

# C247 Final Project

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| Model  | Training accuracy | Test accuracy |
|--|-------------------|---------------|
| Vanilla LSTM   | 100.0%            | 27.3%         |
| LSTM (only subject 1)                                      | 100.0%            | 20.0%         |
| Vanilla CNN  | 67.6%             | 59.8%         |
| Vanilla CNN (only subject 1)                               | 93.1%             | 52.0%         |
| Spatio-temporal CNN  | 95.1%             | 71.6%         |
| Spatio-temporal CNN w/ data-preprocessing                  | 97.1%             | 71.1%         |
| Spatio-temporal CNN (only subject 1)                       | 99.9%             | 58.0%         |
| Spatio-temporal CNN w/ data-preprocessing (only subject 1) | 99.9%             | 68.5%         |
| LSTM+CNN w/ data-preprocessing                             | 100.0%            | 62.5%         |
| LSTM+CNN w/ data-preprocessing (only subject 1)            | 100.0%            | 45.0%         |
| ViT  | 54.4%             | 42.0%         |
| ViT w/ data-preprocessing                                  | 58.6%             | 45.5%         |
| ViT (only subject 1)                                       | 77.8%             | 38.0%         |

| Layer (type)   | Output Shape       | Param # |
|----------------|--------------------|---------|
| Conv2d-1       | [-1, 32, 22, 1000] | 320     |
| Conv2d-2       | [-1, 32, 22, 1000] | 9,248   |
| MaxPool2d-3    | [-1, 32, 11, 500]  | 0       |
| BatchNorm2d-4  | [-1, 32, 11, 500]  | 64      |
| ELU-5          | [-1, 16, 11, 500]  | 0       |
| Dropout-6      | [-1, 32, 11, 500]  | 0       |
| Conv2d-7       | [-1, 16, 11, 500]  | 4,624   |
| Conv2d-8       | [-1, 16, 11, 500]  | 2,320   |
| MaxPool2d-9    | [-1, 16, 11, 250]  | 0       |
| BatchNorm2d-10 | [-1, 16, 11, 250]  | 32      |
| ELU-11         | [-1, 16, 11, 250]  | 0       |
| Dropout-12     | [-1, 16, 11, 250]  | 0       |
| Conv2d-13      | [-1, 8, 11, 250]   | 3,208   |
| Conv2d-14      | [-1, 8, 11, 250]   | 584     |
| MaxPool2d-15   | [-1, 8, 11, 125]   | 0       |
| BatchNorm2d-16 | [-1, 8, 11, 125]   | 16      |
| ELU-17         | [-1, 8, 11, 125]   | 0       |
| Dropout-18     | [-1, 8, 11, 125]   | 0       |
| Conv2d-19      | [-1, 4, 11, 125]   | 804     |
| Conv2d-20      | [-1, 4, 11, 125]   | 148     |
| AvgPool2d-21   | [-1, 4, 11, 25]    | 0       |
| BatchNorm2d-22 | [-1, 4, 11, 25]    | 8       |
| ELU-23         | [-1, 4, 11, 25]    | 0       |
| Dropout-24     | [-1, 4, 11, 25]    | 0       |
| Linear-25      | [-1, 256]          | 281,856 |
| Linear-26      | [-1, 64]           | 16,448  |
| Linear-27      | [-1, 16]           | 1,040   |
| Linear-28      | [-1, 4]            | 68      |
| Softmax-29     | [-1, 4]            | 0       |

Total params: 320,788

Vanilla CNN

| Layer (type)   | Output Shape       | Param # |
|----------------|--------------------|---------|
| Conv2d-1       | [-1, 32, 22, 1000] | 2,080   |
| BatchNorm2d-2  | [-1, 32, 22, 1000] | 64      |
| Conv2d-3       | [-1, 64, 1, 1000]  | 45,120  |
| BatchNorm2d-4  | [-1, 64, 1, 1000]  | 128     |
| ELU-5          | [-1, 64, 1, 1000]  | 0       |
| AvgPool2d-6    | [-1, 64, 1, 200]   | 0       |
| Dropout-7      | [-1, 64, 1, 200]   | 0       |
| Conv2d-8       | [-1, 64, 1, 200]   | 65,600  |
| Conv2d-9       | [-1, 64, 1, 200]   | 4,160   |
| BatchNorm2d-10 | [-1, 64, 1, 200]   | 128     |
| ELU-11         | [-1, 64, 1, 200]   | 0       |
| AvgPool2d-12   | [-1, 64, 1, 40]    | 0       |
| Dropout-13     | [-1, 64, 1, 40]    | 0       |
| Linear-14      | [-1, 256]          | 655,616 |
| Linear-15      | [-1, 4]            | 1,028   |

Total params: 773,924

Spatio-temporal CNN

| Layer (type) | Output Shape  | Param # |
|--------------|---------------|---------|
| Linear-1     | [-1, 500, 8]  | 360     |
| LayerNorm-2  | [-1, 501, 8]  | 16      |
| Linear-3     | [-1, 4]       | 20      |
| Linear-4     | [-1, 4]       | 20      |
| Linear-5     | [-1, 4]       | 20      |
| Softmax-6    | [-1, 501]     | 0       |
| Linear-7     | [-1, 4]       | 20      |
| Linear-8     | [-1, 4]       | 20      |
| Linear-9     | [-1, 4]       | 20      |
| Softmax-10   | [-1, 501]     | 0       |
| Linear-11    | [-1, 4]       | 20      |
| Linear-12    | [-1, 4]       | 20      |
| Linear-13    | [-1, 4]       | 20      |
| Softmax-14   | [-1, 501]     | 0       |
| Linear-15    | [-1, 4]       | 20      |
| Linear-16    | [-1, 4]       | 20      |
| Linear-17    | [-1, 4]       | 20      |
| Softmax-18   | [-1, 501]     | 0       |
| MSA-19       | [-1, 501, 8]  | 0       |
| LayerNorm-20 | [-1, 501, 8]  | 16      |
| Linear-21    | [-1, 501, 32] | 288     |
| GELU-22      | [-1, 501, 32] | 0       |
| Linear-23    | [-1, 501, 8]  | 264     |
| ViTBlock-24  | [-1, 501, 8]  | 0       |
| LayerNorm-25 | [-1, 501, 8]  | 16      |
| Linear-26    | [-1, 4]       | 20      |
| Linear-27    | [-1, 4]       | 20      |
| Linear-28    | [-1, 4]       | 20      |
| Softmax-29   | [-1, 501]     | 0       |
| Linear-30    | [-1, 4]       | 20      |
| Linear-31    | [-1, 4]       | 20      |
| Linear-32    | [-1, 4]       | 20      |
| Softmax-33   | [-1, 501]     | 0       |
| Linear-34    | [-1, 4]       | 20      |
| Linear-35    | [-1, 4]       | 20      |
| Linear-36    | [-1, 4]       | 20      |
| Softmax-37   | [-1, 501]     | 0       |
| Linear-38    | [-1, 4]       | 20      |
| Linear-39    | [-1, 4]       | 20      |
| Linear-40    | [-1, 4]       | 20      |
| Softmax-41   | [-1, 501]     | 0       |
| MSA-42       | [-1, 501, 8]  | 0       |
| LayerNorm-43 | [-1, 501, 8]  | 16      |
| Linear-44    | [-1, 501, 32] | 288     |
| GELU-45      | [-1, 501, 32] | 0       |
| Linear-46    | [-1, 501, 8]  | 264     |
| ViTBlock-47  | [-1, 501, 8]  | 0       |
| Linear-48    | [-1, 4]       | 36      |
| Softmax-49   | [-1, 4]       | 0       |

Total params: 2,044

Vision Transformer (ViT)

| Layer (type)   | Output Shape      | Param # |
|----------------|-------------------|---------|
| Conv2d-1       | [-1, 32, 22, 250] | 2,080   |
| BatchNorm2d-2  | [-1, 32, 22, 250] | 64      |
| Conv2d-3       | [-1, 64, 1, 250]  | 45,120  |
| BatchNorm2d-4  | [-1, 64, 1, 250]  | 128     |
| ELU-5          | [-1, 64, 1, 250]  | 0       |
| AvgPool2d-6    | [-1, 64, 1, 50]   | 0       |
| Dropout-7      | [-1, 64, 1, 50]   | 0       |
| Conv2d-8       | [-1, 64, 1, 50]   | 65,600  |
| Conv2d-9       | [-1, 64, 1, 50]   | 4,160   |
| BatchNorm2d-10 | [-1, 64, 1, 50]   | 128     |
| ELU-11         | [-1, 64, 1, 50]   | 0       |
| AvgPool2d-12   | [-1, 64, 1, 10]   | 0       |
| Dropout-13     | [-1, 64, 1, 10]   | 0       |
| Linear-14      | [-1, 256]         | 164,096 |
| Linear-15      | [-1, 4]           | 1,028   |

Total params: 282,404

Spatio-temporal CNN w/ data-preprocessing

| Layer (type)              | Input Shape  | Param # | Tr. Param # |
|---------------------------|--------------|---------|-------------|
| LSTM-1                    | [1, 250, 22] | 130,400 | 130,400     |
| Linear-2                  | [1, 100]     | 6,464   | 6,464       |
| BatchNorm1d-3             | [1, 64]      | 128     | 128         |
| ReLU-4                    | [1, 64]      | 0       | 0           |
| Dropout-5                 | [1, 64]      | 0       | 0           |
| Linear-6                  | [1, 64]      | 2,080   | 2,080       |
| BatchNorm1d-7             | [1, 32]      | 64      | 64          |
| ReLU-8                    | [1, 32]      | 0       | 0           |
| Linear-9                  | [1, 32]      | 132     | 132         |
| Total params: 139,268     |              |         |             |
| Trainable params: 139,268 |              |         |             |
| Non-trainable params: 0   |              |         |             |

Vanilla LSTM

| Layer (type)              | Input Shape      | Param # | Tr. Param # |
|---------------------------|------------------|---------|-------------|
| Conv2d-1                  | [1, 1, 250, 22]  | 3,250   | 3,250       |
| MaxPool2d-2               | [1, 50, 250, 22] | 0       | 0           |
| BatchNorm2d-3             | [1, 50, 83, 22]  | 100     | 100         |
| ELU-4                     | [1, 50, 83, 22]  | 0       | 0           |
| Dropout-5                 | [1, 50, 83, 22]  | 0       | 0           |
| Conv2d-6                  | [1, 50, 83, 22]  | 110,100 | 110,100     |
| MaxPool2d-7               | [1, 100, 83, 22] | 0       | 0           |
| BatchNorm2d-8             | [1, 100, 27, 22] | 200     | 200         |
| ELU-9                     | [1, 100, 27, 22] | 0       | 0           |
| Dropout-10                | [1, 100, 27, 22] | 0       | 0           |
| Conv2d-11                 | [1, 100, 27, 22] | 320,200 | 320,200     |
| MaxPool2d-12              | [1, 200, 27, 22] | 0       | 0           |
| BatchNorm2d-13            | [1, 200, 9, 22]  | 400     | 400         |
| ELU-14                    | [1, 200, 9, 22]  | 0       | 0           |
| Dropout-15                | [1, 200, 9, 22]  | 0       | 0           |
| Conv2d-16                 | [1, 200, 9, 22]  | 6,432   | 6,432       |
| MaxPool2d-17              | [1, 32, 9, 22]   | 0       | 0           |
| BatchNorm2d-18            | [1, 32, 3, 22]   | 64      | 64          |
| ELU-19                    | [1, 32, 3, 22]   | 0       | 0           |
| Dropout-20                | [1, 32, 3, 22]   | 0       | 0           |
| Linear-21                 | [1, 2112]        | 67,616  | 67,616      |
| LSTM-22                   | [1, 32]          | 134,400 | 134,400     |
| Linear-23                 | [1, 100]         | 6,464   | 6,464       |
| BatchNorm1d-24            | [1, 64]          | 128     | 128         |
| Dropout-25                | [1, 64]          | 0       | 0           |
| Linear-26                 | [1, 64]          | 2,080   | 2,080       |
| BatchNorm1d-27            | [1, 32]          | 64      | 64          |
| ELU-28                    | [1, 32]          | 0       | 0           |
| Linear-29                 | [1, 32]          | 132     | 132         |
| Total params: 651,630     |                  |         |             |
| Trainable params: 651,630 |                  |         |             |
| Non-trainable params: 0   |                  |         |             |

LSTM+CNN w/ data-preprocessing

(We used Adam as an optimizer and cross-entropy loss as a loss function in all the training)