Simulating Stock Prices With Monte Carlo Methods

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Background

- A Markov chain is a random sequence of events where the next step depends only on the previous step

- A monte carlo simulation is the process of determining properties of a phenomenon using random sampling and the law of large numbers[1]

Background (cont.)

- Daily volatility of a stock's return is the standard deviation of the daily percent change[2]

- Compound Annual Growth Rate (CAGR) measures the annualized return over a set time, assuming any profits are reinvested[3]

Procedure

1. Gather data (quandl, yahoo, etc.)
2. Calculate volatility and CAGR

Volatility

```
vol = prices['Return'].std()
vol
```

```
0.030330551761188238
```

Growth rate

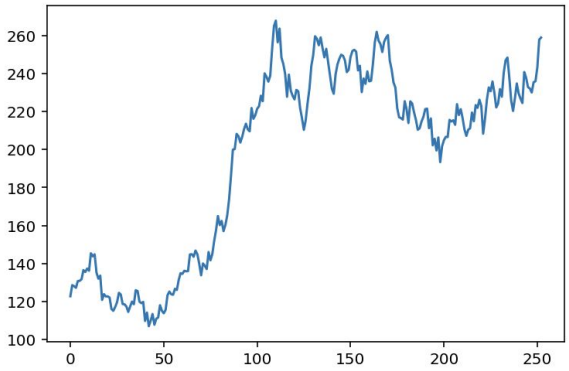
```
growth = prices['Adj Close'][-1] / prices['Adj Close'][0]
days = (prices.index[-1] - prices.index[0]).days
timeframe = days / 365
annual_growth = (growth ** (1/timeframe)) - 1
```

Procedure (cont.)

3. Compute distribution
   a. Assuming a Normal distribution with mean CAGR / 252 and variance equal to daily volatility
4. Sample one year of random returns and run a single Markov chain with them

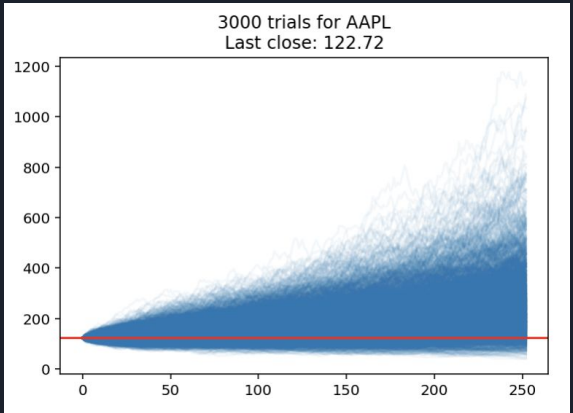
Distribution and Markov Chain

```
mu = annual_growth / 252
rand_returns = np.random.normal(mu, vol, 252) + 1
res = [prices['Adj Close'][-1]]

for r in rand_returns:
    res.append(res[-1] * r)

plt.plot(range(len(res)), res)
plt.show()
```



Procedure (cont.)

5. Repeat step 4 thousands of times to construct a Monte Carlo simulation of stock movement over 1 year
6. (optional) Compute the probability of profit and mean price in a year



Probability of profit

```
sum(end_prices > last_close) / trials
```

```
0.9
```

```
print(f'Last close: {last_close}, Average simulated close: {np.mean(end_prices)}')
```

```
Last close: 122.72000122070312, Average simulated close: 258.15811148209286
```

Disclaimer: This is a random simulation and should not be used as investment advice/guidance

References and Further Reading

- (1) Monte Carlo Methods
- Markov Chains
- (2) Volatility
- (3) Compound Annual Growth Rate