Artificial Intelligence for Investment Analysis

投姧心理始學與姧為財務學
(Investing Psychology and Behavioral Finance)

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Assistant Professor
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http://mail.tku.edu.tw/myday/
2018-10-04
<table>
<thead>
<tr>
<th>週次 (Week)</th>
<th>日期 (Date)</th>
<th>內容 (Subject/Topics)</th>
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<tbody>
<tr>
<td>1 2018/09/13</td>
<td>人工智慧投資分析課程介紹 (Course Orientation on Artificial Intelligence for Investment Analysis)</td>
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<td>2 2018/09/20</td>
<td>AI 金融科技: 金融服務創新應用 (AI in FinTech: Financial Services Innovation and Application)</td>
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<td>3 2018/09/27</td>
<td>機器人理財顧問與AI交談機器人 (Robo-Advisors and AI Chatbots)</td>
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<td>4 2018/10/04</td>
<td>投資心理學與行為財務學 (Investing Psychology and Behavioral Finance)</td>
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<td>5 2018/10/11</td>
<td>財務金融事件研究法 (Event Studies in Finance)</td>
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<td>6 2018/10/18</td>
<td>人工智慧投資分析個案研究 I (Case Study on Artificial Intelligence for Investment Analysis I)</td>
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| 7          | 2018/10/25 | Python AI投資分析基礎  
(Foundations of AI Investment Analysis in Python) |
| 8          | 2018/11/01 | Python Pandas量化投資分析  
(Quantitative Investing with Pandas in Python) |
| 9          | 2018/11/08 | Python Scikit-Learn 機器學習  
(Machine Learning with Scikit-Learn In Python) |
| 10         | 2018/11/15 | 期中報告 (Midterm Project Report) |
| 11         | 2018/11/22 | TensorFlow 深度學習財務時間序列預測 I  
(Deep Learning for Financial Time Series Forecasting with TensorFlow I) |
| 12         | 2018/11/29 | TensorFlow 深度學習財務時間序列預測 II  
(Deep Learning for Financial Time Series Forecasting with TensorFlow II) |
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<th>週次 (Week)</th>
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| 13          | 2018/12/06  | 人工智慧投資分析個案研究 II  
(Case Study on Artificial Intelligence for Investment Analysis II) |
| 14          | 2018/12/13  | TensorFlow 深度學習財務時間序列預測 III  
(Deep Learning for Financial Time Series Forecasting with TensorFlow III) |
| 15          | 2018/12/20  | 投資組合最佳化與程式交易  
(Portfolio Optimization and Algorithmic Trading) |
| 16          | 2018/12/27  | 自然語言處理 (Natural Language Processing) |
| 17          | 2019/01/03  | 期末報告 I (Final Project Presentation I) |
| 18          | 2019/01/10  | 期末報告 II (Final Project Presentation II) |
Investing Psychology and Behavioral Finance
Investor Sentiment
Fear & Greed Index
What emotion is driving the market now?

Now: Neutral

Last updated Oct 2 at 6:30pm

Source: https://money.cnn.com/data/fear-and-greed/
Consumer Psychology and Behavior
How consumers think, feel, and act

Fintech: Technology Innovation in Financial Services
Fintech Impact on Consumer Behavior

Behavioral Finance

Source: https://www.amazon.com/Beyond-Greed-Fear-Understanding-Association/dp/0195304217
Lucy Ackert and Richard Deaves (2009), Behavioral Finance: Psychology, Decision-Making, and Markets, South-Western College Pub

Edwin Burton and Sunit N. Shah (2013)
Behavioral Finance: Understanding the Social, Cognitive, and Economic Debates, Wiley

H. Kent Baker and Victor Ricciardi (2014)
Investor Behavior: The Psychology of Financial Planning and Investing, Wiley
Marketing

“Meeting needs profitably”

Value
the sum of the tangible and intangible benefits and costs

Total customer benefit

Customer perceived value

Total customer cost

Customer Perceived Value

- Product benefit
- Services benefit
- Personnel benefit
- Image benefit

Total customer benefit

- Monetary cost
- Time cost
- Energy cost
- Psychological cost

Total customer cost

Customer perceived value

Model of Consumer Behavior

Marketing Stimuli
- Products & Services
- Price
- Distribution
- Communications

Other Stimuli
- Economic
- Technological
- Political
- Cultural

Psychology
- Motivation
- Perception
- Learning
- Memory

Consumer Characteristics
- Cultural
- Social
- Personal

Buying Decision Process
- Problem Recognition
- Information Search
- Evaluation of Alternatives
- Purchase decision
- Post-purchase behavior

Purchase Decision
- Product choice
- Brand choice
- Dealer choice
- Purchase amount
- Purchase timing
- Payment method

Building Customer Value, Satisfaction, and Loyalty

Customer Perceived Value, Customer Satisfaction, and Loyalty

Customer Perceived Performance

Customer Perceived Value

Customer Expectations

Customer Satisfaction

Customer Loyalty

Theory of Reasoned Action (TRA)

TRA (1975)

Fig. 1.2 Schematic presentation of conceptual framework for the prediction of specific intentions and behaviors.

Theory of Planned Behavior (TPB)

FIG. 10.2. Theory of planned behavior.

FIG. 1. Theory of planned behavior

Icek Aizen (Ajzen)

Professor of Psychology
University of Massachusetts

Theory of Planned Behavior

Behavioral Beliefs → Attitude Toward the Behavior
Normative Beliefs → Subjective Norm
Control Beliefs → Perceived Behavioral Control

Intention → Behavior

Last modified: April 13, 2005

http://www.people.umass.edu/aizen/index.html
Technology Acceptance Model (TAM)

TAM (1989)

Behavioral Finance
Rational Behavior

Irrational Behavior
Emotion

Sentiment
Modern Financial Research

• Theoretical Finance
  – study of logical relationships among assets.

• Empirical Finance
  – study of data in order to infer relationships.

• Behavioral Finance
  – integrates psychology into the investment process.

Source: Robert A. Strong (2004), Practical Investment Management, South-Western
Psychology in Behavior Finance

• Beliefs

• Preferences
  – Prospect theory
  – Ambiguity aversion

Behavioral Finance Themes

• Heuristic-Driven Bias
• Framing Dependence
• Inefficient Markets

Efficient Market Hypothesis (EMH)

Expected Utility Theory (EUT)

Prospect theory: An analysis of decision under risk

Prospect Theory
(Kahneman and Tversky, 1979)

PROSPECT THEORY: AN ANALYSIS OF DECISION UNDER RISK

By Daniel Kahneman and Amos Tversky

This paper presents a critique of expected utility theory as a descriptive model of decision making under risk, and develops an alternative model, called prospect theory. Choices among risky prospects exhibit several pervasive effects that are inconsistent with the basic tenets of utility theory. In particular, people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty. This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses. In addition, people generally discard components that are shared by all prospects under consideration. This tendency, called the isolation effect, leads to inconsistent preferences when the same choice is presented in different forms. An alternative theory of choice is developed, in which value is assigned to gains and losses rather than to final assets and in which probabilities are replaced by decision weights. The value function is normally concave for gains, commonly convex for losses, and is generally steeper for losses than for gains. Decision weights are generally lower than the corresponding probabilities, except in the range of low probabilities. Overweighting of low probabilities may contribute to the attractiveness of both insurance and gambling.
Decision Making under Risk

Which of the following would you prefer?

• A:
  –50% chance to win 1,000,
  –50% chance to win nothing;

• B:
  –450 for sure.

Decision

Problem 1: Choose between

A: 2,500 with probability .33, 2,400 with probability .66, 0 with probability .01;

B: 2,400 with certainty.

Problem 1: Choose between

A: 2,500 with probability .33, 2,400 with probability .66, 0 with probability .01;

\[ N = 72 \begin{array}{l} \text{[18]} \end{array} \begin{array}{l} \text{[82]}^* \end{array} \]

**Decision**

**Problem 2:** Choose between

C: 2,500 with probability .33, 0 with probability .67;  
D: 2,400 with probability .34, 0 with probability .66.

Decision

Problem 2: Choose between

C: 2,500 with probability .33, 0 with probability .67;

D: 2,400 with probability .34, 0 with probability .66.

\[ N = 72 \quad [83]^* \quad [17] \]
Expected Utility

\[ u(2,400) > 0.33u(2,500) + 0.66u(2,400) \text{ or } 0.34u(2,400) > 0.33u(2,500) \]

Problem 3:

A: (4,000,.80), or B: (3,000).
Problem 3:

A: (4,000,.80), or B: (3,000).

\[ N = 95 \quad [20] \quad [80]* \]
Problem 4:

C: (4,000, .20), or D: (3,000, .25).

Problem 4:

C: (4,000,.20), or D: (3,000,.25).

\[ N = 95 \quad [65]^* \quad [35] \]
Decision

Problem 5:

A: 50% chance to win a three-week tour of England, France, and Italy;

\[ N = 72 \quad [22] \]

B: A one-week tour of England, with certainty.

[78]*

Problem 6:

C: 5% chance to win a three-week tour of England, France, and Italy;

\[ N = 72 \quad [67]* \]

D: 10% chance to win a one-week tour of England.

[33]

Decision

Problem 7:

A: (6,000, .45), B: (3,000, .90).

\[ N = 66 \quad [14] \quad [86]^* \]

Problem 8:

C: (6,000, .001), D: (3,000, .002).

\[ N = 66 \quad [73]^* \quad [27] \]

Source: Kahneman, Daniel, and Amos Tversky. "Prospect theory: An analysis of decision under risk." 
# Preferences Between Positive and Negative Prospects

<table>
<thead>
<tr>
<th>Positive prospects</th>
<th>Negative prospects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem 3:</strong></td>
<td><strong>Problem 3′:</strong></td>
</tr>
<tr>
<td>$(4,000, .80)$</td>
<td>$(-4,000, .80)$</td>
</tr>
<tr>
<td>$(3,000)$</td>
<td>$(-3,000)$</td>
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<td>$N = 95$</td>
<td>$N = 95$</td>
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<tr>
<td>[20]</td>
<td>[92]*</td>
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<td></td>
<td>[80]*</td>
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<tr>
<td><strong>Problem 4:</strong></td>
<td><strong>Problem 4′:</strong></td>
</tr>
<tr>
<td>$(4,000, .20)$</td>
<td>$(-4,000, .20)$</td>
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<td>$(3,000, .25)$</td>
<td>$(-3,000, .25)$</td>
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<td>[65]*</td>
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<td>[35]</td>
<td>[58]</td>
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<tr>
<td><strong>Problem 7:</strong></td>
<td><strong>Problem 7′:</strong></td>
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<td>$(3,000, .90)$</td>
<td>$(-3,000, .90)$</td>
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<td>[86]*</td>
<td>[8]</td>
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<td>[14]</td>
<td>[92]*</td>
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<tr>
<td><strong>Problem 8:</strong></td>
<td><strong>Problem 8′:</strong></td>
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<tr>
<td>$(3,000, .002)$</td>
<td>$(-3,000, .002)$</td>
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<tr>
<td>$(6,000, .001)$</td>
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<tr>
<td>[27]</td>
<td>[70]*</td>
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<tr>
<td>[73]*</td>
<td>[30]</td>
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</tbody>
</table>

Certainty, Probability, and Possibility

Prospect theory
Value Function

Prospect theory
Weighting Function

Problem 4 as a decision tree (standard formulation)

Problem 10 as a decision tree (sequential formulation)

Source: Kahneman, Daniel, and Amos Tversky. "Prospect theory: An analysis of decision under risk." 
**Problem 11:** In addition to whatever you own, you have been given 1,000. You are now asked to choose between

A: \((1,000, .50)\), and B: \((500)\).

\[N = 70 \quad [16] \quad [84]^*\]

**Problem 12:** In addition to whatever you own, you have been given 2,000. You are now asked to choose between

C: \((-1,000, .50)\), and D: \((-500)\).

\[N = 68 \quad [69]^* \quad [31]\]

Decision

**Problem 13:**

\[(6,000, .25), \quad \text{or} \quad (4,000, .25; 2,000, .25).\]

\[N = 68 \quad [18] \quad [82]^*\]

**Problem 13':**

\[(-6,000, .25), \quad \text{or} \quad (-4,000, .25; -2,000, .25).\]

\[N = 64 \quad [70]^* \quad [30]\]

**Problem 14:**

\[(5,000, .001), \quad \text{or} \quad (5).\]

\[N = 72 \quad [72]^* \quad [28]\]

**Problem 14':**

\[(-5,000, .001), \quad \text{or} \quad (-5).\]

\[N = 72 \quad [17] \quad [83]^*\]

Prospect theory

• People underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty.

  – This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses.

Source: Kahneman, Daniel, and Amos Tversky. "Prospect theory: An analysis of decision under risk." 
Prospect theory

- People generally discard components that are shared by all prospects under consideration.
  - This tendency, called the isolation effect, leads to inconsistent preferences when the same choice is presented in different form.

Prospect theory

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Prospect theory

- **Value** is assigned to **gains and losses** rather than to **final assets** and in which **probabilities** are replaced by **decision weights**.

- The value function is normally concave for **gains**, commonly convex for **losses**, and is generally steeper for **losses** than for **gains**.

Prospect theory

• Decision weights are generally lower than the corresponding probabilities, except in the range of low probabilities.

• Overweighting of low probabilities may contribute to the attractiveness of both insurance and gambling.

Behavioral Heuristics and Biases in Decision Making
Behavioral Finance Anomalies

• The Rational Man
  – Consumer Choice with Certainty
  – Consumer Choice with Uncertainty
  – The Allais Paradox
Prospect Theory

• The Reference Point
• The S-Curve
• Loss Aversion

Behavioral Finance Anomalies

• Perception Biases
• Inertial Effects
• Causality and Statistics
• Illusions

Perception Biases

- Saliency
- Framing
- Anchoring
- Sunk Cost Bias

Inertial Effects

• Endowment Effect
• Status Quo Effect
• Disposition Effect

Causality and Statistics

• Representativeness
• Conjunction Fallacy
• Reading into Randomness
• Small Sample Bias
• Probability Neglect

Illusions

• Illusion of Talent
• Illusion of Skill
• Illusion of Superiority
• Illusion of Validity

Behavioral Finance:
Two Major Foundations

• Investor Sentiment
  – creates disturbances to efficient prices.

• Limited arbitrage
  – arbitrage is never riskfree, hence it does not counter irrational disturbances.
    • Prices may not react to information by the “right” amount.
    • Prices may react to non-information.
    • Markets may remain efficient.
Arbitrage
Arbitrage

Buy Low in Market A

Sell High in Market B

Gain $20

$100

$120
Heuristics

• Overconfidence
  – people overestimate the reliability of their knowledge.

• Excessive trading

• Framing Effect
Heuristics

• Regret Aversion
  – anticipation of a future regret can influence current decision.

• Disposition Effect
  – sell winners, hold on to the losers.

• Anchoring and adjustment: can create under-reaction.
Fashions and Fads

• People are influenced by each other. There is a social pressure to conform.
• Herding behavior: “safety-in-numbers”.
• Informational Cascades
• Positive Feedback
• Example: excessive demand for internet IPOs. Extremely high opening day returns.
Social Influences

• Social norms
  – The informal opinions, rules, and procedures of a group.
  – Your piers and social groups influence your investment participation

• Herding Behavior
  – The movement into or out of a stock or industry of companies by large groups of investors.
Psychology of Belief

Confirmation Bias

Source: https://www.interaction-design.org/literature/article/confirmation-bias-it-s-not-what-we-think-we-know-that-counts
Confirmation Bias

The Facts

Your Beliefs

Overvalued

Source: Robert A. Strong (2004), Practical Investment Management, South-Western
Representativeness Heuristic

\[ P(\text{A} \& \text{B}) < P(\text{A}) \text{ or } P(\text{B}) \]

Source: Robert A. Strong (2004), Practical Investment Management, South-Western
Herding Behavior

• Herding refers to the lemming-like behavior of investors and analysts looking around, seeing what each other is doing, and heading in that direction.

• There may not have been safety in numbers, but there probably was some comfort in them.

Source: Robert A. Strong (2004), Practical Investment Management, South-Western v
Katona’s Economic Psychology Model

Economic Conditions (E) → Personal Characteristics (P) → Economic Behavior (B)

References


