Vietnam National University Ho Chi Minh City
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Faculty of Information Technology
Module: Advanced Topics in Software Development Technology

Trading Rule Identification by CNN

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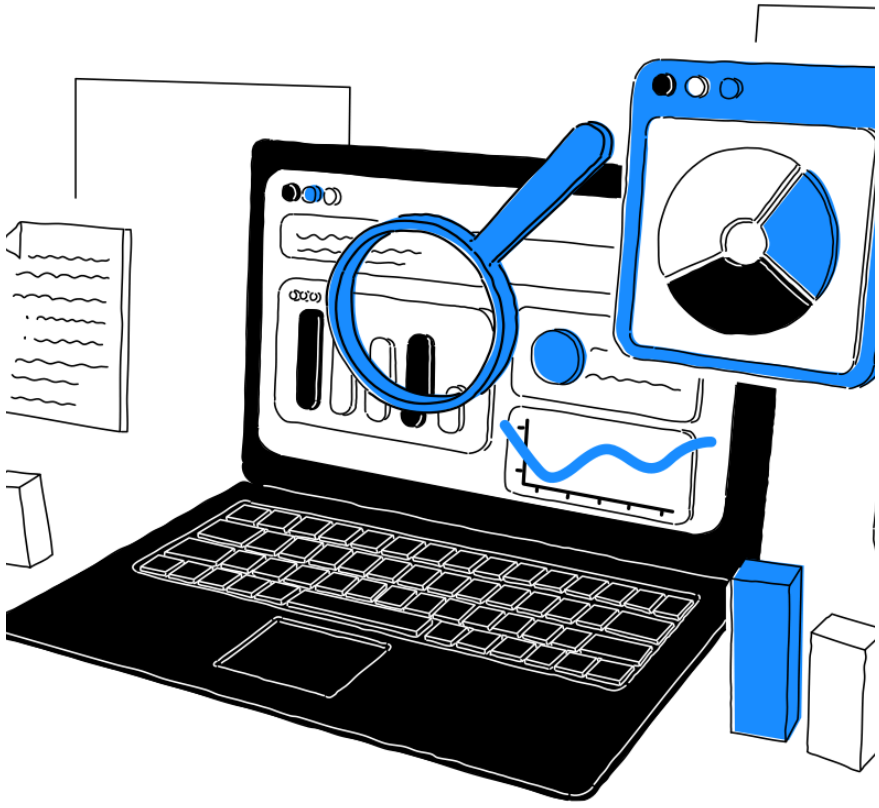
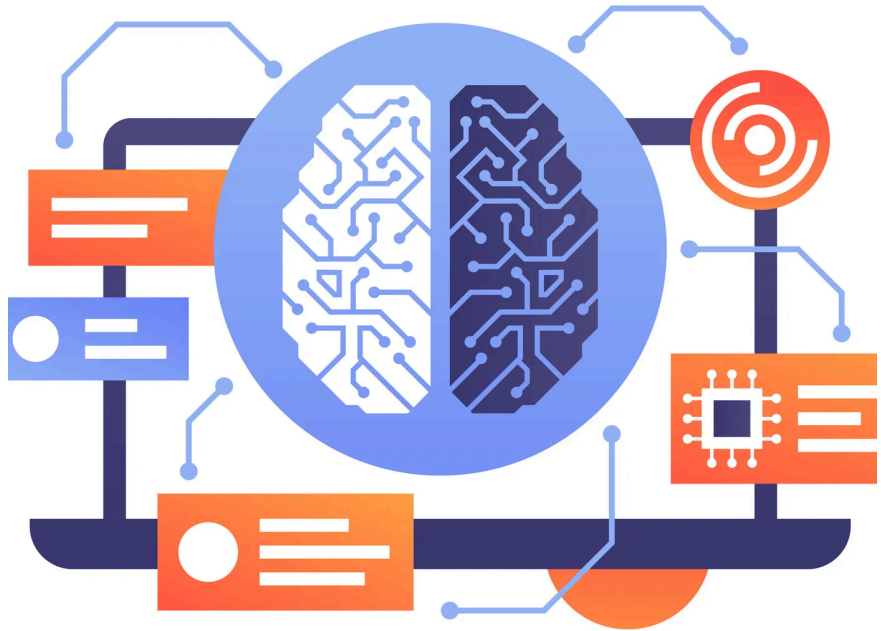


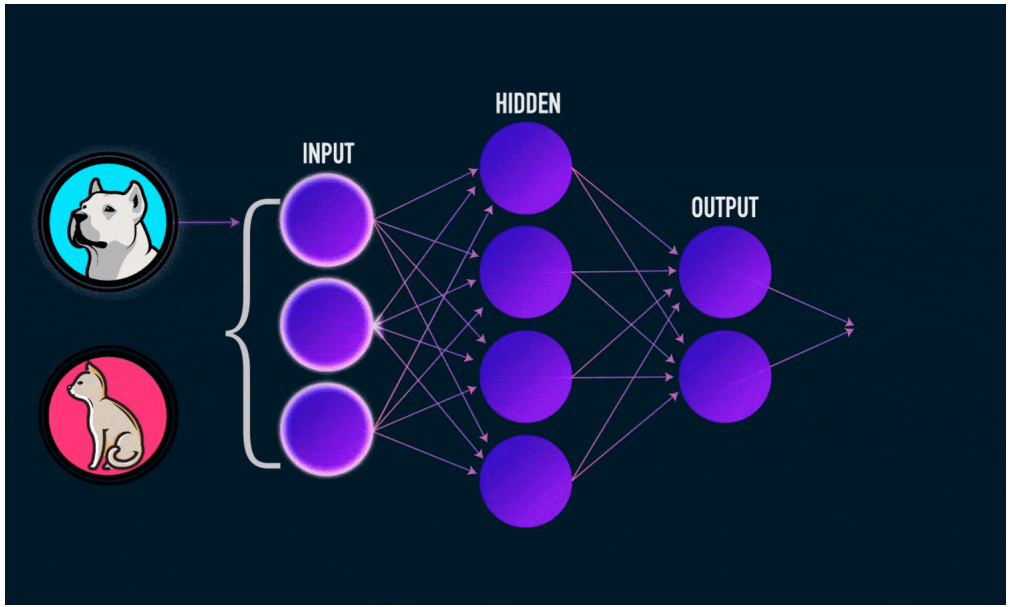
Data handling

Benchmarking alternative models



Benchmarking alternative models

Constructing a convolutional neural network



Human Decision Process in Trading

- Filter noise by observing multiple data points
- Confidence builds with consistent price trends
- Compare new data to historical patterns
- Act if patterns match confidently
- CNNs automate this decision-making
- Apply across multiple assets

Modeling Investment Logic

- Optimal observation period before trading
- Use moving-average data over 12 days
- Take most frequent action
- Hold if multiple crossovers or confusion
- If 8 out of 12 actions are to buy, consider buying
- Identify patterns to validate actions

Selecting the Network Architecture

Selecting the appropriate architecture depends on the input data:

- Input defined as a tensor to capture temporal features
- Utilize multiple data points to capture volatility
- Convolutional layer size depends on data analysis depth
- Use bigger convolutional windows for capturing moving averages

Architecture selection is an art rather than a science:

Heuristics can guide rather than dictate the process

CNN Architecture

- An input layer: 12 x 3 tensor representing 12 observations of 3 features
- A convolutional layer: Convolution to a space of a 6 x 6 tensor to capture patterns
- A pooling layer to flatten the data
- An output layer with 3 classes

Setting up the data in the correct format

Explanation of Data Segmentation

- Data is segmented into smaller segments.
- Each segment typically contains 12 observations.
- Overlapping windows capture patterns across data points.
- Segmented data is converted to NumPy arrays for CNN input.
- Arrays are saved in h5 files for efficient retrieval.
- Utility functions aid TensorFlow code implementation.

Setting up the data in the correct format

Split the data into windows of the required time horizon

```
def windows(data, size):
    # Hàm này tạo ra các cửa sổ (windows) từ dữ liệu với kích thước được định nghĩa bởi 'size'.
    start = 0  # Khởi tạo biến bắt đầu tại vị trí 0
    while start < data.count():  # Tiếp tục tạo cửa sổ cho đến khi vị trí bắt đầu vượt quá số lượng phần tử trong dữ liệu
        yield int(start), int(start + size)  # Trả về một cặp giá trị (start, start + size) đại diện cho cửa sổ dữ liệu hiện tại
        start += (size / 2)  # Di chuyển vị trí bắt đầu thêm nửa kích thước cửa sổ để tạo ra cửa sổ mới (các cửa sổ sẽ chồng lấn lé
```

Setting up the data in the correct format

Segment the data into a signal and its corresponding label

```
def segment_signal(data,window_size = 12):
    segments = np.empty((0,window_size,6))
    labels = np.empty((0))
    for (start, end) in windows(data['Date'], window_size):
        x = data["mav5"][start:end]
        y = data["mav10"][start:end]
        z = data["mav20"][start:end]
        a = data["mav30"][start:end]
        b = data["mav50"][start:end]
        c = data["mav100"][start:end]
        if(len(data['Date'][start:end]) == window_size):
            segments = np.vstack([segments,np.dstack([x,y,z,a,b,c])])
            unique_labels, counts = np.unique(data["Action"][start:end], return_counts=True)
            most_frequent_label = unique_labels[np.argmax(counts)]
            labels = np.append(labels, most_frequent_label)
    return segments, labels
```

Setting up the data in the correct format

Create batches from these segments that can be used to train our model

```
def get_batches(X, y, batch_size=100):
    """ Trả về một generator cho các batch """

    # Tính số lượng batch có thể tạo ra
    n_batches = len(X) // batch_size

    # Cắt bớt dữ liệu X và y để phù hợp với số lượng batch
    X, y = X[:n_batches*batch_size], y[:n_batches*batch_size]

    # Lặp qua các batch và trả về từng batch
    for b in range(0, len(X), batch_size):
        yield X[b:b+batch_size], y[b:b+batch_size]

# Mạng nơ-ron được huấn luyện theo từng batch để tránh tình trạng tràn bộ nhớ.
```

Setting up the data in the correct format

Create the training and test data in a format that can be used by TensorFlow

```
def create_tensorflow_train_data(csvfilename):
    df = pd.read_csv('sampledata/'+ csvfilename)
    df = df[['Date','symbolid','buyret','sellret','Action','mav5', 'mav10','mav20','mav30','mav50','mav100']]
    df['Action'].fillna('None', inplace=True)
    symbols = df.symbolid.unique()
    segments, labels = segment_signal(df[df.symbolid == symbols[0]])
    df = df[df.symbolid != symbols[0]]
    symbols = symbols[1:]
    for i in range(0,len(symbols)):
        x, a = segment_signal(df[df.symbolid == symbols[i]])
        segments = np.concatenate((segments, x), axis = 0)
        labels = np.concatenate((labels, a), axis = 0)
        df = df[df.symbolid != symbols[i]]
        print(str(round(i/len(symbols)*100,2)) + ' percent done')
    list_ch_train = pd.get_dummies(labels)
    list_ch_train = np.asarray(list_ch_train.columns)
    labels = np.asarray(pd.get_dummies(labels), dtype = np.int8)
    X_tr, X_vld, lab_tr, lab_vld = train_test_split(segments, labels, stratify = labels, random_state = 123)
```


Setting up the data in the correct format

Create the training and test data in a format that can be used by TensorFlow

```
def create_tensorflow_test_data(csvfilename):
    df = pd.read_csv('sampledata/'+ csvfilename)
    df = df[['Date','symbolid','buyret','sellret','Action','mav5', 'mav10','mav20','mav30','mav50','mav100']]
    df['Action'].fillna('None', inplace=True)
    list_ch_test = df.Action.unique()
    symbols = df.symbolid.unique()
    segments, labels = segment_signal(df[df.symbolid == symbols[0]])
    df = df[df.symbolid != symbols[0]]
    symbols = symbols[1:]
    for i in range(0,len(symbols)):
        x, a = segment_signal(df[df.symbolid == symbols[i]])
        segments = np.concatenate((segments, x), axis = 0)
        labels = np.concatenate((labels, a), axis = 0)
        df = df[df.symbolid != symbols[i]]
        print(str(round(i/len(symbols)*100,2)) + ' percent done')
    list_ch_test = pd.get_dummies(labels)
    list_ch_test = np.asarray(list_ch_test.columns)
    labels = np.asarray(pd.get_dummies(labels), dtype = np.int8)
    X_test = segments
```

Setting up the data in the correct format

The training and test data saved as h5 files

```
def savedataset(csvfilename, h5filename):
    dt = h5py.special_dtype(vlen=str)
    hf = h5py.File('h5files/'+ h5filename, 'w')
    for i in range(0,len(csvfilename)):
        csvfile = csvfilename[i]
        if(csvfile[:4] != 'test'):
            X_tr, X_vld, lab_tr, lab_vld, list_ch_train = create_tensorflow_train_data(csvfile)
            hf.create_dataset('X_tr',data=X_tr)
            hf.create_dataset('X_vld',data=X_vld)
            hf.create_dataset('lab_tr',data=lab_tr)
            hf.create_dataset('lab_vld',data=lab_vld)
            hf.create_dataset('list_ch_train',data=list_ch_train, dtype = dt)
            del(X_tr, X_vld, lab_tr, lab_vld, list_ch_train)
        else:
            X_test, y_test, list_ch_test = create_tensorflow_test_data(csvfile)
            hf.create_dataset('X_test', data = X_test)
            hf.create_dataset('y_test', data = y_test)
            hf.create_dataset('list_ch_test', data = list_ch_test, dtype = dt)
            del(X_test, y_test, list_ch_test)
```

Setting up the data in the correct format

The training and test data saved as h5 files

```
def get_tf_train_data(h5filename):

    hf = h5py.File('h5files/' + h5filename, 'r')
    X_tr = hf['X_tr'][:]
    X_vld = hf['X_vld'][:]
    lab_tr = hf['lab_tr'][:]
    lab_vld = hf['lab_vld'][:]
    list_ch_train = hf['list_ch_train'][:]
    hf.close()
    return X_tr, X_vld, lab_tr, lab_vld, list_ch_train

def get_tf_test_data(h5filename):

    hf = h5py.File('h5files/' + h5filename, 'r')
    X_test = hf['X_test'][:]
    y_test = hf['y_test'][:]
    list_ch_test = hf['list_ch_test'][:]

    return X_test, y_test, list_ch_test
```

Training and testing the model

Read the train data

```
traindtfile = 'hdf_50.h5'
testdtfile = 'hdf_50.h5'
losssavefig = 'cnn_train_50_loss.png'
accsavefig = 'cnn_train_50_accuracy.png'
resultsave = 'cnn_train_50.h5'
chkpointdir = 'cnn-50/'

X_tr, X_vld, y_tr, y_vld, list_ch_train = get_tf_train_data(traindtfile)
```

Training and testing the model

Define hyperparameters

```
batch_size = 600       # Batch size
seq_len = 12          # Number of steps
learning_rate = 0.0001
epochs = 1000
```

Summary