

Introduction

Christopher Ting

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

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

✉: christophert@smu.edu.sg

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Broad Lesson Plan

1 Introduction

2 Shift in QF

3 $\alpha\mathcal{F}$

4 Algorithm

5 Data and AI

6 Assessment

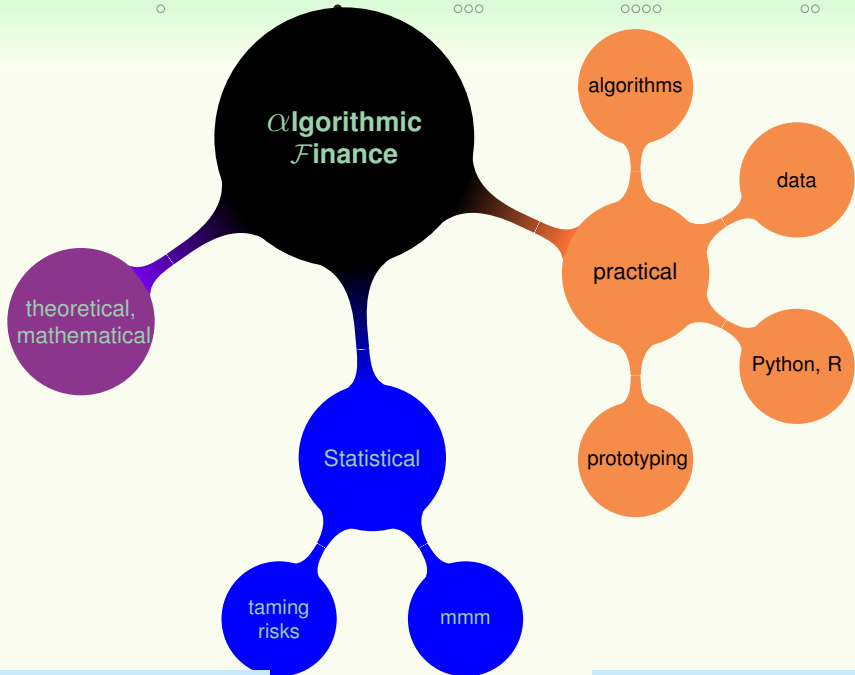
Shift in QF

- ✱ 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).

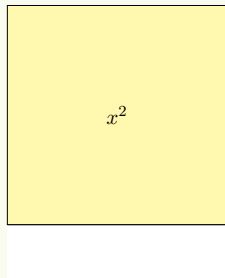
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Al-Khwarizm's Solution of $x^2 + 10x = 39$

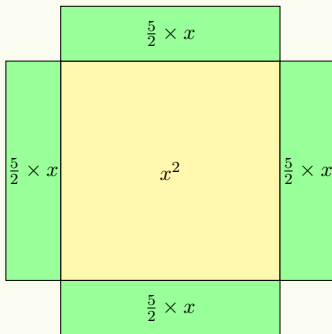
Step 1

$$x \times x$$



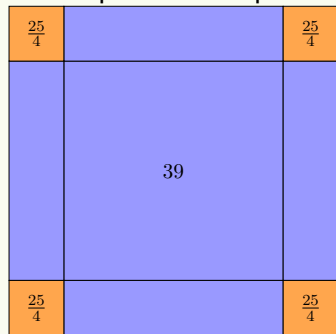
Step 2

$$x^2 + 10x$$



Step 3

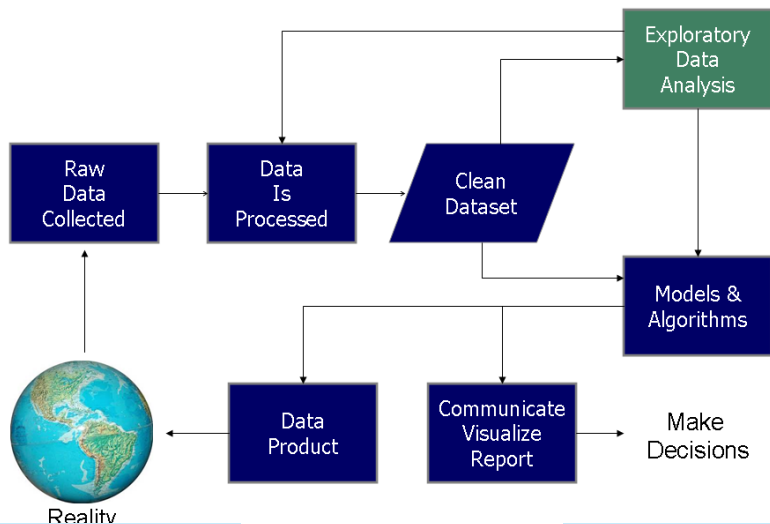
Completion of Square



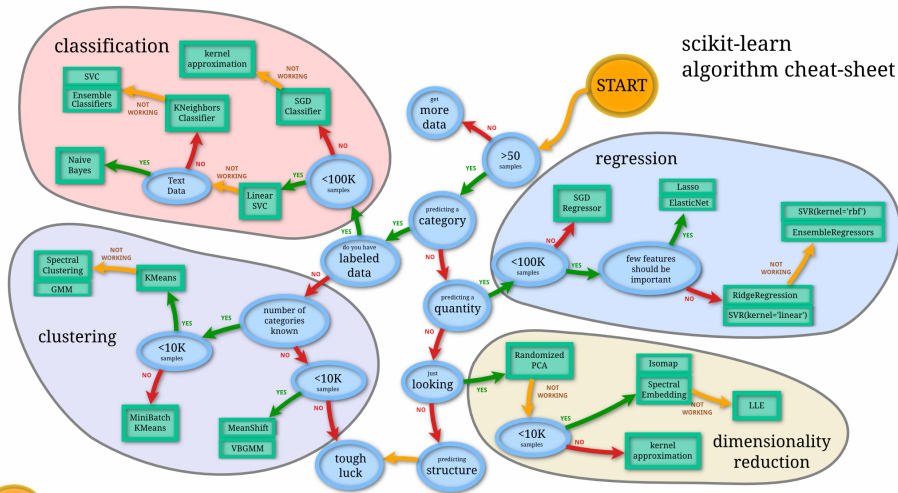
The completed square's area is $4 \times \frac{25}{4} + 39 = 64$. Each side of the square is therefore 8. But each side is of length $\frac{5}{2} + x + \frac{5}{2}$ so $x + 5 = 8$, giving $x = 3$ as a solution.

Algorithms for Data Analysis

Data Science Process



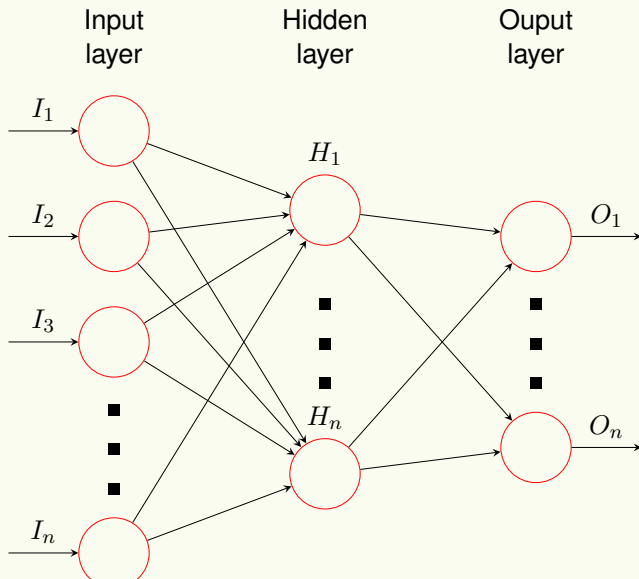
Machine Learning with Python



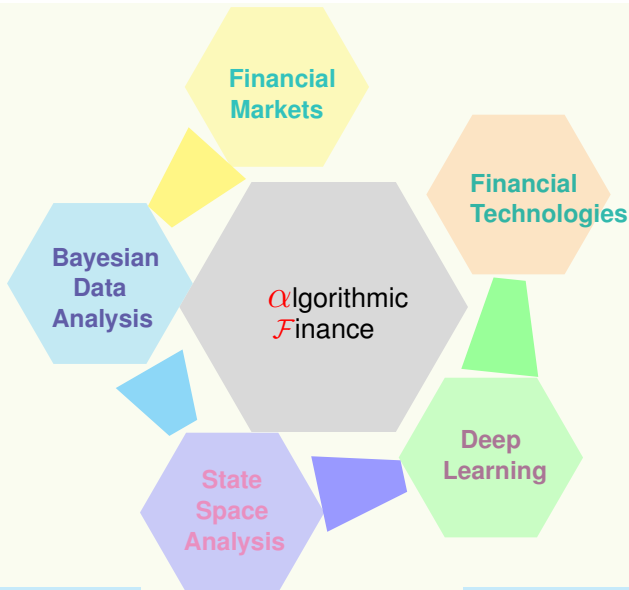
Back



Black-Box Algorithm



New Developments



Assessment

Class Activity/Test: 10%

- ★ Ask questions **enthusiastically**.
- ★ Respond to questions with insightful comments.
- ★ Do not surf the web or check emails during class unless asked to do so.

Mini-Project: 40%

- ◆ Presentation on Session 15 (10%)
- ◆ Project Report (30%)

Homework Assignments: 50%

- ▶ Exercises
- ▶ Each student will be given different data sets for data analysis.
- ▶ For data analysis assignments, assessment is based on scientific correctness of the statistics obtained, statement on assumptions, relevant hypothesis used, correctness of inferences, timeliness in meeting the deadline, creative elements, and X factor.

Grace versus Grade

