Why Math

Introduction to Math Finance and Courses

Shang-Yuan Shiu

Department of Mathematics
National Central University

at Interdisciplinary Program of Science

September 18, 2018

Where to work

You can be a

Where to work

You can be a

- Actuary;

Where to work

You can be a

- Actuary;
- Data Analyst;

Where to work

You can be a

- Actuary;
- Data Analyst;
- Statistician;

Where to work

You can be a

- Actuary;
- Data Analyst;
- Statistician;
- Mathematician.

Where to work

You can be a

- Actuary;
- Data Analyst;
- Statistician;
- Mathematician.

You can work at

Where to work

You can be a

- Actuary;
- Data Analyst;
- Statistician;
- Mathematician.

You can work at

- Hedge fund company: Renaissance Technologies (Top 3, US$84 billion on 2018);

Where to work

You can be a

- Actuary;
- Data Analyst;
- Statistician;
- Mathematician.

You can work at

- Hedge fund company: Renaissance Technologies (Top 3, US$84 billion on 2018);
- Bank;

Where to work

You can be a

- Actuary;
- Data Analyst;
- Statistician;
- Mathematician.

You can work at

- Hedge fund company: Renaissance Technologies (Top 3, US$84 billion on 2018);
- Bank;
- Pharmaceutical industry;

Where to work

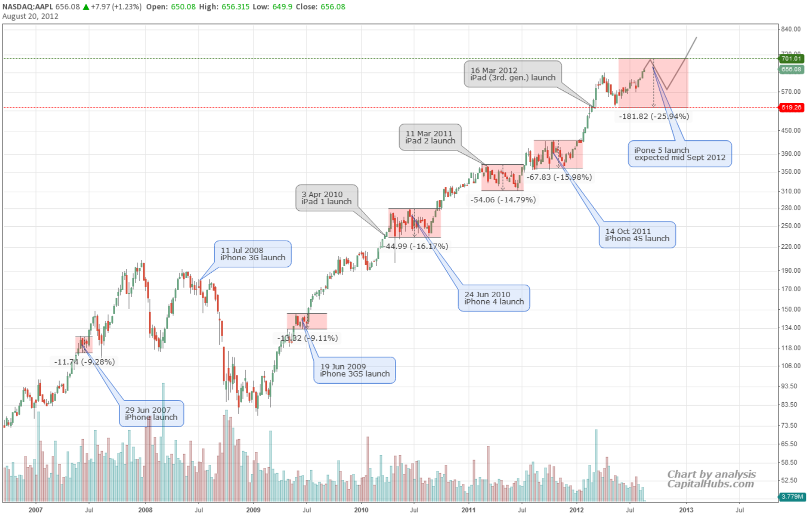
You can be a

- Actuary;
- Data Analyst;
- Statistician;
- Mathematician.

You can work at

- Hedge fund company: Renaissance Technologies (Top 3, US$84 billion on 2018);
- Bank;
- Pharmaceutical industry;
- Science Park.

Stock Price



Source: **TradingView.com**

Figure: Path of Brownian Motion

Path of Brownian Motion

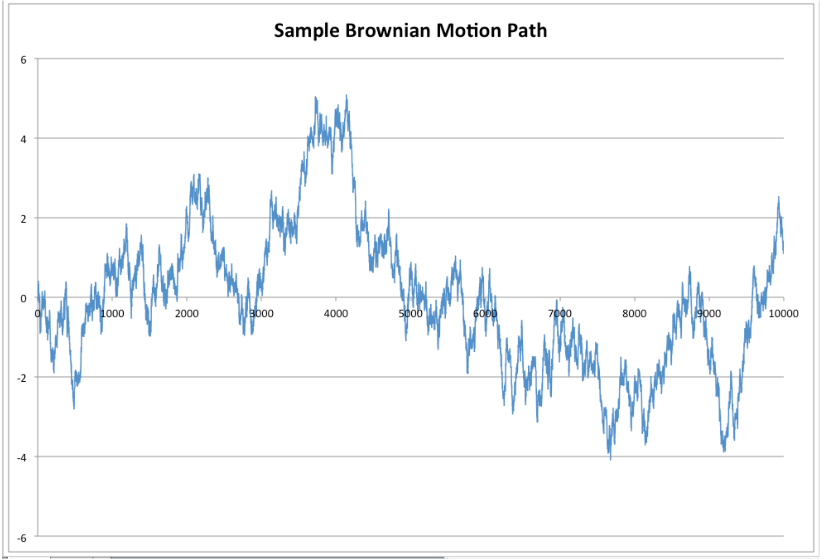


Figure: Path of Brownian Motion

Brownian Motion

- In 1827, botanist Robert Brown observed the movement of pollen immersed in water.

Brownian Motion

- In 1827, botanist Robert Brown observed the movement of pollen immersed in water.
- Albert Einstein published a paper in 1905 that explained in precise detail how the motion that Brown had observed was a result of the pollen being moved by individual water molecules.

Brownian Motion

- In 1827, botanist Robert Brown observed the movement of pollen immersed in water.
- Albert Einstein published a paper in 1905 that explained in precise detail how the motion that Brown had observed was a result of the pollen being moved by individual water molecules.

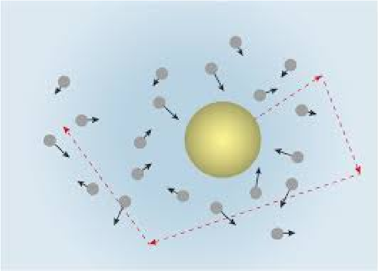


Figure: Brownian Motion

Brownian Motion $B(t)$

Brownian Motion

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.
- $B(t) - B(s)$ has Normal distribution with mean zero and variance $t - s$.

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.
- $B(t) - B(s)$ has Normal distribution with mean zero and variance $t - s$.
- $B(t)$ is continuous in t.

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.
- $B(t) - B(s)$ has Normal distribution with mean zero and variance $t - s$.
- $B(t)$ is continuous in t.

Integral

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.
- $B(t) - B(s)$ has Normal distribution with mean zero and variance $t - s$.
- $B(t)$ is continuous in t.

Integral:

- Riemann Integral $\int_0^t f(s)ds$;

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.
- $B(t) - B(s)$ has Normal distribution with mean zero and variance $t - s$.
- $B(t)$ is continuous in t.

Integral:

- Riemann Integral $\int_0^t f(s)ds$;
- Riemann-Stieltjes Integral $\int_0^t f(s)dg(s)$:

Brownian Motion $B(t)$

Brownian Motion:

- $B(0) = 0$
- $B(t) - B(s)$ is independent of the past.
- $B(t) - B(s)$ has Normal distribution with mean zero and variance $t - s$.
- $B(t)$ is continuous in t.

Integral:

- Riemann Integral $\int_0^t f(s)ds$;
- Riemann-Stieltjes Integral $\int_0^t f(s)dg(s)$:
- Stochastic Integral $\int_0^t f(s)dB(s)$.

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$$dS_t = \mu S_t dt + \sigma S_t dB_t$$

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$$dS_t = \mu S_t dt + \sigma S_t dB_t$$

- S: the price of the stock;

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$$dS_t = \mu S_t dt + \sigma S_t dB_t$$

- S: the price of the stock;
- V(S,t): the price of a derivative as a function of time and stock price;

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$$dS_t = \mu S_t dt + \sigma S_t dB_t$$

- S: the price of the stock;
- V(S,t): the price of a derivative as a function of time and stock price;
- r: the annualized risk-free interest rate, continuously compounded;

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$$dS_t = \mu S_t dt + \sigma S_t dB_t$$

- S: the price of the stock;
- V(S,t): the price of a derivative as a function of time and stock price;
- r: the annualized risk-free interest rate, continuously compounded;
- σ: the standard deviation of the stock's returns;

Black–Scholes Equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

$$dS_t = \mu S_t dt + \sigma S_t dB_t$$

- S: the price of the stock;
- V(S,t): the price of a derivative as a function of time and stock price;
- r: the annualized risk-free interest rate, continuously compounded;
- σ: the standard deviation of the stock's returns;
- t: a time in years.

Languages

- SQL

Languages

- SQL.
- Python, C++...

Languages

- SQL.
- Python, C++...
- Chinese, English, Japanese...

Calculus

Contents

- Limit;

Calculus

Contents

- Limit;
- Continuity;

Calculus

Contents

- Limit;
- Continuity;
- Derivatives;

Calculus

Contents

- Limit;
- Continuity;
- Derivatives;
- Integral;

Calculus

Contents

- Limit;
- Continuity;
- Derivatives;
- Integral;
- Series;

Calculus

Contents

- Limit;
- Continuity;
- Derivatives;
- Integral;
- Series;
- Taylor Series.

Calculus

Contents

- Limit;
- Continuity;
- Derivatives;
- Integral;
- Series;
- Taylor Series.

Probability, Statistics, Financial Math.

Analysis

Contents

- Set Theory;
- Topology on Euclidean Space;

Analysis

Contents

- Set Theory;
- Topology on Euclidean Space;
- Metric Space;

Analysis

Contents

- Set Theory;
- Topology on Euclidean Space;
- Metric Space; ,
- More on Limits and Continuity ;

Analysis

Contents

- Set Theory;
- Topology on Euclidean Space;
- Metric Space; ,
- More on Limits and Continuity ;
- High dimensional Derivatives;

Analysis

Contents

- Set Theory;
- Topology on Euclidean Space;
- Metric Space; ,
- More on Limits and Continuity ;
- High dimensional Derivatives;
- High dimensional Integral.

Analysis

Contents

- Set Theory;
- Topology on Euclidean Space;
- Metric Space; ,
- More on Limits and Continuity ;
- High dimensional Derivatives;
- High dimensional Integral. .

Probability, Statistics, Financial Math.

Probability

Contents

- Probability Space;

Probability

Contents

- Probability Space;
- Independence;

Probability

Contents

- Probability Space;
- Independence;
- Strong Law of Large Numbers;

Probability

Contents

- Probability Space;
- Independence;
- Strong Law of Large Numbers;
- Central Limit Theorem;

Probability

Contents

- Probability Space;
- Independence;
- Strong Law of Large Numbers;
- Central Limit Theorem;
- Martingale.

Contents

- Optional Pricing;

Contents

- Optional Pricing;
- Actuarial;

Contents

- Optional Pricing;
- Actuarial;
- Insurance;

Financial Math

Contents

- Optional Pricing;
- Actuarial;
- Insurance;
- High-Frequency Trading.