dqn-algorithm

December 22, 2023

[49]:
```
import numpy as np
import pandas as pd
import tensorflow as tf
from collections import deque
import random
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import MinMaxScaler
```

[50]:
```
df = pd.read_csv("/kaggle/input/salesforce-stock-date-latest-and-updated/
 ↪Salesforce_stock_history.csv")
df.head()
```

[50]:
```
         Date    Open    High     Low  Close    Volume  Dividends  \
0  2004-06-23  3.7500  4.3250  3.6875   4.30  43574400          0
1  2004-06-24  4.3875  4.4225  4.1250   4.19   8887200          0
2  2004-06-25  4.1275  4.1875  3.9475   3.95   6710000          0
3  2004-06-28  4.0000  4.0525  3.8600   4.00   2270800          0
4  2004-06-29  4.0000  4.1750  3.9575   4.10   2112000          0

   Stock Splits
0           0.0
1           0.0
2           0.0
3           0.0
4           0.0
```

[51]:
```
df['Date'] = pd.to_datetime(df['Date'])
df.set_index('Date', inplace=True)
```

[52]:
```
df.head()
```

[52]:
```
              Open    High     Low  Close    Volume  Dividends  Stock Splits
Date
2004-06-23  3.7500  4.3250  3.6875   4.30  43574400          0           0.0
2004-06-24  4.3875  4.4225  4.1250   4.19   8887200          0           0.0
2004-06-25  4.1275  4.1875  3.9475   3.95   6710000          0           0.0
```

```
2004-06-28  4.0000  4.0525  3.8600   4.00   2270800          0            0.0
2004-06-29  4.0000  4.1750  3.9575   4.10   2112000          0            0.0
```

[53]:
```
df.info()
```

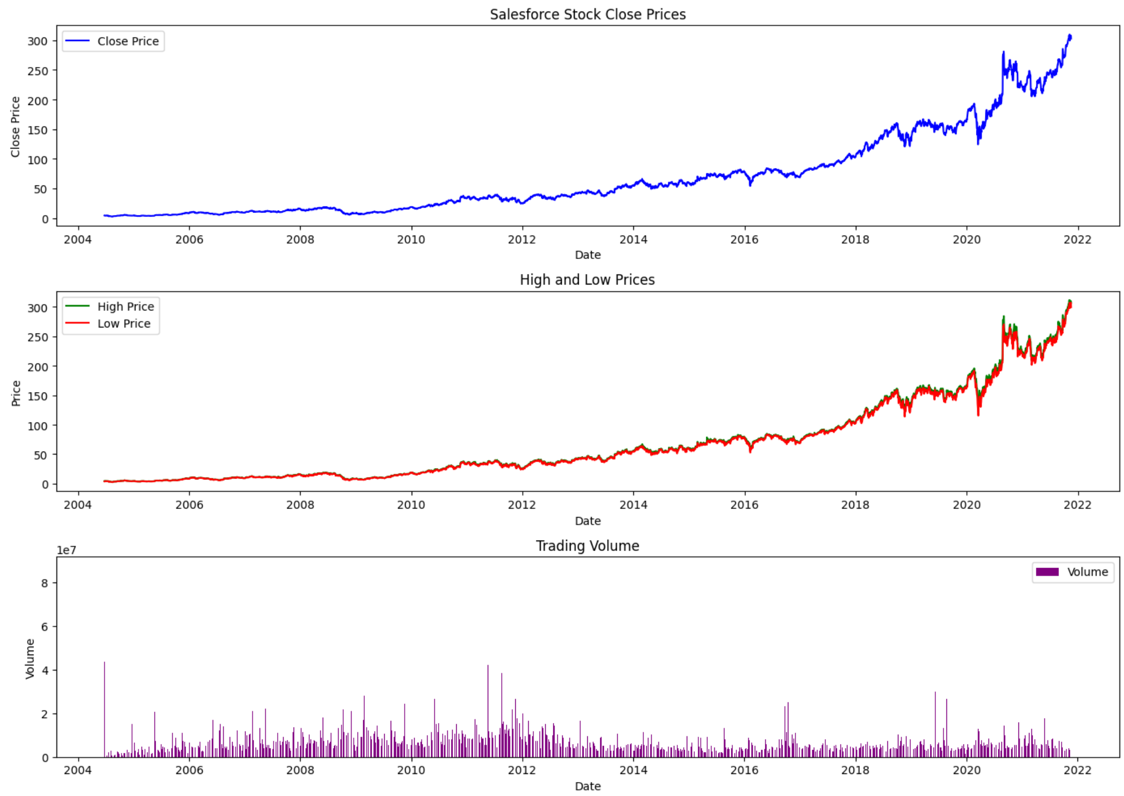
```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 4385 entries, 2004-06-23 to 2021-11-18
Data columns (total 7 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Open          4385 non-null   float64
 1   High          4385 non-null   float64
 2   Low           4385 non-null   float64
 3   Close         4385 non-null   float64
 4   Volume        4385 non-null   int64
 5   Dividends     4385 non-null   int64
 6   Stock Splits  4385 non-null   float64
dtypes: float64(5), int64(2)
memory usage: 274.1 KB
```

[54]:
```
df.describe()
```

[54]:
```
              Open         High          Low        Close        Volume  \
count  4385.000000  4385.000000  4385.000000  4385.000000  4.385000e+03
mean     68.295873    69.129664    67.392306    68.302940  6.903280e+06
std      69.520512    70.271386    68.656155    69.495068  5.300726e+06
min       2.400000     2.462500     2.250000     2.397500  4.636000e+05
25%      13.207500    13.560000    12.917500    13.195000  3.936800e+06
50%      41.880001    42.435001    41.387501    41.900002  5.544400e+06
75%      90.000000    90.699997    89.419998    90.120003  8.214400e+06
max     310.000000   311.750000   307.250000   309.959991  8.733240e+07

       Dividends  Stock Splits
count     4385.0   4385.000000
mean         0.0      0.000912
std          0.0      0.060405
min          0.0      0.000000
25%          0.0      0.000000
50%          0.0      0.000000
75%          0.0      0.000000
max          0.0      4.000000
```

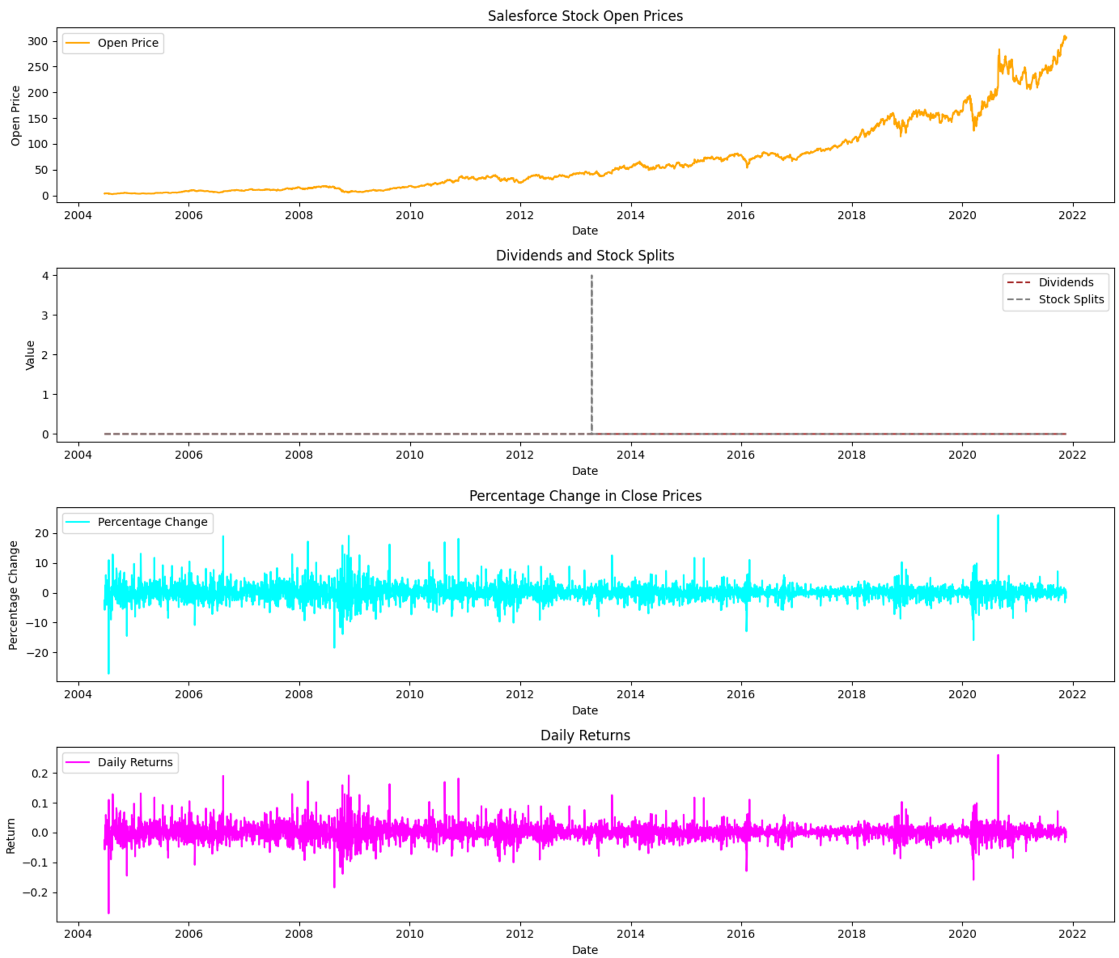
[55]:
```
# Plotting
plt.figure(figsize=(14, 10))

# Plot Close Prices
plt.subplot(3, 1, 1)
```

```python
plt.plot(df.index, df['Close'], label='Close Price', color='blue')
plt.title('Salesforce Stock Close Prices')
plt.xlabel('Date')
plt.ylabel('Close Price')
plt.legend()

# Plot High and Low Prices
plt.subplot(3, 1, 2)
plt.plot(df.index, df['High'], label='High Price', color='green')
plt.plot(df.index, df['Low'], label='Low Price', color='red')
plt.title('High and Low Prices')
plt.xlabel('Date')
plt.ylabel('Price')
plt.legend()

# Plot Trading Volume
plt.subplot(3, 1, 3)
plt.bar(df.index, df['Volume'], label='Volume', color='purple')
plt.title('Trading Volume')
plt.xlabel('Date')
plt.ylabel('Volume')
plt.legend()

plt.tight_layout()
plt.show()
```



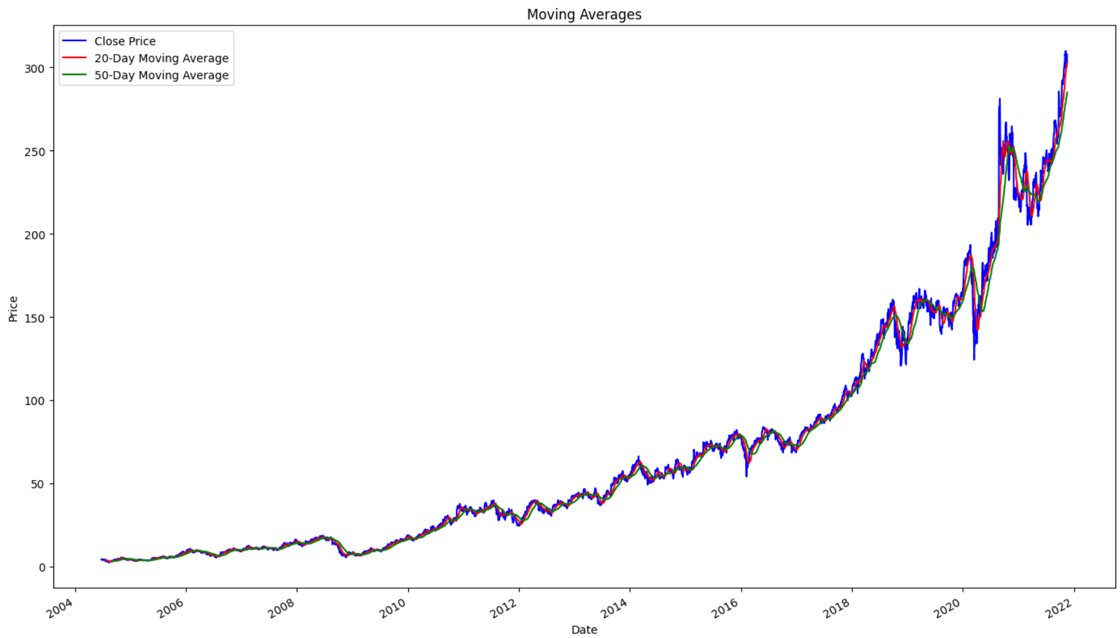
[56]:
```
plt.figure(figsize=(14, 12))

# Plot Open Prices
plt.subplot(4, 1, 1)
plt.plot(df.index, df['Open'], label='Open Price', color='orange')
plt.title('Salesforce Stock Open Prices')
plt.xlabel('Date')
plt.ylabel('Open Price')
plt.legend()

# Plot Dividends and Stock Splits
plt.subplot(4, 1, 2)
plt.plot(df.index, df['Dividends'], label='Dividends', color='brown',␣
↪linestyle='dashed')
plt.plot(df.index, df['Stock Splits'], label='Stock Splits', color='gray',␣
↪linestyle='dashed')
plt.title('Dividends and Stock Splits')
plt.xlabel('Date')
plt.ylabel('Value')
plt.legend()

# Plot Percentage Change in Close Prices
```

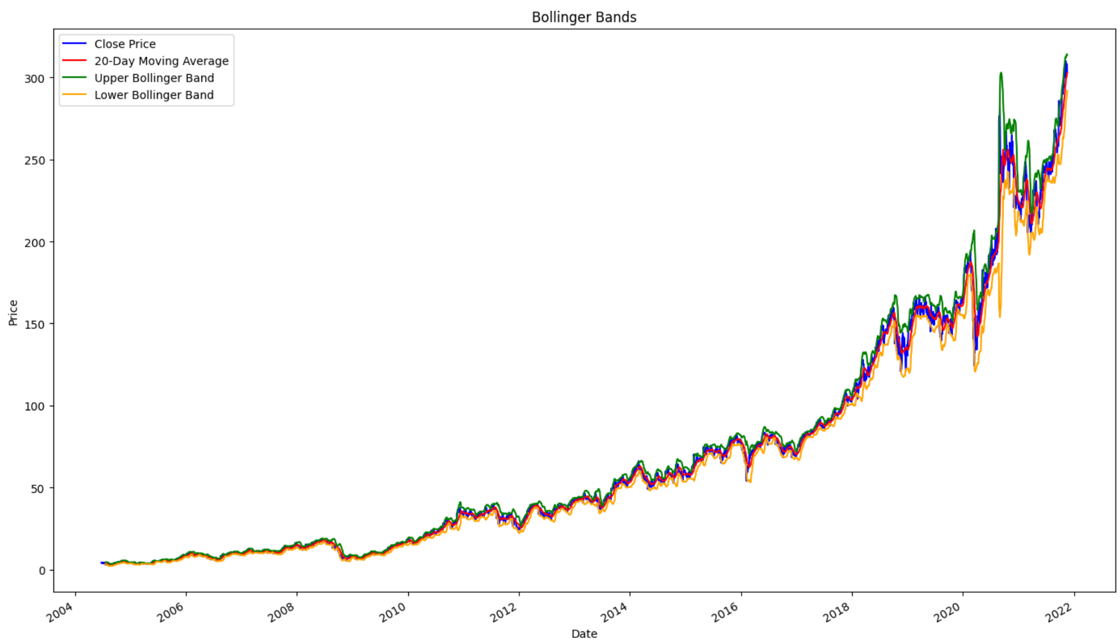
```
percentage_change = df['Close'].pct_change() * 100
plt.subplot(4, 1, 3)
plt.plot(df.index, percentage_change, label='Percentage Change', color='cyan')
plt.title('Percentage Change in Close Prices')
plt.xlabel('Date')
plt.ylabel('Percentage Change')
plt.legend()

# Plotting Daily Returns
daily_returns = df['Close'].pct_change()
plt.subplot(4, 1, 4)
plt.plot(df.index, daily_returns, label='Daily Returns', color='magenta')
plt.title('Daily Returns')
plt.xlabel('Date')
plt.ylabel('Return')
plt.legend()

plt.tight_layout()
plt.show()
```



[57]:

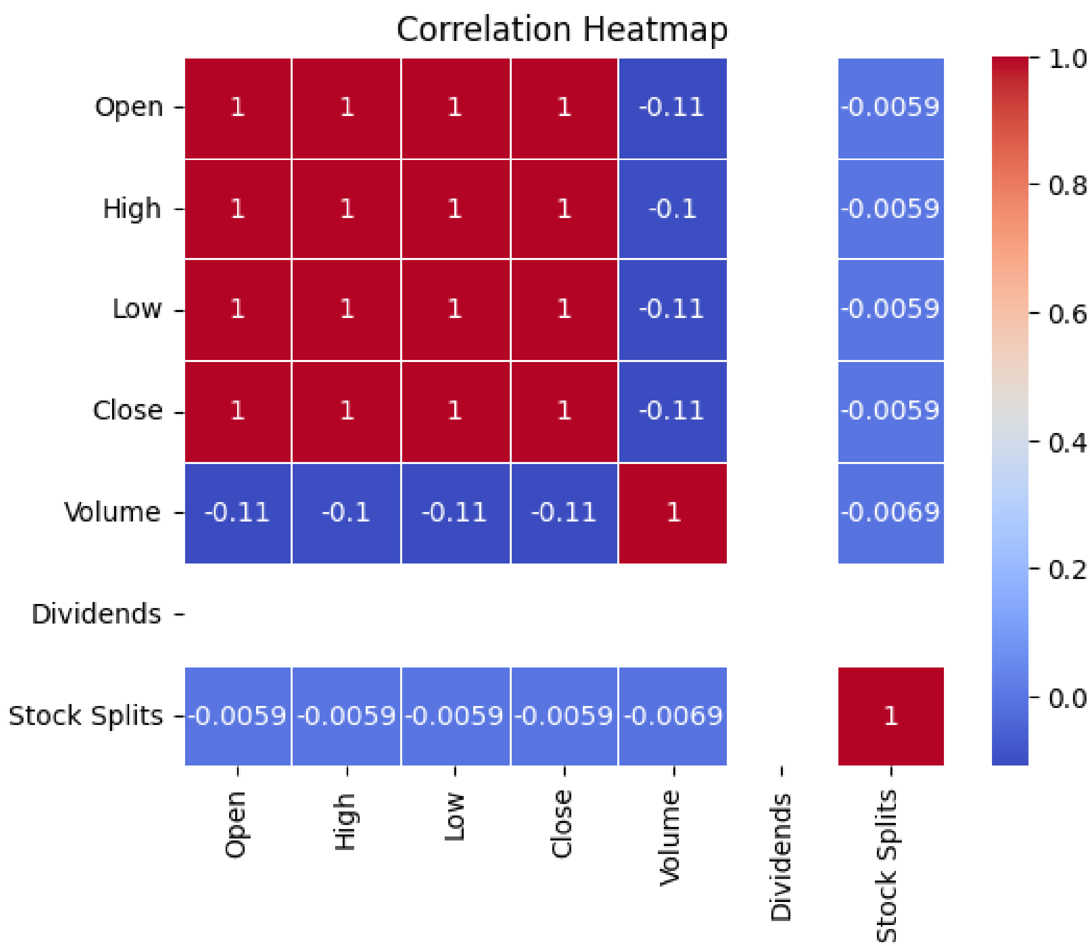
```
plt.figure(figsize=(14, 16))

# Plot Moving Averages
plt.subplot(2, 1, 1)
df['Close'].plot(label='Close Price', color='blue')
df['Close'].rolling(window=20).mean().plot(label='20-Day Moving Average',␣
 ↪color='red')
df['Close'].rolling(window=50).mean().plot(label='50-Day Moving Average',␣
 ↪color='green')
plt.title('Moving Averages')
plt.xlabel('Date')
plt.ylabel('Price')
plt.legend()

# Plot Bollinger Bands
rolling_mean = df['Close'].rolling(window=20).mean()
rolling_std = df['Close'].rolling(window=20).std()

upper_band = rolling_mean + (2 * rolling_std)
lower_band = rolling_mean - (2 * rolling_std)

plt.subplot(2, 1, 2)
df['Close'].plot(label='Close Price', color='blue')
rolling_mean.plot(label='20-Day Moving Average', color='red')
upper_band.plot(label='Upper Bollinger Band', color='green')
lower_band.plot(label='Lower Bollinger Band', color='orange')
plt.title('Bollinger Bands')
plt.xlabel('Date')
plt.ylabel('Price')
plt.legend()

plt.tight_layout()
plt.show()
```





[58]:
```
# Heatmap of Correlation
corr_matrix = df.corr()
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', linewidths=.5)
plt.title('Correlation Heatmap')
```

[58]: Text(0.5, 1.0, 'Correlation Heatmap')



1 Feature scaling (MinMaxScaler)

[59]:
```
scaler = MinMaxScaler(feature_range=(0, 1))
df_scaled = scaler.fit_transform(df[['Open', 'High', 'Low', 'Close', 'Volume',
    'Dividends', 'Stock Splits']])
df_scaled = pd.DataFrame(df_scaled, columns=['Open', 'High', 'Low', 'Close',
    'Volume', 'Dividends', 'Stock Splits'])
df_scaled['Date'] = df.index
df_scaled.set_index('Date', inplace=True)
```

2 Define DQN class

[60]:
```python
class DQNAgent:
    def __init__(self, state_size, action_size):
        self.state_size = state_size
        self.action_size = action_size
        self.memory = deque(maxlen=2000)
        self.gamma = 0.95   # Discount factor
        self.epsilon = 1.0  # Exploration rate
        self.epsilon_decay = 0.995
        self.epsilon_min = 0.01
        self.learning_rate = 0.001
        self.model = self.build_model()

    def build_model(self):
        model = tf.keras.Sequential()
        model.add(tf.keras.layers.Dense(24, input_dim=self.state_size,
 ↪activation='relu'))
        model.add(tf.keras.layers.Dense(24, activation='relu'))
        model.add(tf.keras.layers.Dense(self.action_size, activation='linear'))
        model.compile(loss='mse', optimizer=tf.keras.optimizers.Adam(lr=self.
 ↪learning_rate))
        return model

    def remember(self, state, action, reward, next_state, done):
        self.memory.append((state, action, reward, next_state, done))

    def act(self, state):
        if np.random.rand() <= self.epsilon:
            return np.random.choice(self.action_size)
        q_values = self.model.predict(state)
        return np.argmax(q_values[0])

    def replay(self, batch_size):
        if len(self.memory) < batch_size:
            return
        minibatch = random.sample(self.memory, batch_size)
        for state, action, reward, next_state, done in minibatch:
            target = reward
            if not done:
                target = (reward + self.gamma * np.amax(self.model.
 ↪predict(next_state)[0]))
            target_f = self.model.predict(state)
            target_f[0][action] = target
            self.model.fit(state, target_f, epochs=1, verbose=0)
        if self.epsilon > self.epsilon_min:
            self.epsilon *= self.epsilon_decay
```

[61]:
```
# Preprocess function for the state
def preprocess_state(state):
    return np.reshape(state, [1, state_size])
```

[62]:
```
# Initialize the environment
state_size = 7  # Number of features
action_size = 3  # Buy, Hold, Sell
```

[63]:
```
# Initialize DQNAgent
agent = DQNAgent(state_size, action_size)
```

3 Training the agent

[64]:
```
num_episodes = 10  # Set the desired number of episodes
batch_size = 32
skip_factor = 5  # Skip every 5 data points
print_frequency = 1  # Set the desired frequency for printing progress

for episode in tqdm(range(num_episodes), desc='Training Episodes',␣
 ↪unit='episode'):
    for i in range(0, len(df_scaled) - 1, skip_factor):
        state = preprocess_state(np.array([df_scaled.iloc[i].values]))
        next_state = preprocess_state(np.array([df_scaled.iloc[i + 1].values]))
        action = agent.act(state)

        # Assume a simple reward function (customize as needed)
        reward = 1 if df['Close'].iloc[i + 1] > df['Close'].iloc[i] else -1
        done = i + skip_factor >= len(df_scaled) - 1  # Done at the last step␣
 ↪or when skipping is about to go out of bounds
        agent.remember(state, action, reward, next_state, done)

    agent.replay(batch_size)

print('Training completed.')
```

```
Training Episodes:   0%|          | 0/10 [00:00<?, ?episode/s]

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Training Episodes:  10%|          | 1/10 [00:09<01:24,  9.35s/episode]

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Training Episodes:  20%|          | 2/10 [00:20<01:21, 10.13s/episode]

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Training Episodes:  40%|        | 4/10 [00:39<00:58,  9.77s/episode]

1/1 [==============================] - 0s 25ms/step
1/1 [==============================] - 0s 27ms/step
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Training Episodes:  50%|          | 5/10 [00:48<00:48,  9.72s/episode]

1/1 [==============================] - 0s 23ms/step
1/1 [==============================] - 0s 23ms/step
1/1 [==============================] - 0s 25ms/step
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Training Episodes:  60%|       | 6/10 [00:58<00:38,  9.68s/episode]

1/1 [==============================] - 0s 25ms/step
1/1 [==============================] - 0s 27ms/step
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Training Episodes:  70%|       | 7/10 [01:08<00:29,  9.86s/episode]

1/1 [==============================] - 0s 24ms/step
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Training Episodes:  80%|       | 8/10 [01:18<00:20, 10.00s/episode]

1/1 [==============================] - 0s 28ms/step
1/1 [==============================] - 0s 25ms/step
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Training Episodes:  90%|      | 9/10 [01:30<00:10, 10.62s/episode]

1/1 [==============================] - 0s 25ms/step
1/1 [==============================] - 0s 26ms/step
1/1 [==============================] - 0s 25ms/step
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1/1 [==============================] - 0s 26ms/step
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Training Episodes: 100%|          | 10/10 [01:43<00:00, 10.32s/episode]

Training completed.
```

4 Evaluate the trained agent

[65]:
```python
state = preprocess_state(np.array([df_scaled.iloc[0].values]))
total_reward = 0

for i in range(len(df_scaled) - 1):
    action = agent.act(state)
    next_state = preprocess_state(np.array([df_scaled.iloc[i + 1].values]))

    # Assume a simple reward function for evaluation
    reward = 1 if df['Close'].iloc[i + 1] > df['Close'].iloc[i] else -1
    done = i == len(df_scaled) - 2  # Done at the last step
    agent.remember(state, action, reward, next_state, done)
    total_reward += reward
```

```
    state = next_state

print(f'Total Evaluation Reward: {total_reward}')
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Total Evaluation Reward: 122
```

5 Plotting

[66]:
```
buy_sell_actions = [action[1] for action in agent.memory]

plt.figure(figsize=(12, 6))

# Plot Close Prices
plt.subplot(2, 1, 1)
plt.plot(df.index, df['Close'], label='Close Price', color='blue')
plt.title('Salesforce Stock Close Prices')
plt.xlabel('Date')
plt.ylabel('Close Price')
plt.legend()

# Plot Buy/Sell signals
plt.subplot(2, 1, 2)
# Make sure the dimensions match
plt.plot(df.index[:-1][:len(buy_sell_actions)], buy_sell_actions, label='Buy/
 ↪Sell Signal', marker='o', color='red')
plt.title('Buy/Sell Signals')
plt.xlabel('Date')
plt.ylabel('Action (0: Hold, 1: Buy, 2: Sell)')
plt.legend()
```

```
plt.tight_layout()
plt.show()
```