I used:  
X\_jma shape: (85325, 10, 10)

y\_jma shape: (85325, 1)

def build\_optimized\_cnn\_gru\_model(input\_shape):  
 model = Sequential()  
  
 # CNN Layers  
 model.add(Conv1D(filters=64, kernel\_size=3, padding='same', input\_shape=input\_shape))  
 model.add(LeakyReLU(alpha=0.1)) # LeakyReLU for better gradient flow  
 model.add(BatchNormalization())  
 model.add(MaxPooling1D(pool\_size=2))  
  
 model.add(Conv1D(filters=128, kernel\_size=3, padding='same'))  
 model.add(LeakyReLU(alpha=0.1))  
 model.add(BatchNormalization())  
 model.add(MaxPooling1D(pool\_size=2))  
  
 # GRU Layers  
 model.add(GRU(units=192, return\_sequences=True, kernel\_regularizer=l2(0.0001)))  
 model.add(Dropout(0.3))  
 model.add(GRU(units=128, return\_sequences=False, kernel\_regularizer=l2(0.0001)))  
 model.add(Dropout(0.3))  
  
 # Dense Layers  
 model.add(Dense(units=64))  
 model.add(LeakyReLU(alpha=0.1))  
 model.add(Dropout(0.4))  
 model.add(Dense(units=1, activation='linear')) # Regression Output  
  
 # Compile the model  
 model.compile(optimizer=Adam(learning\_rate=0.001), loss='mse', metrics=['mae'])  
  
 return model

input\_shape = (10, 10) # Adjust based on your data  
model = build\_optimized\_cnn\_gru\_model(input\_shape)

from tensorflow.keras.callbacks import LearningRateScheduler  
# Define Callbacks  
early\_stopping = EarlyStopping(  
 monitor='val\_loss',  
 patience=15, # Stop if no improvement after 10 epochs  
 restore\_best\_weights=True  
)  
reduce\_lr = ReduceLROnPlateau(  
 monitor='val\_loss',  
 factor=0.5, # Reduce learning rate by half  
 patience=5, # After 5 epochs of no improvement  
 min\_lr=1e-6 # Minimum learning rate  
)  
# Define the learning rate scheduler function  
def lr\_schedule(epoch, lr):  
 if epoch % 5 == 0 and epoch != 0: # Decay every 5 epochs, excluding the first epoch  
 return lr \* 0.95 # Multiply the current learning rate by 0.9  
 return lr  
  
# Create the LearningRateScheduler callback  
lr\_scheduler = LearningRateScheduler(lr\_schedule, verbose=1)

# Adjust the input shape to match the new data  
input\_shape = (X\_jma.shape[1], X\_jma.shape[2]) # (10, 10)  
  
# Build the model  
model = build\_optimized\_cnn\_gru\_model(input\_shape)  
model.summary()

Model: "sequential\_28"

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Layer (type) Output Shape Param #

=================================================================

conv1d\_57 (Conv1D) (None, 10, 64) 1984

leaky\_re\_lu\_39 (LeakyReLU) (None, 10, 64) 0

batch\_normalization\_56 (Ba (None, 10, 64) 256

tchNormalization)

max\_pooling1d\_56 (MaxPooli (None, 5, 64) 0

ng1D)

conv1d\_58 (Conv1D) (None, 5, 128) 24704

leaky\_re\_lu\_40 (LeakyReLU) (None, 5, 128) 0

batch\_normalization\_57 (Ba (None, 5, 128) 512

tchNormalization)

max\_pooling1d\_57 (MaxPooli (None, 2, 128) 0

ng1D)

gru\_54 (GRU) (None, 2, 192) 185472

dropout\_69 (Dropout) (None, 2, 192) 0

gru\_55 (GRU) (None, 128) 123648

dropout\_70 (Dropout) (None, 128) 0

dense\_50 (Dense) (None, 64) 8256

leaky\_re\_lu\_41 (LeakyReLU) (None, 64) 0

dropout\_71 (Dropout) (None, 64) 0

dense\_51 (Dense) (None, 1) 65

=================================================================

Total params: 344897 (1.32 MB)

Trainable params: 344513 (1.31 MB)

Non-trainable params: 384 (1.50 KB)

# Train the model  
history = model.fit(  
 X\_jma, y\_jma,  
 validation\_split=0.2,  
 epochs=100, # Increased to 100 to allow for more learning  
 batch\_size=64,  
 callbacks=[early\_stopping, reduce\_lr, lr\_scheduler],  
)

I got:  
Training Loss: 0.5508

Training MAE: 0.5567

Epoch 1: LearningRateScheduler setting learning rate to 7.878116593929008e-05.

Epoch 1/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5633 - mae: 0.5636 - val\_loss: 0.5343 - val\_mae: 0.5699 - lr: 7.8781e-05

Epoch 2: LearningRateScheduler setting learning rate to 7.878116593929008e-05.

Epoch 2/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5628 - mae: 0.5632 - val\_loss: 0.5314 - val\_mae: 0.5683 - lr: 7.8781e-05

Epoch 3: LearningRateScheduler setting learning rate to 7.878116593929008e-05.

Epoch 3/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5632 - mae: 0.5635 - val\_loss: 0.5305 - val\_mae: 0.5693 - lr: 7.8781e-05

Epoch 4: LearningRateScheduler setting learning rate to 7.878116593929008e-05.

Epoch 4/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5614 - mae: 0.5623 - val\_loss: 0.5079 - val\_mae: 0.5473 - lr: 7.8781e-05

Epoch 5: LearningRateScheduler setting learning rate to 7.878116593929008e-05.

Epoch 5/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5629 - mae: 0.5631 - val\_loss: 0.5094 - val\_mae: 0.5495 - lr: 7.8781e-05

Epoch 6: LearningRateScheduler setting learning rate to 7.484210764232557e-05.

Epoch 6/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5617 - mae: 0.5632 - val\_loss: 0.5018 - val\_mae: 0.5424 - lr: 7.4842e-05

Epoch 7: LearningRateScheduler setting learning rate to 7.484210800612345e-05.

Epoch 7/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5622 - mae: 0.5626 - val\_loss: 0.5097 - val\_mae: 0.5509 - lr: 7.4842e-05

Epoch 8: LearningRateScheduler setting learning rate to 7.484210800612345e-05.

Epoch 8/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5616 - mae: 0.5627 - val\_loss: 0.5055 - val\_mae: 0.5467 - lr: 7.4842e-05

Epoch 9: LearningRateScheduler setting learning rate to 7.484210800612345e-05.

Epoch 9/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5605 - mae: 0.5621 - val\_loss: 0.5084 - val\_mae: 0.5473 - lr: 7.4842e-05

Epoch 10: LearningRateScheduler setting learning rate to 7.484210800612345e-05.

Epoch 10/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5609 - mae: 0.5624 - val\_loss: 0.5049 - val\_mae: 0.5437 - lr: 7.4842e-05

Epoch 11: LearningRateScheduler setting learning rate to 7.110000260581728e-05.

Epoch 11/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5616 - mae: 0.5627 - val\_loss: 0.5152 - val\_mae: 0.5528 - lr: 3.5550e-05

Epoch 12: LearningRateScheduler setting learning rate to 3.555000148480758e-05.

Epoch 12/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5597 - mae: 0.5616 - val\_loss: 0.5034 - val\_mae: 0.5435 - lr: 3.5550e-05

Epoch 13: LearningRateScheduler setting learning rate to 3.555000148480758e-05.

Epoch 13/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5607 - mae: 0.5624 - val\_loss: 0.5028 - val\_mae: 0.5432 - lr: 3.5550e-05

Epoch 14: LearningRateScheduler setting learning rate to 3.555000148480758e-05.

Epoch 14/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5588 - mae: 0.5615 - val\_loss: 0.5102 - val\_mae: 0.5505 - lr: 3.5550e-05

Epoch 15: LearningRateScheduler setting learning rate to 3.555000148480758e-05.

Epoch 15/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5608 - mae: 0.5623 - val\_loss: 0.4996 - val\_mae: 0.5412 - lr: 3.5550e-05

Epoch 16: LearningRateScheduler setting learning rate to 3.37725014105672e-05.

Epoch 16/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5580 - mae: 0.5616 - val\_loss: 0.5063 - val\_mae: 0.5471 - lr: 3.3772e-05

Epoch 17: LearningRateScheduler setting learning rate to 3.37724995915778e-05.

Epoch 17/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5594 - mae: 0.5614 - val\_loss: 0.5056 - val\_mae: 0.5459 - lr: 3.3772e-05

Epoch 18: LearningRateScheduler setting learning rate to 3.37724995915778e-05.

Epoch 18/100

1067/1067 [==============================] - 11s 10ms/step - loss: 0.5594 - mae: 0.5619 - val\_loss: 0.5017 - val\_mae: 0.5421 - lr: 3.3772e-05

Epoch 19: LearningRateScheduler setting learning rate to 3.37724995915778e-05.

Epoch 19/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5574 - mae: 0.5602 - val\_loss: 0.5021 - val\_mae: 0.5429 - lr: 3.3772e-05

Epoch 20: LearningRateScheduler setting learning rate to 3.37724995915778e-05.

Epoch 20/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5579 - mae: 0.5604 - val\_loss: 0.5101 - val\_mae: 0.5508 - lr: 1.6886e-05

Epoch 21: LearningRateScheduler setting learning rate to 1.6041937305999452e-05.

Epoch 21/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5561 - mae: 0.5606 - val\_loss: 0.5047 - val\_mae: 0.5455 - lr: 1.6042e-05

Epoch 22: LearningRateScheduler setting learning rate to 1.6041936760302633e-05.

Epoch 22/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5554 - mae: 0.5590 - val\_loss: 0.5114 - val\_mae: 0.5529 - lr: 1.6042e-05

Epoch 23: LearningRateScheduler setting learning rate to 1.6041936760302633e-05.

Epoch 23/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5560 - mae: 0.5596 - val\_loss: 0.5034 - val\_mae: 0.5442 - lr: 1.6042e-05

Epoch 24: LearningRateScheduler setting learning rate to 1.6041936760302633e-05.

Epoch 24/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5572 - mae: 0.5600 - val\_loss: 0.5046 - val\_mae: 0.5451 - lr: 1.6042e-05

Epoch 25: LearningRateScheduler setting learning rate to 1.6041936760302633e-05.

Epoch 25/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5577 - mae: 0.5604 - val\_loss: 0.5083 - val\_mae: 0.5483 - lr: 8.0210e-06

Epoch 26: LearningRateScheduler setting learning rate to 7.61991996114375e-06.

Epoch 26/100

1067/1067 [==============================] - 10s 9ms/step - loss: 0.5554 - mae: 0.5592 - val\_loss: 0.5039 - val\_mae: 0.5437 - lr: 7.6199e-06

Epoch 27: LearningRateScheduler setting learning rate to 7.6199198701942805e-06.

Epoch 27/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5578 - mae: 0.5611 - val\_loss: 0.5076 - val\_mae: 0.5478 - lr: 7.6199e-06

Epoch 28: LearningRateScheduler setting learning rate to 7.6199198701942805e-06.

Epoch 28/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5562 - mae: 0.5600 - val\_loss: 0.5010 - val\_mae: 0.5415 - lr: 7.6199e-06

Epoch 29: LearningRateScheduler setting learning rate to 7.6199198701942805e-06.

Epoch 29/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5559 - mae: 0.5593 - val\_loss: 0.5005 - val\_mae: 0.5410 - lr: 7.6199e-06

Epoch 30: LearningRateScheduler setting learning rate to 7.6199198701942805e-06.

Epoch 30/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5567 - mae: 0.5599 - val\_loss: 0.4983 - val\_mae: 0.5382 - lr: 7.6199e-06

Epoch 31: LearningRateScheduler setting learning rate to 7.238923876684566e-06.

Epoch 31/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5562 - mae: 0.5597 - val\_loss: 0.5063 - val\_mae: 0.5470 - lr: 7.2389e-06

Epoch 32: LearningRateScheduler setting learning rate to 7.238923899421934e-06.

Epoch 32/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5558 - mae: 0.5593 - val\_loss: 0.5080 - val\_mae: 0.5485 - lr: 7.2389e-06

Epoch 33: LearningRateScheduler setting learning rate to 7.238923899421934e-06.

Epoch 33/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5559 - mae: 0.5588 - val\_loss: 0.5108 - val\_mae: 0.5511 - lr: 7.2389e-06

Epoch 34: LearningRateScheduler setting learning rate to 7.238923899421934e-06.

Epoch 34/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5564 - mae: 0.5598 - val\_loss: 0.5091 - val\_mae: 0.5493 - lr: 7.2389e-06

Epoch 35: LearningRateScheduler setting learning rate to 7.238923899421934e-06.

Epoch 35/100

1067/1067 [==============================] - 11s 10ms/step - loss: 0.5561 - mae: 0.5600 - val\_loss: 0.4998 - val\_mae: 0.5405 - lr: 3.6195e-06

Epoch 36: LearningRateScheduler setting learning rate to 3.4384888522254183e-06.

Epoch 36/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5543 - mae: 0.5587 - val\_loss: 0.5060 - val\_mae: 0.5469 - lr: 3.4385e-06

Epoch 37: LearningRateScheduler setting learning rate to 3.4384888749627862e-06.

Epoch 37/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5558 - mae: 0.5594 - val\_loss: 0.5049 - val\_mae: 0.5454 - lr: 3.4385e-06

Epoch 38: LearningRateScheduler setting learning rate to 3.4384888749627862e-06.

Epoch 38/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5568 - mae: 0.5598 - val\_loss: 0.5046 - val\_mae: 0.5450 - lr: 3.4385e-06

Epoch 39: LearningRateScheduler setting learning rate to 3.4384888749627862e-06.

Epoch 39/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5560 - mae: 0.5593 - val\_loss: 0.5030 - val\_mae: 0.5438 - lr: 3.4385e-06

Epoch 40: LearningRateScheduler setting learning rate to 3.4384888749627862e-06.

Epoch 40/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5549 - mae: 0.5586 - val\_loss: 0.5062 - val\_mae: 0.5472 - lr: 1.7192e-06

Epoch 41: LearningRateScheduler setting learning rate to 1.6332822156073233e-06.

Epoch 41/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5565 - mae: 0.5595 - val\_loss: 0.5047 - val\_mae: 0.5455 - lr: 1.6333e-06

Epoch 42: LearningRateScheduler setting learning rate to 1.6332821815012721e-06.

Epoch 42/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5541 - mae: 0.5583 - val\_loss: 0.5018 - val\_mae: 0.5423 - lr: 1.6333e-06

Epoch 43: LearningRateScheduler setting learning rate to 1.6332821815012721e-06.

Epoch 43/100

1067/1067 [==============================] - 11s 10ms/step - loss: 0.5540 - mae: 0.5587 - val\_loss: 0.5043 - val\_mae: 0.5451 - lr: 1.6333e-06

Epoch 44: LearningRateScheduler setting learning rate to 1.6332821815012721e-06.

Epoch 44/100

1067/1067 [==============================] - 11s 10ms/step - loss: 0.5553 - mae: 0.5592 - val\_loss: 0.5011 - val\_mae: 0.5417 - lr: 1.6333e-06

Epoch 45: LearningRateScheduler setting learning rate to 1.6332821815012721e-06.

Epoch 45/100

1067/1067 [==============================] - 10s 10ms/step - loss: 0.5566 - mae: 0.5602 - val\_loss: 0.5028 - val\_mae: 0.5434 - lr: 1.0000e-06



