

# Introduction

**Christopher Ting**

<http://cting.x10host.com/CUHKSZ/CUHKSZ.html>

<http://www.mysmu.edu/faculty/christophert/>

✉: [christophert@smu.edu.sg](mailto:christophert@smu.edu.sg)

June 25, 2018



# Broad Lesson Plan

1 Introduction

2 Shift in QF

3  $\alpha\mathcal{F}$

4 Algorithm

5 Data and AI

6 Assessment

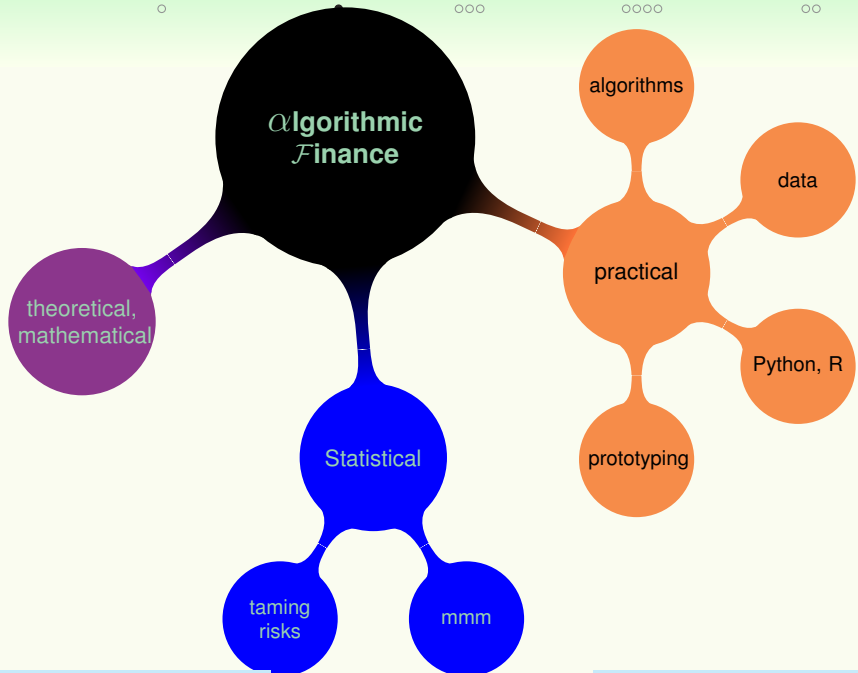
# Shift in QF

- ✱ Risk-neutral pricing and hedging (structuring) have matured.
  - ✱ High-frequency algo trading (dynamics of limit-order book)
  - ✱ Quantitative investment & trading
  - ✱ Quantitative risk management (XVA, multi-curve approach)
  - ✱ Machine learning, AI
- Reading:** [AI Adoption Across Capital Market](#) (May 2018)
- Reading:** [Goldman Sachs Equity Research](#) (November 14, 2016)

Statistics is the study of **algorithms** for data analysis.

**Rudolf Beran**

- ✱ **Research Scientists at Renaissance Technologies**  
Use machine-learning, applied mathematics, and techniques from **modern statistics** to develop and refine models of the financial markets and to develop **trading algorithms** based on those models.



# What is an Algorithm?

- Merriam-Webster  
a set of **steps** that are followed in order to **solve** a mathematical **problem** or to complete a computer process
- Cambridge  
a set of mathematical **instructions** or **rules** that, especially if given to a computer, will help to **calculate** an answer to a **problem**
- Oxford  
a set of **rules** that must be followed when **solving** a particular **problem**
- Longman  
a set of **instructions** that are followed in a fixed order and used for **solving** a mathematical **problem**, making a computer program etc
- WordWeb Online  
precise **rule** (or set of **rules**) specifying how to **solve** some **problem**

# Origin of Algorithm

- Algorithm (Algoritmi) is a Latinisation of **al-Khwārizmī** (c. 780–c. 850).
- He was a Persian (modern Khiva, Uzbekistan) mathematician, astronomer, and geographer.
- He invented two algorithmic operations: al-jabr (completion) and al-muqabala (balancing).

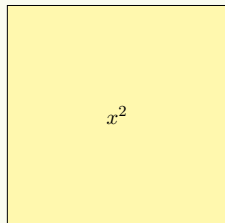
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# Al-Khwarizm's Solution of $x^2 + 10x = 39$

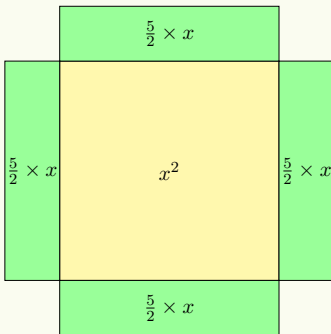
Step 1

$$x \times x$$



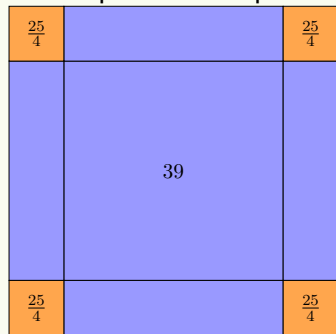
Step 2

$$x^2 + 10x$$



Step 3

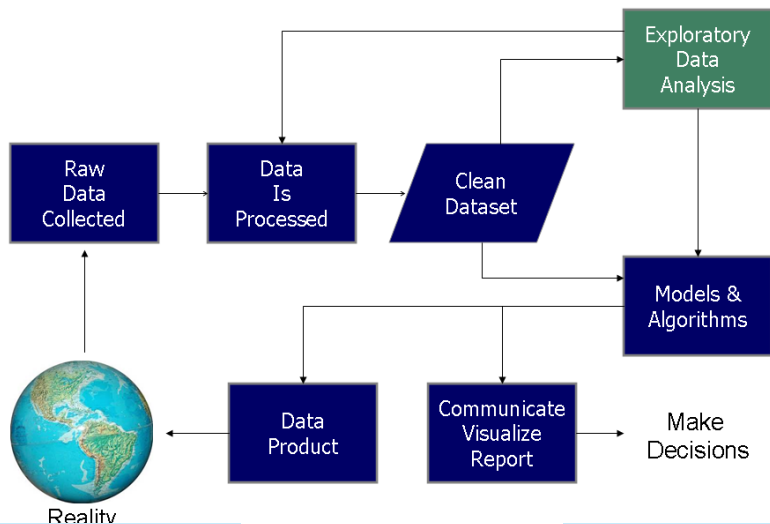
Completion of Square



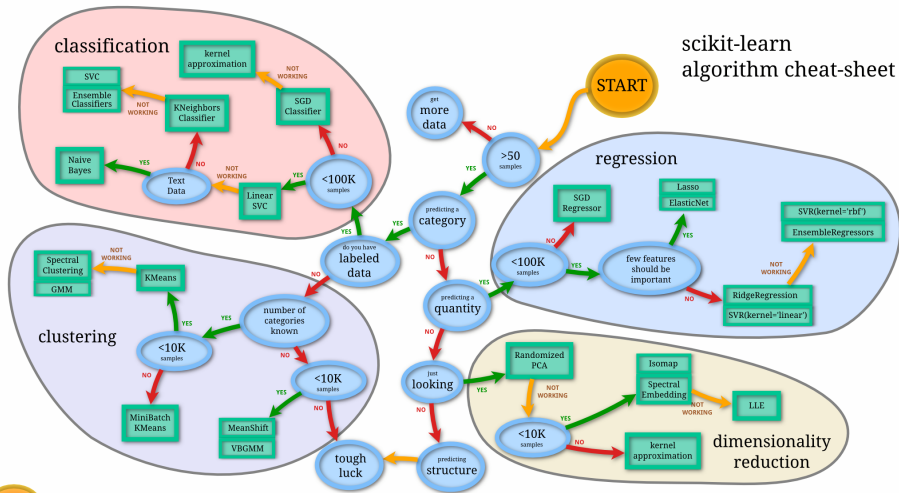
The completed square's area is  $4 \times \frac{25}{4} + 39 = 64$ . Each side of the square is therefore 8. But each side is of length  $\frac{5}{2} + x + \frac{5}{2}$  so  $x + 5 = 8$ , giving  $x = 3$  as a solution.

# Algorithms for Data Analysis

## Data Science Process



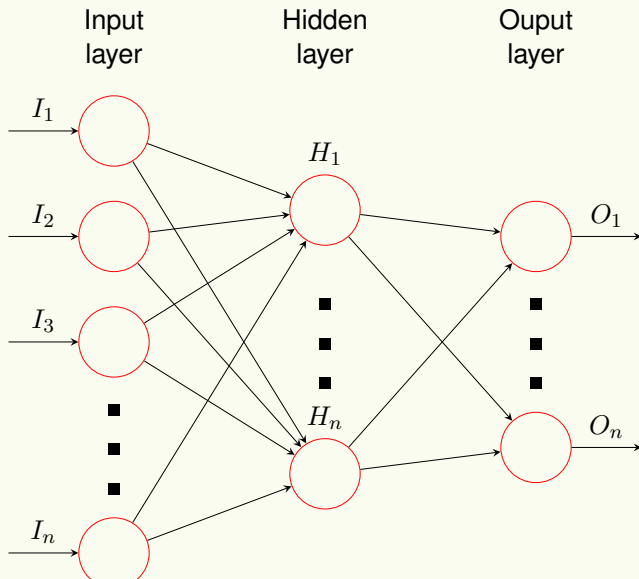
# Machine Learning with Python



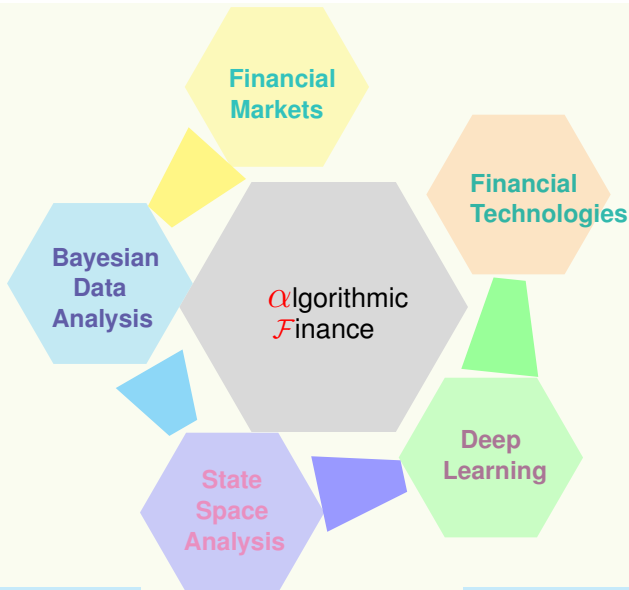
Back



# Black-Box Algorithm



# New Developments



# Assessment

## Class Activity: 10%

- ★ Ask questions **enthusiastically**.
- ★ Respond to questions with insightful comments.
- ★ Class handout

## Mini-Project: 15%

- ◆ Presentation on Session 14 (5%)
- ◆ Project Report (10%)

## Homework Assignments: 15%

## Mid-Term Test in Class: 15%

## Final Exam: 45%

# Grace versus Grade

