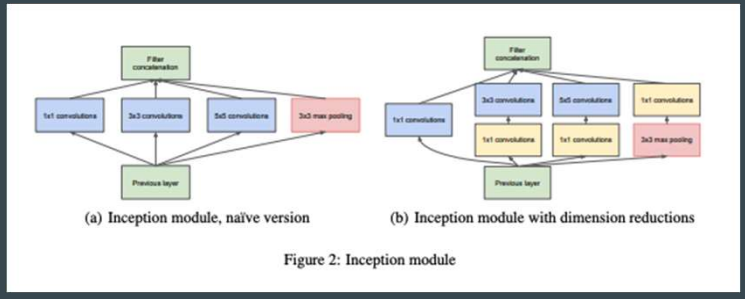
# Transfer Learning

- GoogleNet, ResNet18

# GoogleNet Architecture

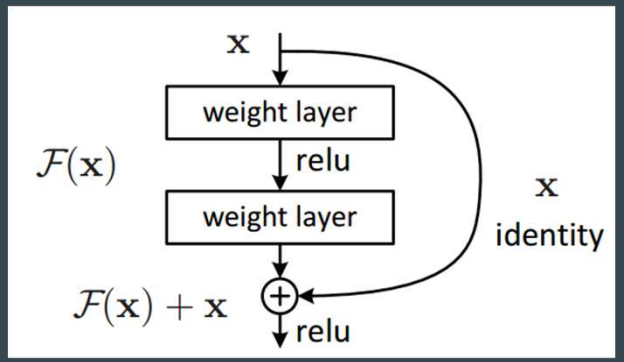
- Deep neural network
- 22 layers
- “Inception” module
- Batch normalization
- 4 million parameters (60 million for AlexNet)





# ResNet

- Different layers: 18, 34, 50, 101, 152
- Residual learning
- Batch normalization after each convolution




| Layer Name | Output Size | ResNet-18 |
|---|---|---|
| conv1 | 112 × 112 × 64 | 7 × 7, 64, stride 2 |
| conv2_x | 56 × 56 × 64 | 3 × 3 max pool, stride 2 |
| | | $\begin{bmatrix} 3 \times 3, 64 \\ 3 \times 3, 64 \end{bmatrix} \times 2$ |
| conv3_x | 28 × 28 × 128 | $\begin{bmatrix} 3 \times 3, 128 \\ 3 \times 3, 128 \end{bmatrix} \times 2$ |
| conv4_x | 14 × 14 × 256 | $\begin{bmatrix} 3 \times 3, 256 \\ 3 \times 3, 256 \end{bmatrix} \times 2$ |
| conv5_x | 7 × 7 × 512 | $\begin{bmatrix} 3 \times 3, 512 \\ 3 \times 3, 512 \end{bmatrix} \times 2$ |
| average pool | 1 × 1 × 512 | 7 × 7 average pool |
| fully connected | 1000 | 512 × 1000 fully connections |
| softmax | 1000 | |

# Test accuracy

| | SVM | ANN | CNN | ResNet |
|---|---|---|---|---|
| Balanced DataSet | 0.761 | 0.759 | 0.770 | 0.821 |
| Unbalanced DataSet | 0.765 | 0.800 | 0.802 | 0.886 |

- Highest test accuracy: ResNet
- Test accuracy on Balanced vs. Unbalanced data

✱ **Future works:** Try various designs!

# Thank you for watching!

## References


- Tan, P. N., Steinbach, M., & Kumar, V. (2016). Introduction to data mining. Pearson Education India.
- Kermany, D. S., Goldbaum, M., Cai, W., Valentim, C. C., Liang, H., Baxter, S. L., ... & Zhang, K. (2018). Identifying medical diagnoses and treatable diseases by image-based deep learning. *Cell*, *172*(5), 1122-1131.https://doi.org/10.1016/j.cell.2018.02.010