Intro to Quant Finance

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Agenda

❖ Brainteaser

❖ What is Quantitative Finance?

❖ Industry Landscape

❖ Quant Roles

Brainteaser

Given a shuffled deck of standard cards, what's the probability that the top two cards drawn will form a pair of the same rank?

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Answer

A Deck of Cards:
- A rank is the identifier at the top of the card (2,3,4,K,J,Q)
- Each deck has 4 suits, thus there are 4 different cards for each rank

Logic Flow:
- The first card drawn will determine the outcome for the rest of your deck
- Draw 1 card and there are now 3 cards left of the SAME rank

Conclusion:
- The probability of drawing a pair is **3/51** or **1/17**

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Core Elements of Quant Finance

Financial Engineering

The design and implementation of financial instruments and strategies to solve financial problems and optimize risk-return profiles.
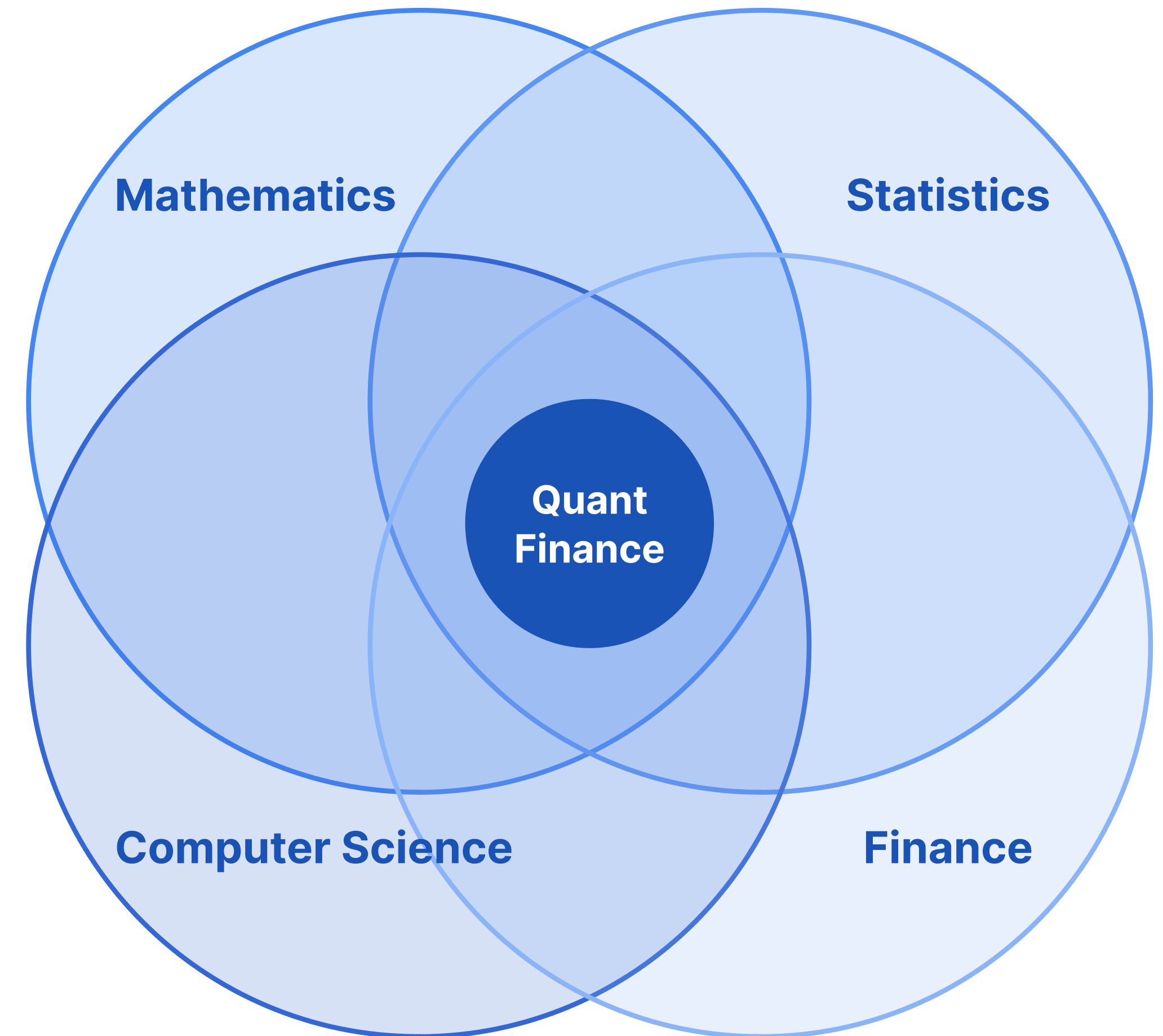
Mathematical Modeling

Application of mathematical frameworks including stochastic calculus and differential equations to describe market dynamics & price financial assets.

Algorithmic Trading

Development of automated systems that execute trading decisions at optimal speed & efficiency based on systematic rules & market data analysis.

Risk Management

Systematic identification, measurement, and mitigation of financial risks through statistical models, stress testing, and sophisticated metrics like Value at Risk (VaR).
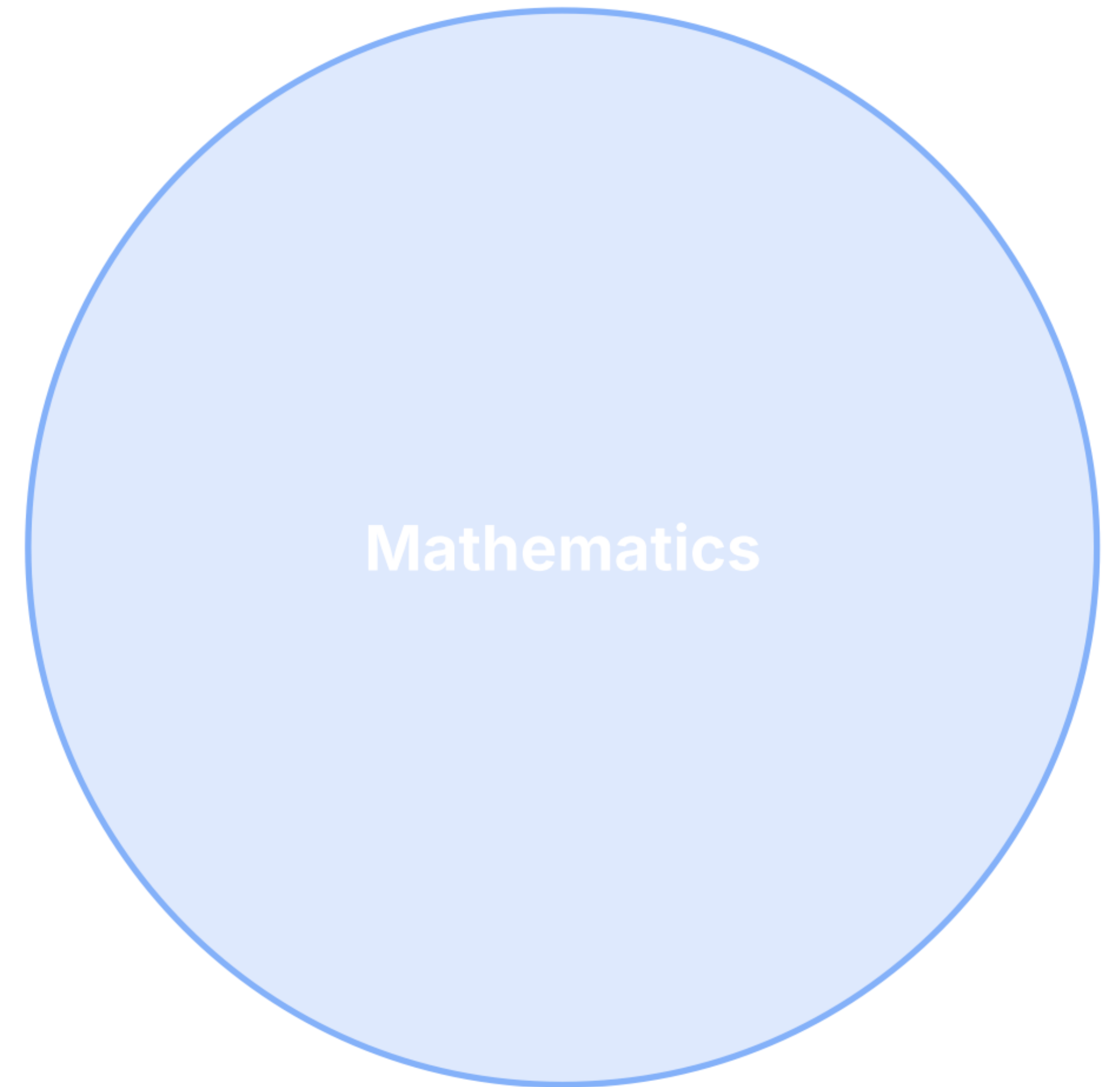
Mathematics   **Statistics**

Quant Finance

Computer Science   **Finance**

Skillset of Quants | Mathematics

Quants rely heavily on advanced mathematical concepts to model financial markets and price assets

Core Areas

• **Stochastic Calculus:** Used for modeling asset price movements (e.g., Black-Scholes model).

• **Linear Algebra:** Essential for portfolio optimization, covariance matrix calculations, and eigenvalue decomposition in principal component analysis (PCA).

• **Probability & Statistics:** Fundamental for risk modeling, Monte Carlo simulations, and statistical arbitrage strategies
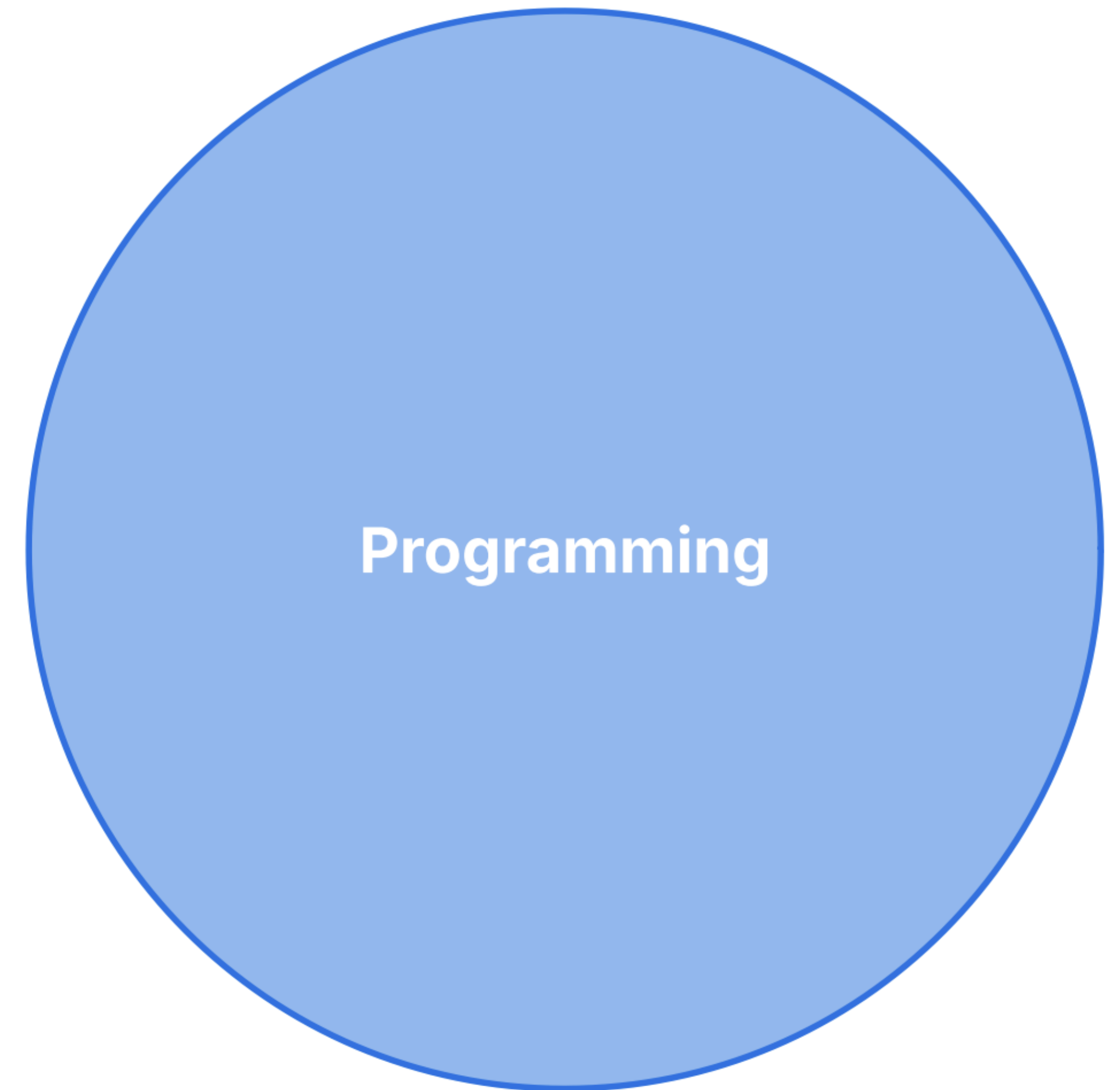
Mathematics

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Skillset of Quants | Programming

Quants must be proficient in programming to implement models, analyze data, and build trading systems

Core Languages

• **Python:** Ideal for prototyping due to their simplicity and extensive libraries for data analysis (e.g., NumPy, pandas).

• **C++:** Preferred for production systems where performance is critical (e.g., high-frequency trading). C++ excels in low-latency environments.

• **Other useful tools include:**

➢ R for statistical analysis

➢ SQL for database management

Programming

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Skillset of Quants | Finance

While quants often come from technical backgrounds, understanding core financial concepts is crucial. After all, it is a finance-based industry

Core Topics

- **Greeks Calculations:** Delta, gamma, vega, theta, and rho are used to measure the sensitivity of derivatives prices to various factors like underlying price changes or time decay.

- **Market Microstructure:** Understanding order flow, liquidity, and bid-ask spreads is critical for algorithmic trading.

- **Arbitrage Pricing Theory (APT):** A framework for asset pricing based on the absence of arbitrage opportunities.
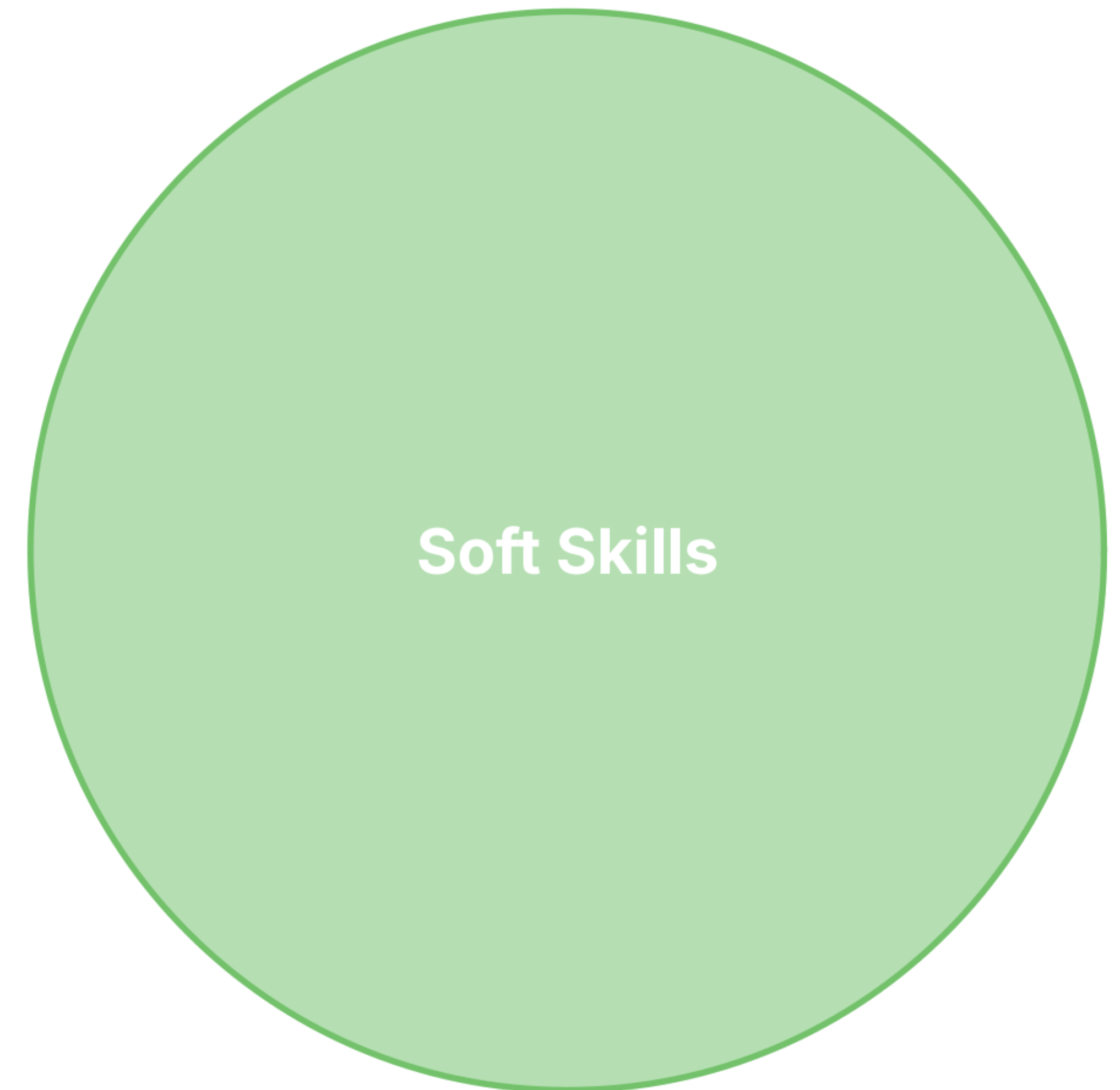
Finance

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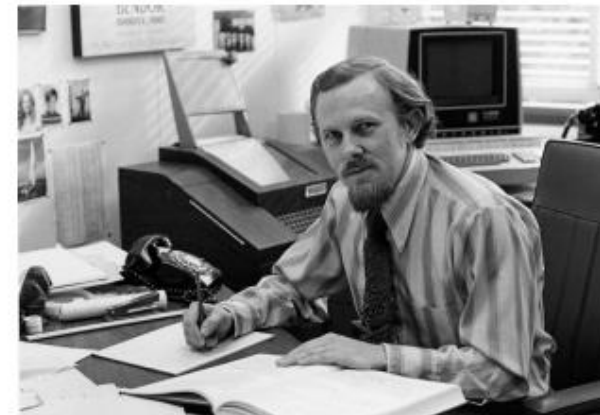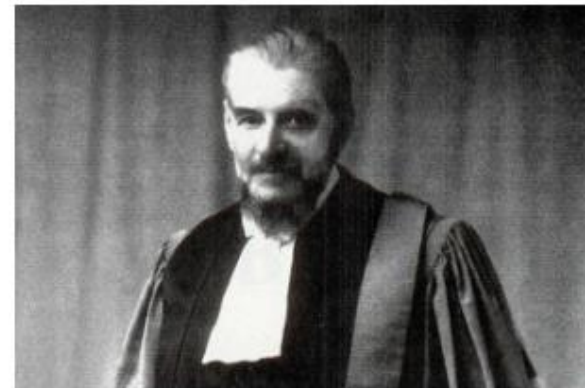
Skillset of Quants | Soft Skills

Quants must analyze financial data, identify patterns, and develop innovative solutions to optimize trading strategies or manage risk

Core Traits

• **Teamwork:** Collaboration with traders, portfolio managers, and software engineers is essential

• **Time Management:** Balancing research, implementation, and testing under tight deadlines

• **Critical Thinking:** The most important skill for a quant is the ability to think critically and solve complex problems. Logical reasoning, creativity, attention to detail, and adaptability is crucial for changing market conditions

Soft Skills

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History & Evolution of Quant
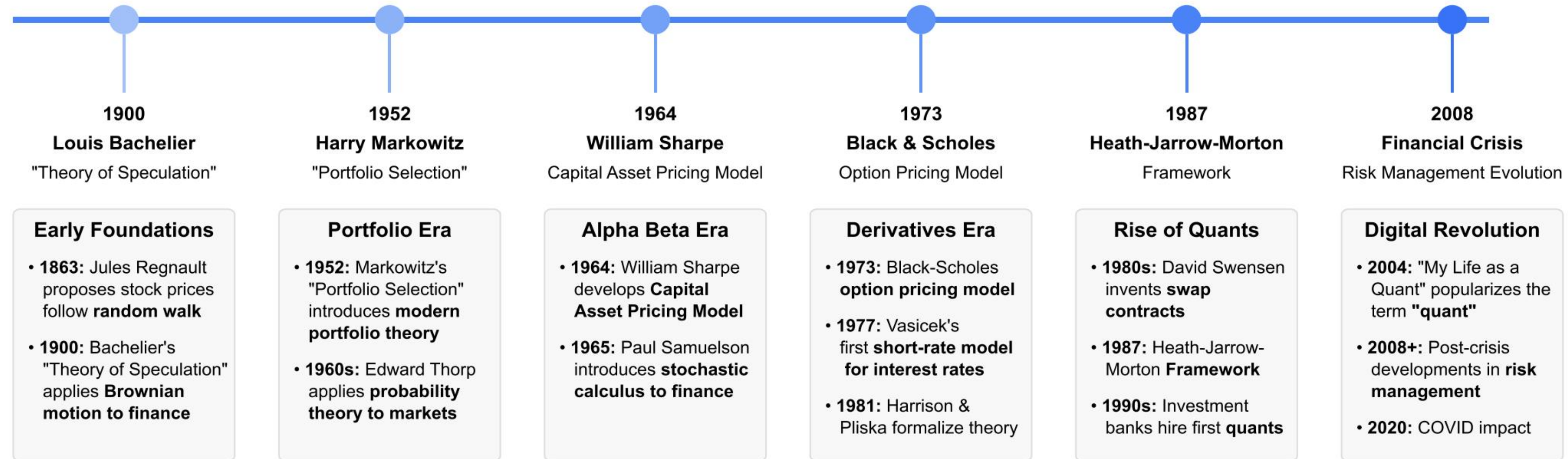

Early Foundations (1800s-1900)	The Portfolio Era (1950s-1960s)	The Alpha Beta Era (1964-1973)	The Derivatives Era (1973-1980s)	Rise of Quants (1980s-1990s)	Digital Revolution (2000s-Present)

1900
Louis Bachelier
"Theory of Speculation"

1952
Harry Markowitz
"Portfolio Selection"

1964
William Sharpe
Capital Asset Pricing Model

1973
Black & Scholes
Option Pricing Model

1987
Heath-Jarrow-Morton
Framework

2008
Financial Crisis
Risk Management Evolution

Early Foundations
- **1863:** Jules Regnault proposes stock prices follow **random walk**
- **1900:** Bachelier's "Theory of Speculation" applies **Brownian motion to finance**

Portfolio Era
- **1952:** Markowitz's "Portfolio Selection" introduces **modern portfolio theory**
- **1960s:** Edward Thorp applies **probability theory to markets**

Alpha Beta Era
- **1964:** William Sharpe develops **Capital Asset Pricing Model**
- **1965:** Paul Samuelson introduces **stochastic calculus to finance**

Derivatives Era
- **1973:** Black-Scholes **option pricing model**
- **1977:** Vasicek's first **short-rate model for interest rates**
- **1981:** Harrison & Pliska formalize theory

Rise of Quants
- **1980s:** David Swensen invents **swap contracts**
- **1987:** Heath-Jarrow-Morton **Framework**
- **1990s:** Investment banks hire first **quants**

Digital Revolution
- **2004:** "My Life as a Quant" popularizes the term **"quant"**
- **2008+:** Post-crisis developments in **risk management**
- **2020:** COVID impact

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Industry Landscape | Types of Firms

1. High Frequency Trading

Primary Objective: *Capitalize on microsecond price inefficiencies at massive scale*

• Trading at extremely fast speeds (microseconds to milliseconds)

• Uses sophisticated algorithms to exploit tiny price discrepancies

• Executes thousands to millions of trades daily

• Typically uses proprietary capital rather than client funds

2. Prop Trading / Market Making

Primary Objective: *Extract value from providing liquidity and managing inventory*

• Provides continuous liquidity by quoting buy/sell prices
  ➤ Earns profits from bid-ask spreads and inventory management

• Manages risk across multiple asset classes

• Primarily uses proprietary capital

• Often serves as official market makers on exchanges

3. Hedge Funds

Primary Objective: *Generate alpha through quantitative/fundamentally driven strategies regardless of market direction*

• Manages both external investor capital and firm money

• Implements diverse quantitative strategies (stat arb, trend following, etc.)

• Operates at medium frequencies (minutes to days)

• Utilizes alternative data and machine learning for alpha

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Types of Firms

Types of Quant Roles

Quant Researcher

Theory & Model Development

Key Requirements:
- PhD in Math/Physics/Statistics
- Statistical analysis expertise

Quant Developer

Implementation & Systems

Key Requirements:
- CS/Engineering background
- Python & C++ proficiency

Risk Quant

Risk Management & Compliance

Key Requirements:
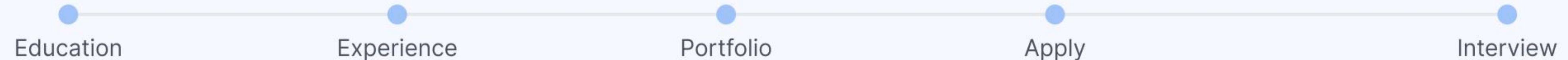- Risk management knowledge
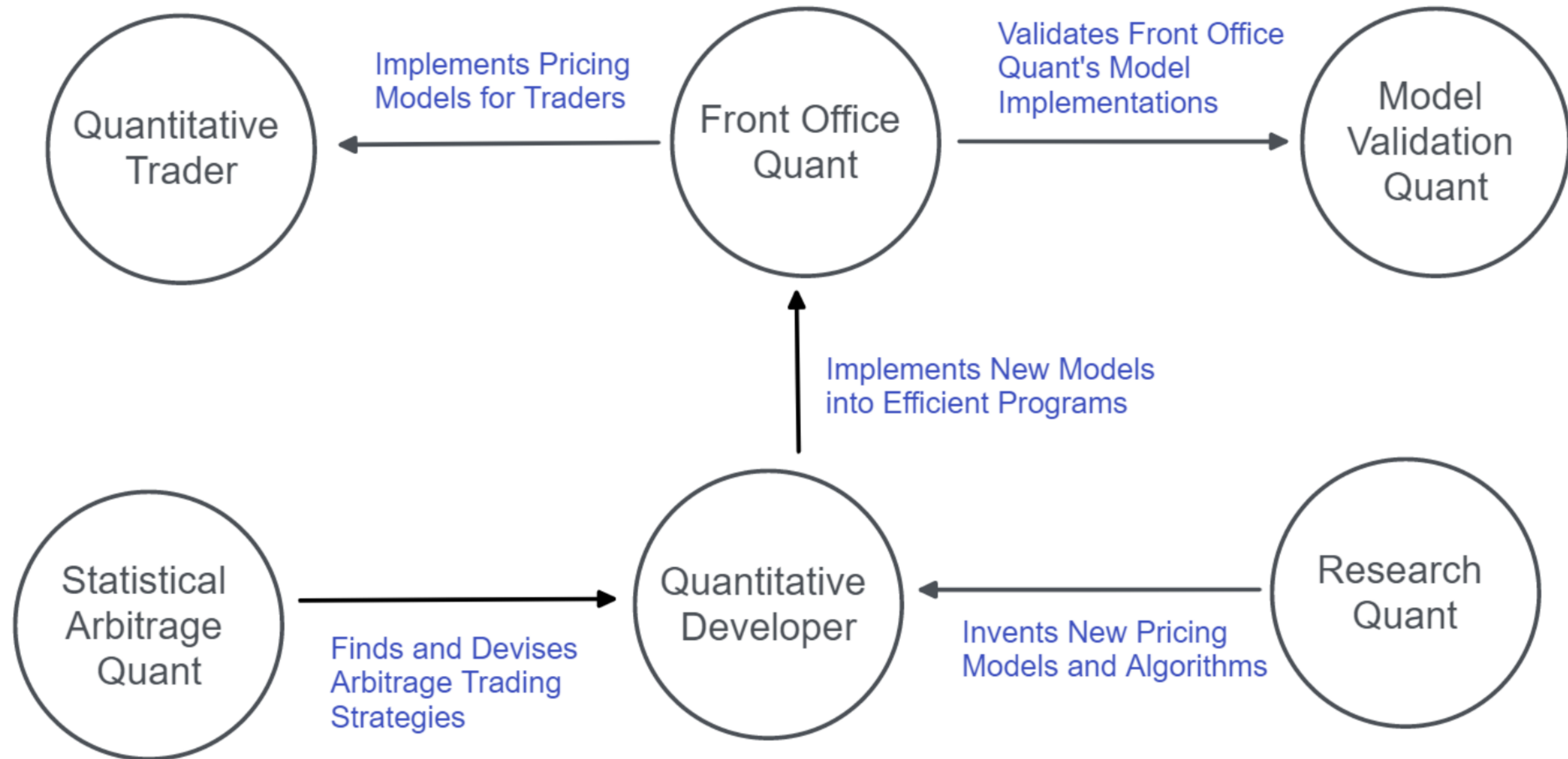- Regulatory understanding

Quant Trader

Trading & Execution

Key Requirements:
- Market structure knowledge
- Trading strategies expertise

Application Process

Education — Experience — Portfolio — Apply — Interview

Competition Level: High, particularly for top-tier firms

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How Each Role Interacts

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Job Flow Process

1 — **2** — **3** — **4** — **5** — **6**

Education
- Math/Statistics
- Physics/CS
- Financial Engineering

Portfolio
- Trading strategies
- Coding projects
- Creative initiative

Experience
- Internships
- Projects
- Industry knowledge

Certification
- Certifications
- Specialized training
- Professional skills

Application
- Hedge funds
- Prop trading firms
- Market Making

Interview
- Technical questions
- Math & coding tests
- Multiple rounds

Competitiveness Factors

High Barriers to Entry
Prestigious universities, math competitions

Demanding Requirements
Advanced math, stats, programming, finance

Limited Positions
Especially for quant trader roles

Compensation Competition
Six-figure potential at top firms

Fiercest competition at top-tier funds and for quant trader positions

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