Welcome to Portfolio Analysis!

INTRODUCTION TO PORTFOLIO ANALYSIS IN PYTHON

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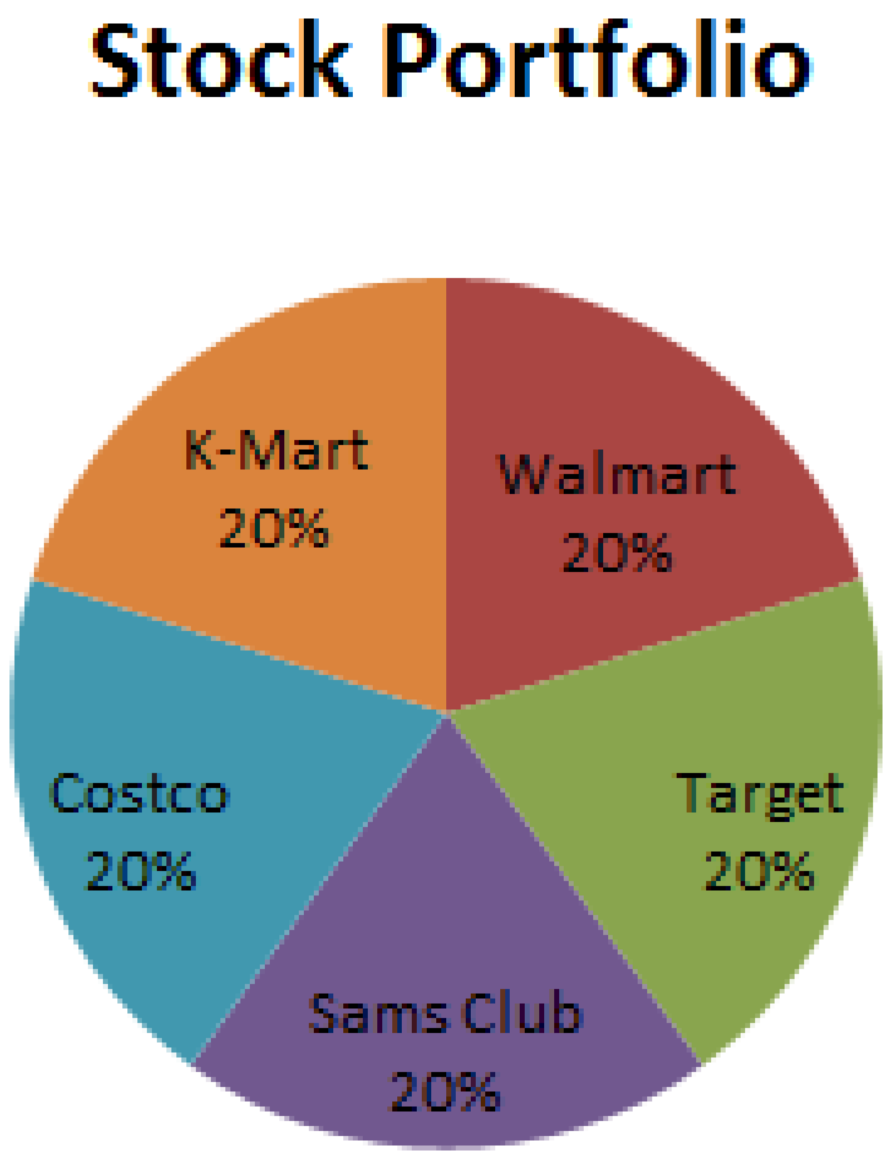
Hi! My name is Charlotte

BLACKROCK

Man | AHL

1737 VAN LANSCHOT KEMPEN

What is a portfolio



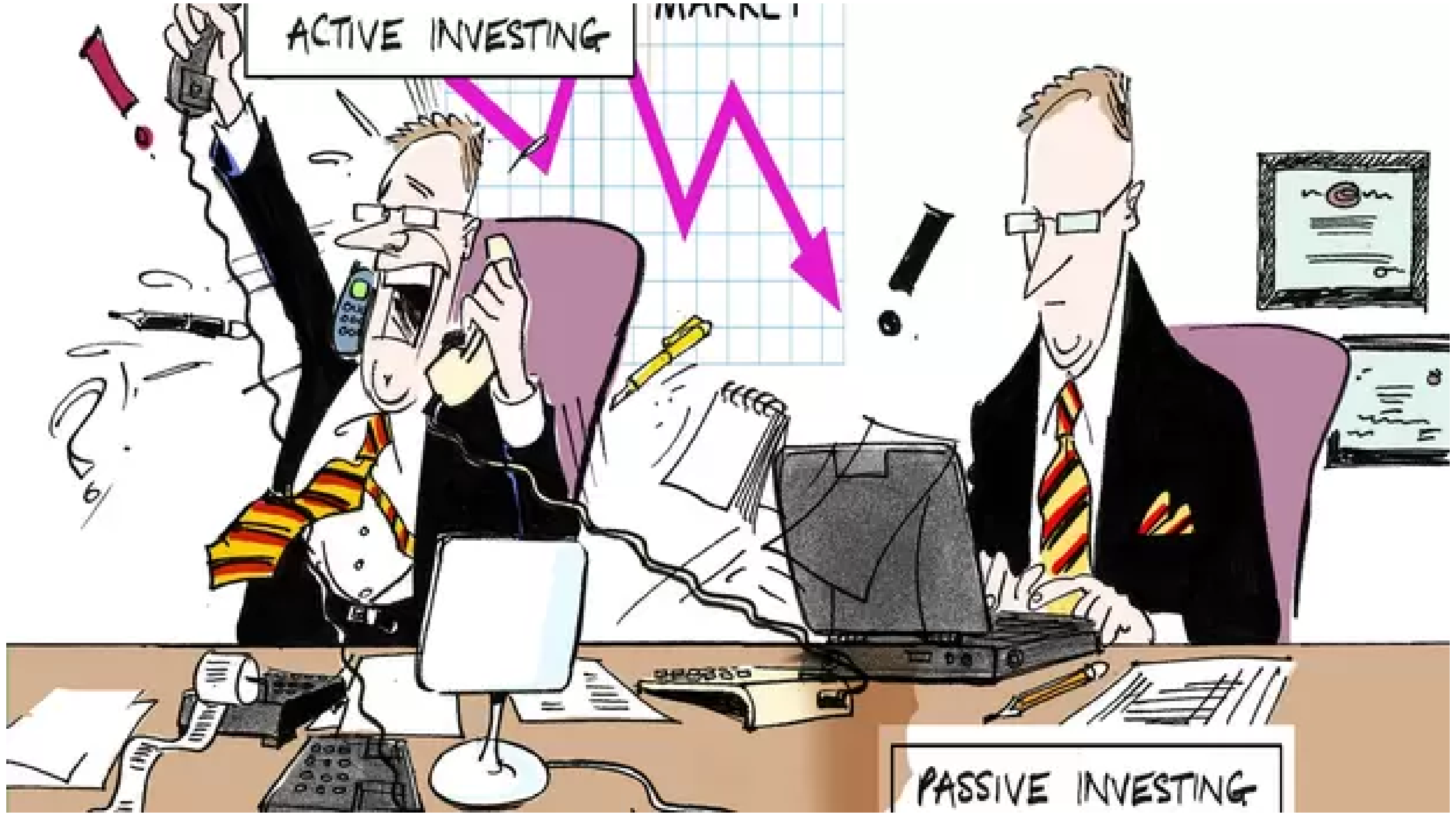
Why do we need portfolio analysis

Portfolio versus fund versus index

- Portfolio: a **collection of investments** (stocks, bonds, commodities, other funds) often **owned by an individual**
- Fund: a **pool of investments** that is **managed by a professional fund manager**. Individual investors buy "units" of the fund and the manager invests the money
- Index: A smaller **sample of the market** that is representative of the whole, e.g. S&P500, Nasdaq, Russell 2000, MSCI World Index

Active versus passive investing

- Passive investing: following a benchmark as closely as possible
- Active investing: taking active "bets" that are different from a benchmark
- Long only strategies: small deviations from a benchmark
- Hedgefunds: no benchmark but 'total return strategies'



Diversification

1. Single stock investments expose you to: a sudden change in management, disappointing financial performance, weak economy, an industry slump, etc
2. Good diversification means combining stocks that are different: risk, cyclical, counter-cyclical, industry, country

Typical portfolio strategies

- Equal weighted portfolios
- Market-cap weighted portfolios
- Risk-return optimized portfolios

Let's practice!

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Portfolio returns

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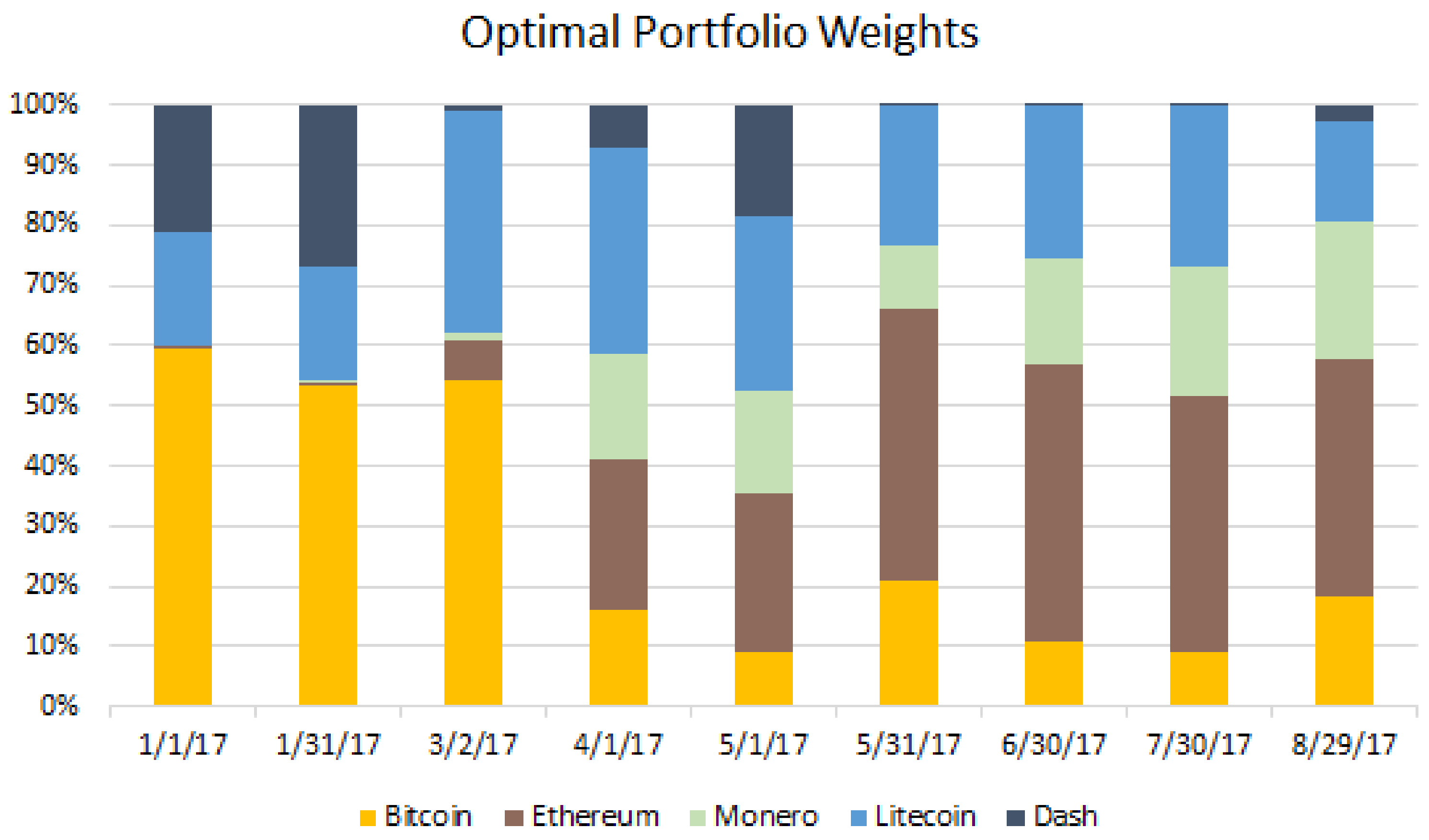
What are portfolio weights?

- Weight is the percentage composition of a particular asset in a portfolio
- All weights together have to sum up to 100%
- Weights and diversification (few large investments versus many small investments)



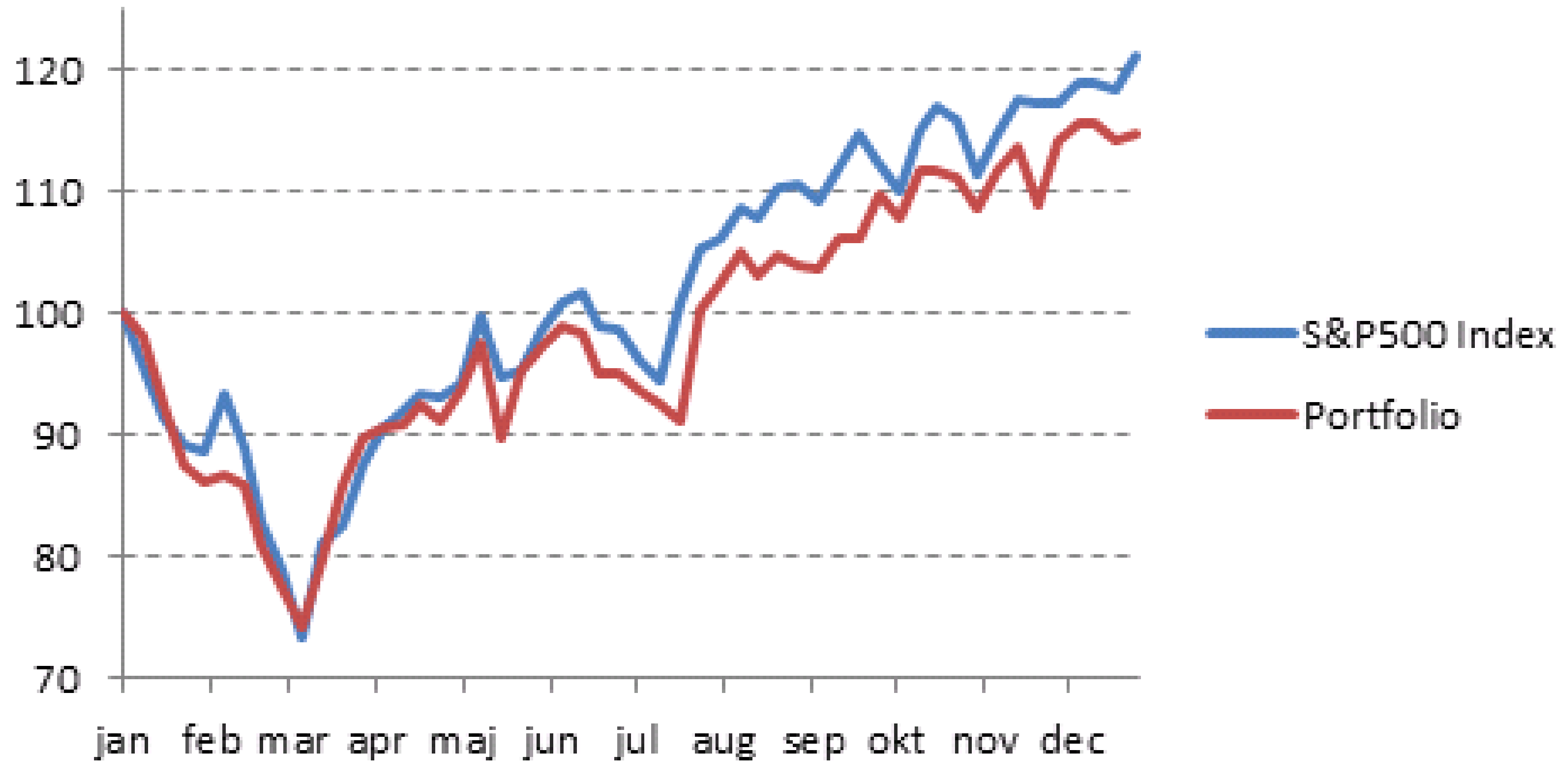
Calculating portfolio weights

- Calculate by dividing the value of a security by total value of the portfolio
- Equal weighted portfolio, or market cap weighted portfolio
- Weights determine your investment strategy, and can be set to optimize risk and expected return

$$Weight = \frac{Stock's\ value}{Total\ portfolio\ value}\ x\ 100$$

Portfolio returns

- Changes in value over time
- $Return_t = \frac{V_t - V_{t-1}}{V_{t-1}}$



Portfolio returns

- $Return_t = \frac{V_t - V_{t-1}}{V_{t-1}}$
- Historic average returns often used to calculate **expected** return
- Warning for confusion: average return, cumulative return, active return, and annualized return

Calculating returns from pricing data

```
df.head(2)
```

```
             AAPL     AMZN      TSLA
date
2018-03-25   13.88    114.74    92.48
2018-03-26   13.35    109.95    89.79
```

```
# Calculate returns over each day
returns = df.pct_change()
```

```
returns.head(2)
```

```
             AAPL          AMZN        TSLA
date
2018-03-25   NaN            NaN        NaN
2018-03-26   -0.013772    0.030838    0.075705
```

Calculating returns from pricing data

```
weights = np.array([0, 0.50, 0.25])
```

```
# Calculate average return for each stock
meanDailyReturns = returns.mean()
```

```
# Calculate portfolio return
portReturn = np.sum(meanDailyReturns*weights)
print (portReturn)
```

```
0.05752375881537723
```

Calculating cumulative returns

```
# Calculate daily portfolio returns
returns['Portfolio']= returns.dot(weights)
```

```
# Let's see what it looks like
returns.head(3)
```

```
                AAPL        AMZN        TSLA        Portfolio
date
2018-03-23    -0.020974    -0.026739    -0.029068    -0.025880
2018-03-26    -0.013772    0.030838     0.075705     0.030902
```

Calculating cumulative returns

```
# Compound the percentage returns over time
daily_cum_ret=(1+returns).cumprod()
```

```
# Plot your cumulative return
daily_cum_ret.Portfolio.plot()
```

Cumulative return plot

Let's practice!

Measuring risk of a portfolio

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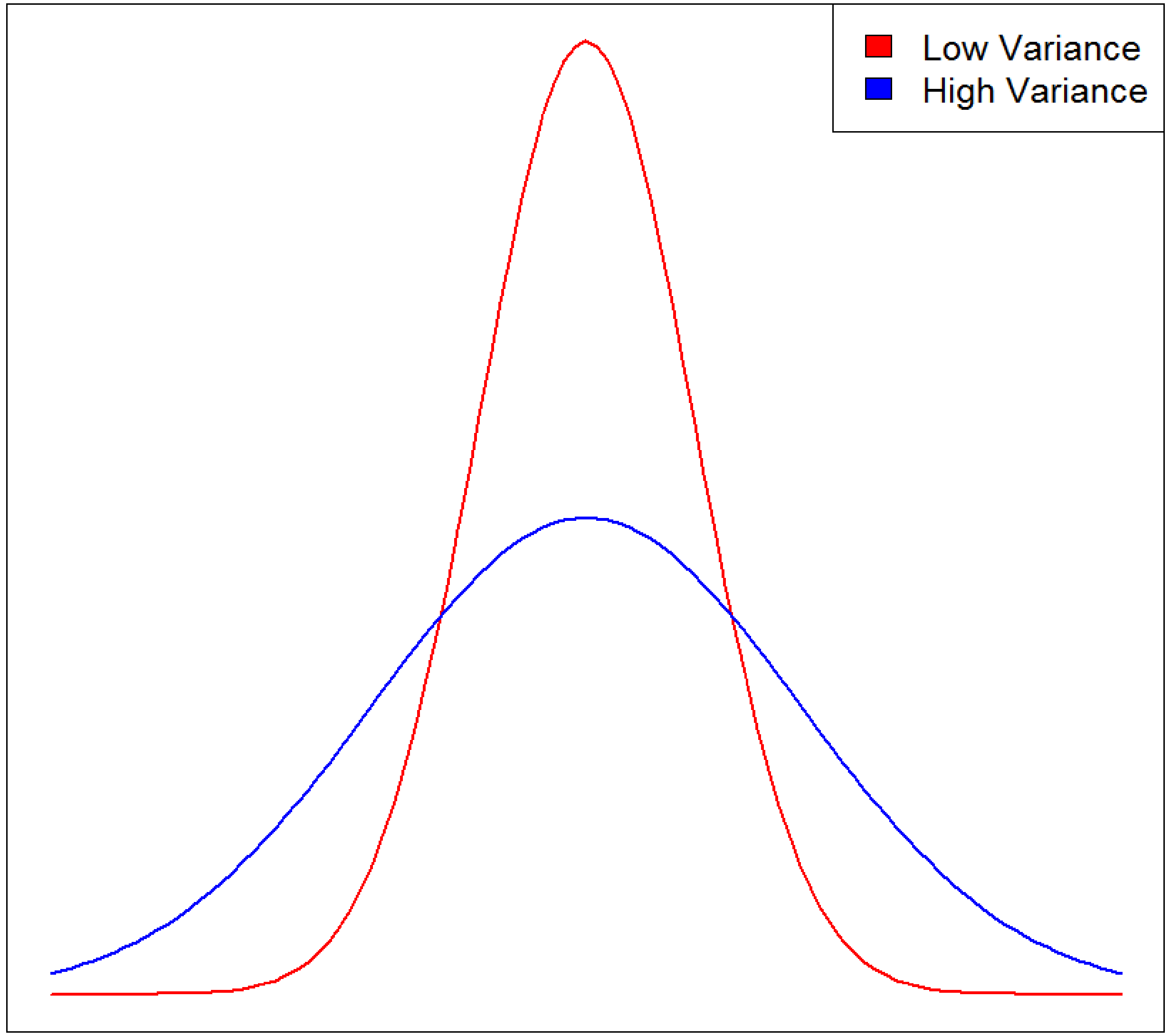
Risk of a portfolio

- Investing is risky: individual assets will go up or down
- Expected return is a **random variable**
- Returns spread around the mean is measured by the **variance** σ^2 and is a common measure of volatility
- $\sigma^2 = \frac{\sum_{i=1}^{N}(X-\mu)^2}{N}$

Variance

- Variance of an individual asset varies: some have more or less spread around the mean
- Variance of the portfolio is **not** simply the weighted variances of the underlying assets
- Because returns of assets are correlated, it becomes complex

High Variance vs Low Variance



How do variance and correlation relate to portfolio risk?

- The **correlation** between asset 1 and 2 is denoted by $\rho_{1,2}$, and tells us to which extend assets move together
- The **portfolio variance** takes into account the individual assets' **variances** $(\sigma_1^2, \sigma_2^2, etc)$, the **weights** of the assets in the portfolio (w_1, w_2), as well as their **correlation** to each other
- The **standard deviation** (σ) is equal to the square root of variance (σ^2), both are a measure of volatility

Calculating portfolio variance

$$\sigma_{pf}^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$$

- $\rho_{1,2}\sigma_1\sigma_2$ is called the covariance between asset 1 and 2
- The covariance can also be written as $\sigma_{1,2}$
- This let's us write:

$$\sigma_{pf}^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_{1,2}$$

Re-writing the portfolio variance shorter

$$\sigma^2_{pf} = w_1^2\sigma_1^2 + 2w_1w_2\sigma_{1,2} + w_2^2\sigma_2^2$$

- This can be re-written in matrix notation, which you can use more easily in code:

$$\sigma^2_{pf} = [w_1 \ w_2] \begin{bmatrix} \sigma_1^2 & \sigma_{1,2} \\ \sigma_{2,1} & \sigma_2^2 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}$$

- In words, what we need to calculate in python is: Portfolio variance = Weights transposed x (Covariance matrix x Weights)

Portfolio variance in python

```
price_data.head(2)

ticker        AAPL      FB       GE      GM      WMT
date
2018-03-21    171.270   169.39   13.88   37.58   88.18
2018-03-22    168.845   164.89   13.35   36.35   87.14
```

```
# Calculate daily returns from prices
daily_returns = df.pct_change()
```

```
# Construct a covariance matrix for the daily returns data
cov_matrix_d = daily_returns.cov()
```

Portfolio variance in python

```
# Construct a covariance matrix from the daily_returns
cov_matrix_d = (daily_returns.cov())*250
print (cov_matrix_d)

        AAPL        FB          GE          GM          WMT
AAPL    0.053569    0.026822    0.013466    0.018119    0.010798
FB      0.026822    0.062351    0.015298    0.017250    0.008765
GE      0.013466    0.015298    0.045987    0.021315    0.009513
GM      0.018119    0.017250    0.021315    0.058651    0.011894
WMT     0.010798    0.008765    0.009513    0.011894    0.041520
```

```
weights = np.array([0.2, 0.2, 0.2, 0.2, 0.2])
```

Portfolio variance in python

```
# Calculate the variance with the formula
port_variance = np.dot(weights.T, np.dot(cov_matrix_a, weights))
print (port_variance)


0.022742232726360567
```

```
# Just converting the variance float into a percentage
print(str(np.round(port_variance, 3) * 100) + '%')


2.3%
```

```
port_stddev = np.sqrt(np.dot(weights.T, np.dot(cov_matrix_a, weights)))
print(str(np.round(port_stddev, 3) * 100) + '%')
15.1%
```

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