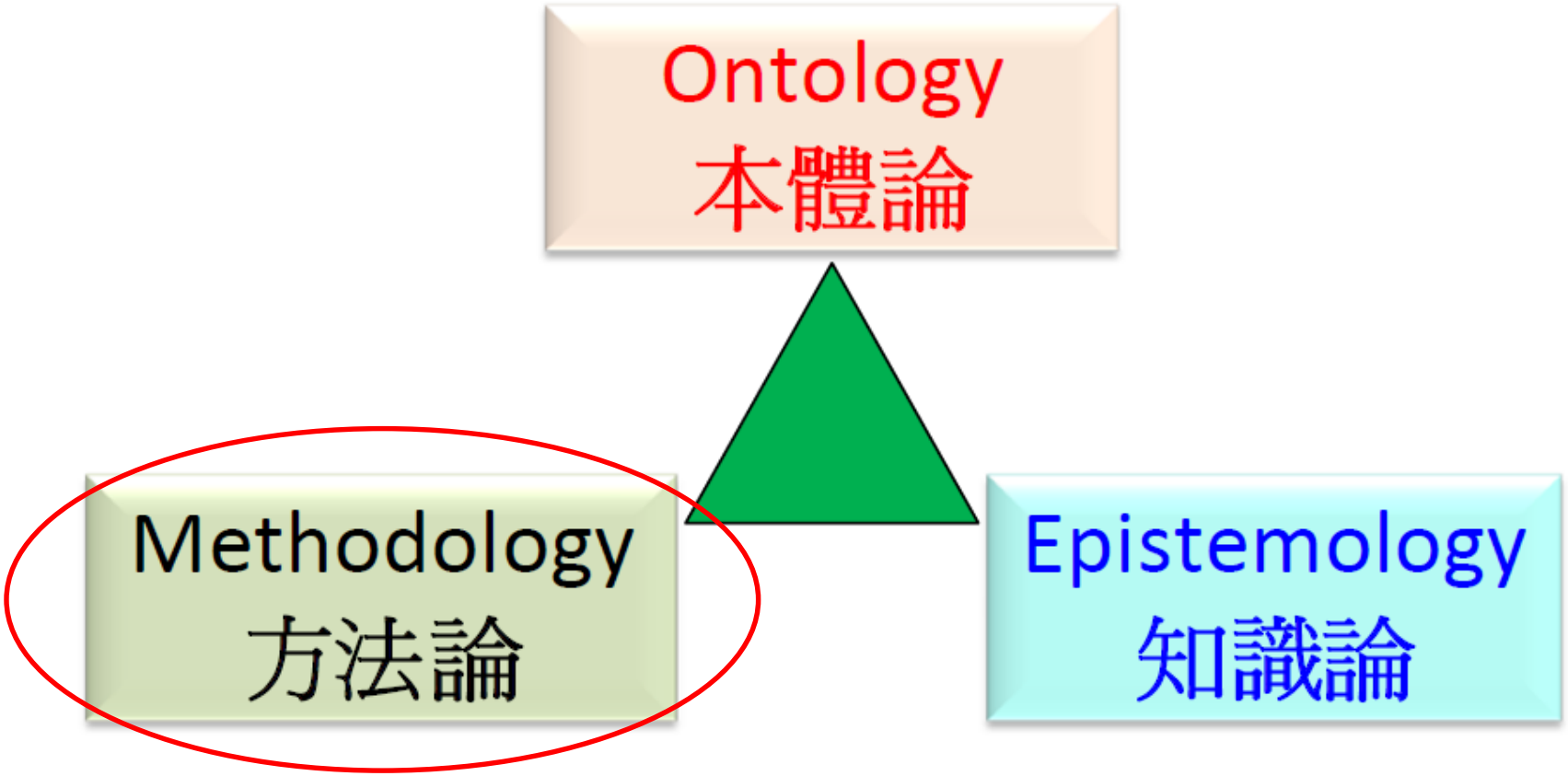
2025 System Dynamics Symposium

決策與系統動態學
Decision Making and System Dynamics

江炯聰

2025/06/15

Philosophy 哲學（Ph.D. vs. DBA)



生成式AI（Spring, 2025）

授課教師：江炯聰，韓揚銘，朱師右，梁義俊

授課時間：每週一晚 7:00-9:45, 共15週, 2025/02/24~06/09

週數:日期	單元主題
1: 02/24	AI歷程及生成式AI
2: 03/03	生成式AI相關晶片
3: 03/10	生成式AI產品趨勢
4: 03/17	生成式AI文字類工具與應用趨勢
5: 03/24	生成式AI圖片類工具與應用趨勢
6: 03/31	生成式AI影音類工具與應用趨勢
7: 04/07	生成式 AI 實作演練展示(1)
8: 04/14	生成式AI實作演練展示(2)
9: 04/28	生成式AI新應用-新零售與行銷科技
10: 05/05	生成式AI新應用-金融科技
11: 05/12	生成式AI新應用-ESG
12: 05/19	生成式AI新應用-高科技製造
13: 05/26	生成式AI新應用-新商模(1)
14: 06/02	生成式AI新應用-新商模(2)
15: 06/09	綜合討論與期末報告

100 AI

Geoffrey Hinton

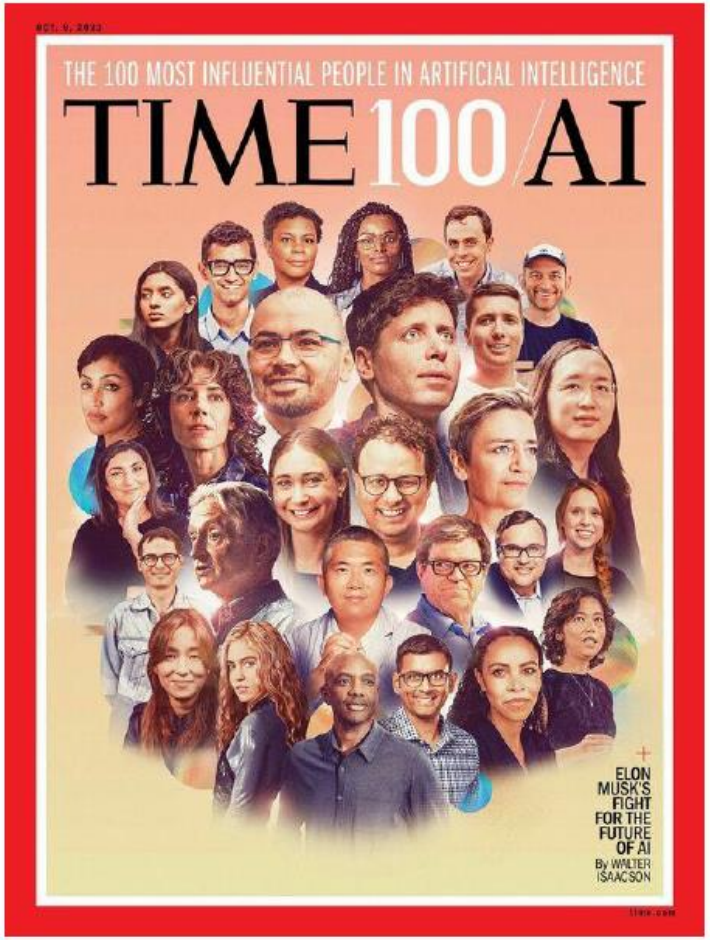
Yann LeCun

Yoshua Bengio

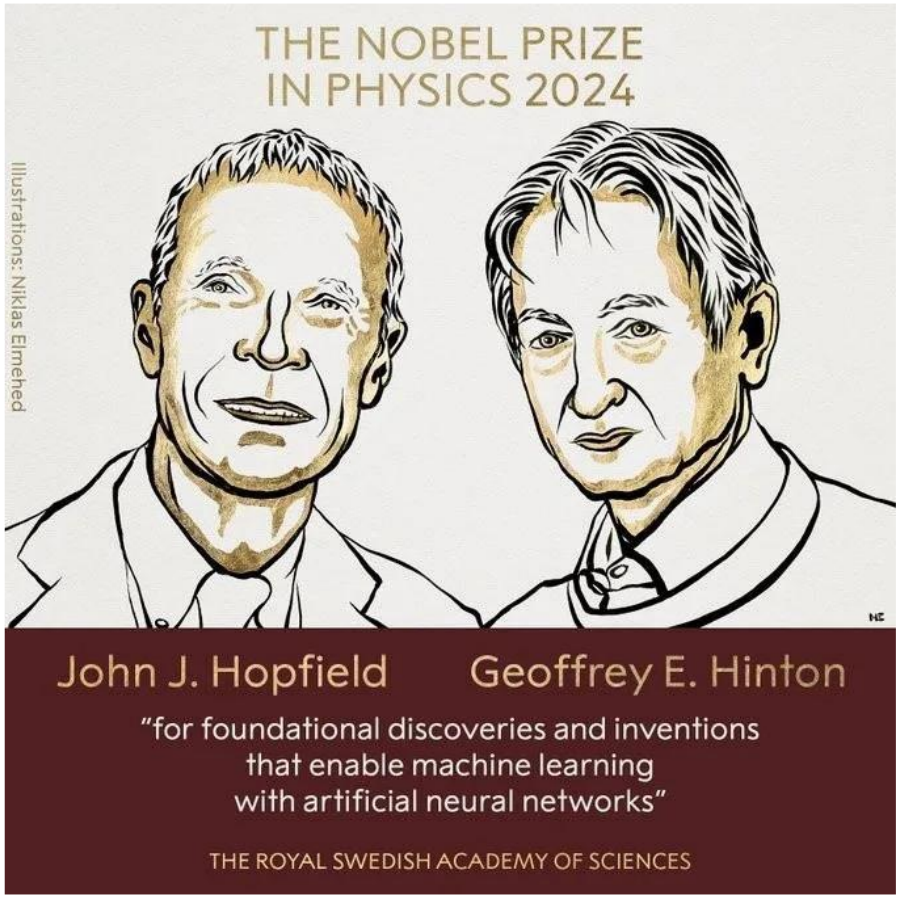
Andrew Ng

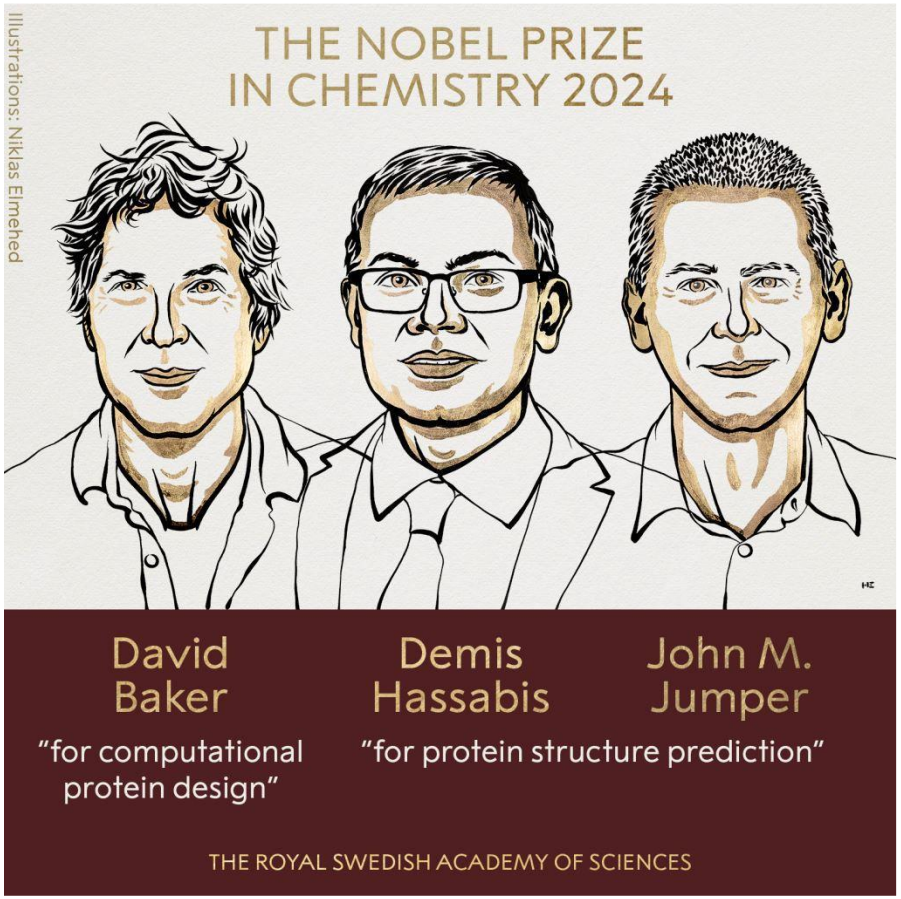
Fei-Fei Li

Demis Hassabis



2024 Nobel Prize in Physics & Chemistry





DeepMind Alpha GO

資料來源：DeepMind，2022年3月

G. Hinton: “Will digital intelligence replace biological intelligence?” (2024.02.19)

Two paradigms for intelligence

The logic-inspired approach

The essence of intelligence is reasoning.

This is done by using symbolic rules to manipulate symbolic expressions.

- Learning can wait. Understanding how knowledge is represented must come first.

The biologically-inspired approach

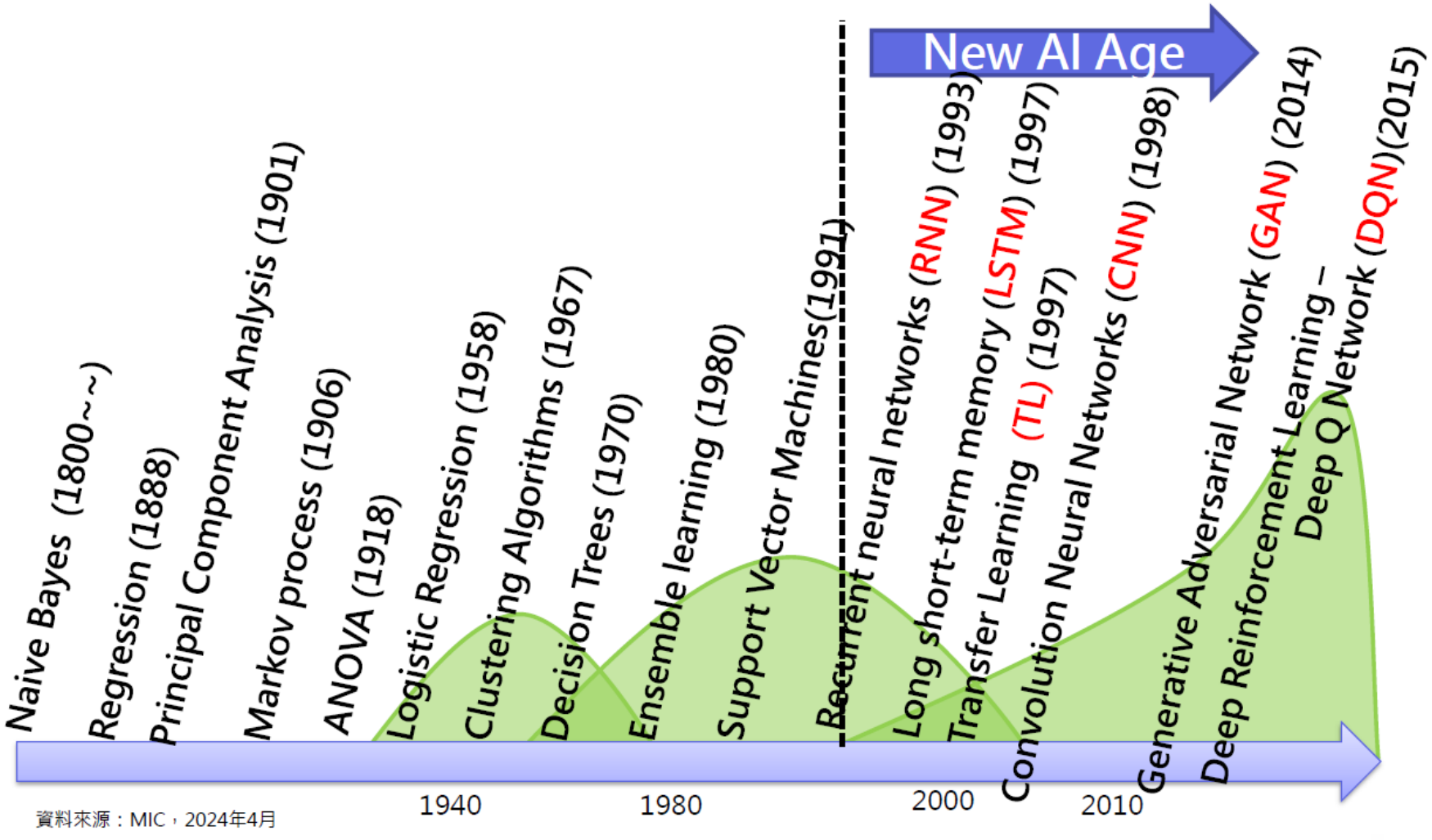
The essence of intelligence is learning the strengths of the connections in a neural network.

- Reasoning can wait. Understanding how learning works must come first.

Two very different theories of the meaning of a word

- Symbolic AI: The meaning of a word comes from its relationships to other words. What a word means is determined by how it occurs with other words in sentences. To capture meaning we need a relational graph.
- Psychology: The meaning of a word is just a big set of semantic features. Words with similar meanings have similar semantic features.

Deep Learning



資料來源：MIC，2024年4月

MIC

市場經濟與經營管理 (財務+投資)
(+ Non-Profit & Public & Voluntary Sectors)

股東權益報酬率 = 淨利 / 股東權益

= (淨利 / 收益) x (收益 / 總資產) x (總資產 / 股東權益)

= 營運 x 投資 x 融資

營運：純益率（淨利 / 收益）

投資：資產周轉率（收益 / 總資產）

融資：槓桿比率（總資產 / 股東權益）

System Dynamics

Modes

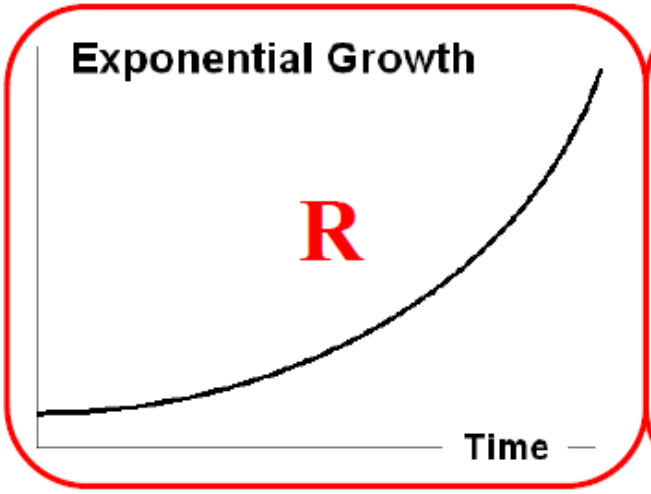
Limits to Growth

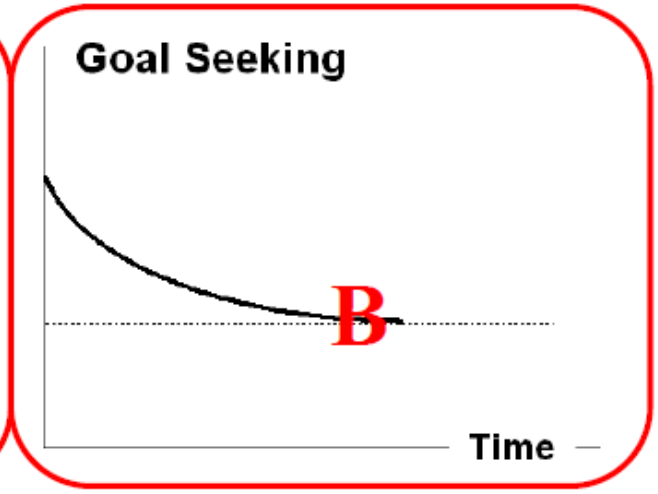
Platform-Mediated Network

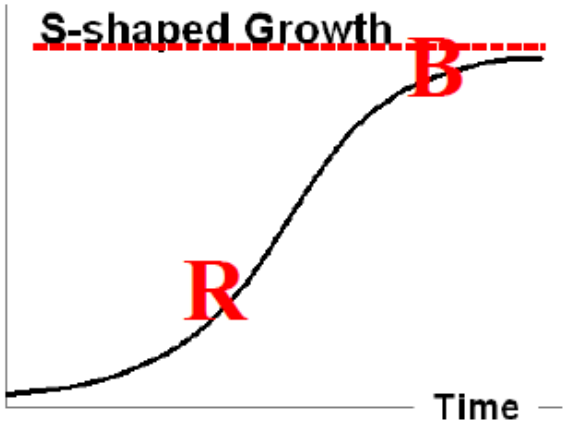
System Dynamics: 3 Basic Modes

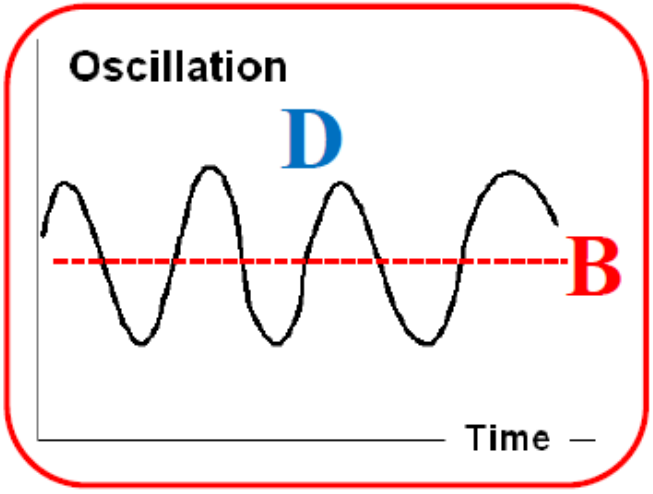
- R: Reinforcing Loop 強化圈
  - Virtuous and/or Vicious Cycles
  - 良性/惡性 循環 (相同正向循環)
- B: Balancing Loop 平衡圈
  - Upper or Lower Limits and Reducing Gaps
  - 高標/低標 限制 (縮差距)
- D: Time Delay 時間延遲
  - Over- or Under-Shooting
  - 超過/不及 交替

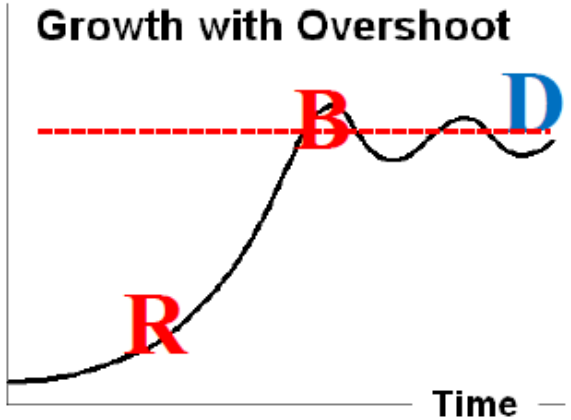
Common Modes of Behavior

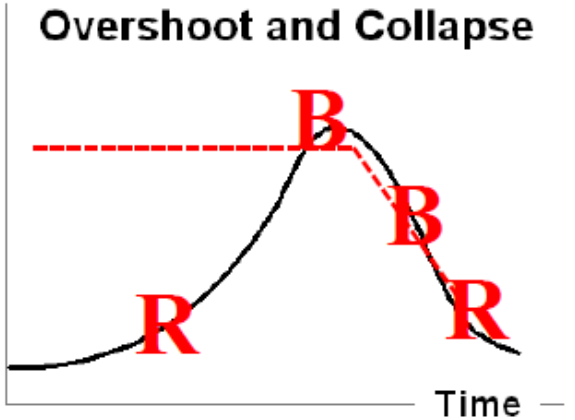




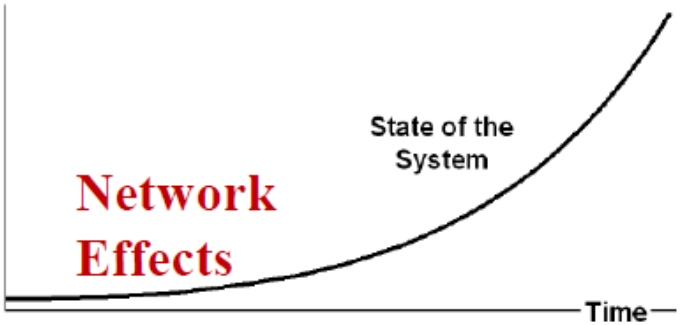






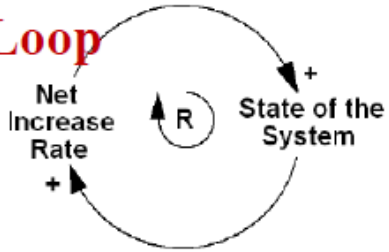


Exponential growth: structure and behavior

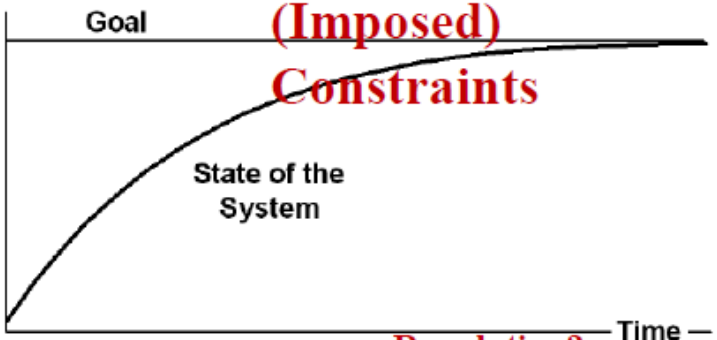


Network Effects

Positive Causal Loop



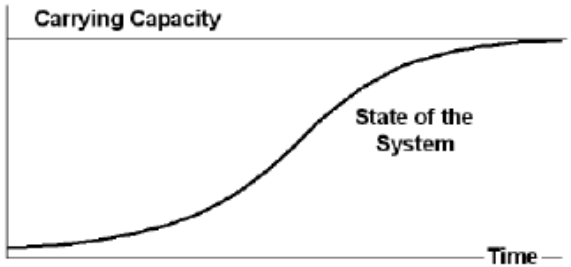
Goal seeking: structure and behavior



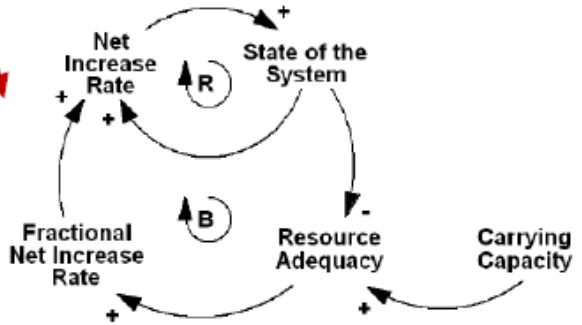
(Imposed) Constraints

Regulation?
Capacity?
Checks and Balances?

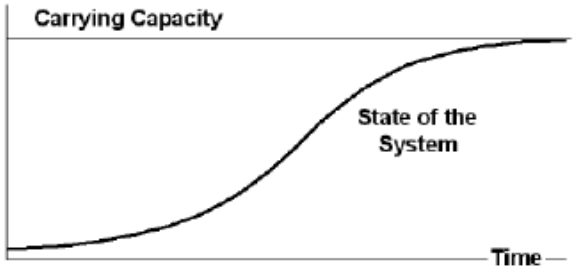
S-shaped growth: structure and behavior



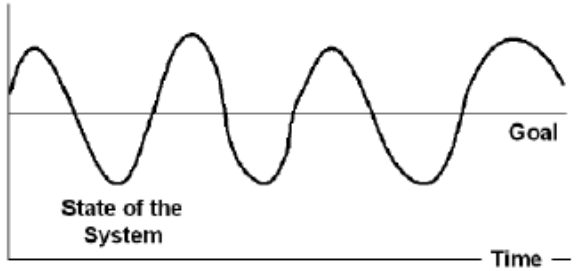
Limits to Growth

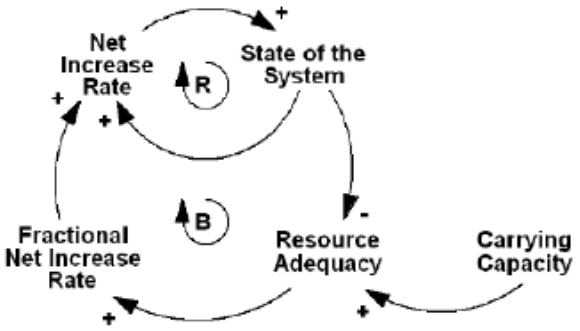


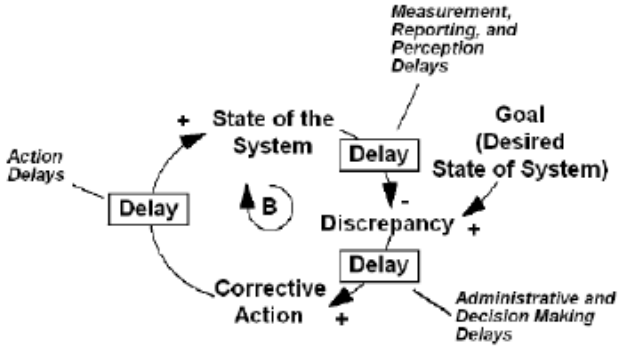
S-shaped growth: structure and behavior



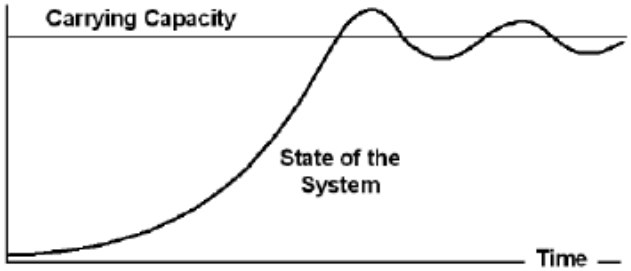
Oscillation: structure and behavior

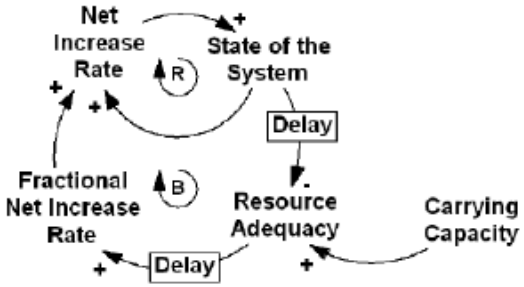




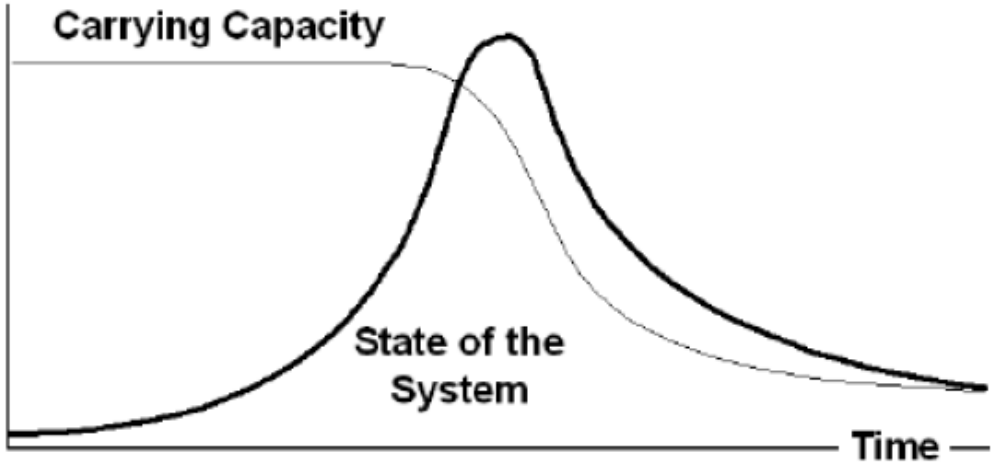


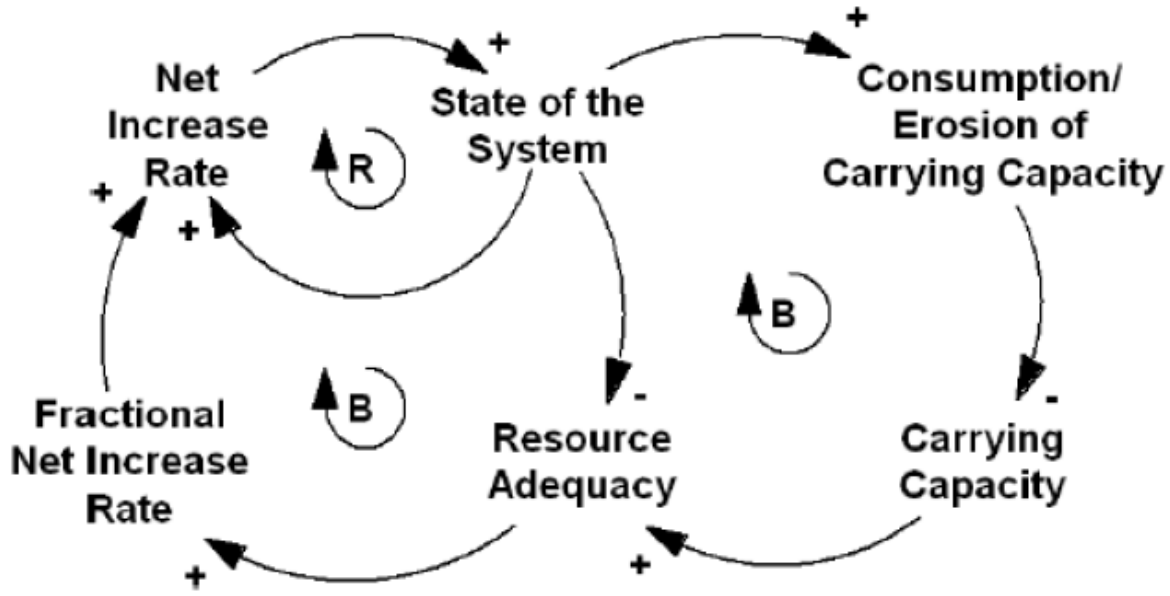
S-shaped growth with overshoot and oscillation: structure and behavior



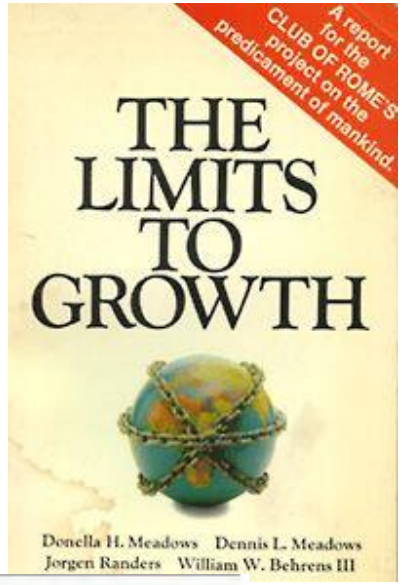


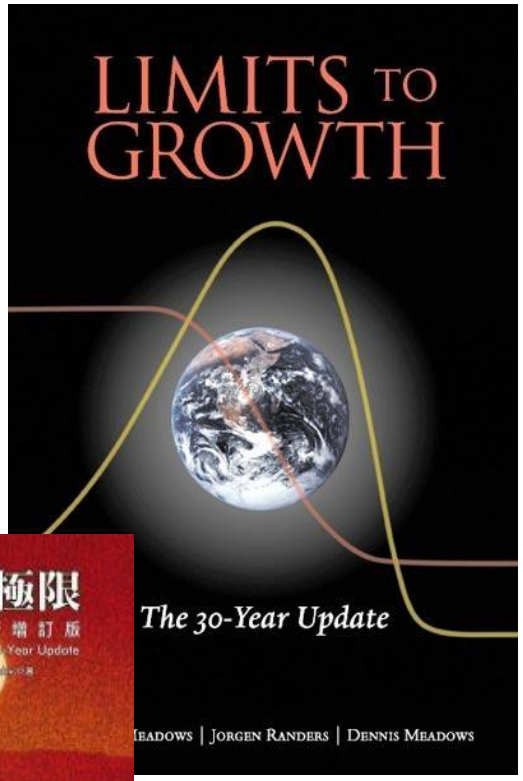
Overshoot and collapse: structure and behavior

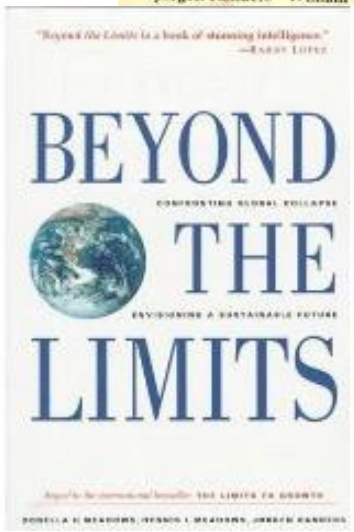


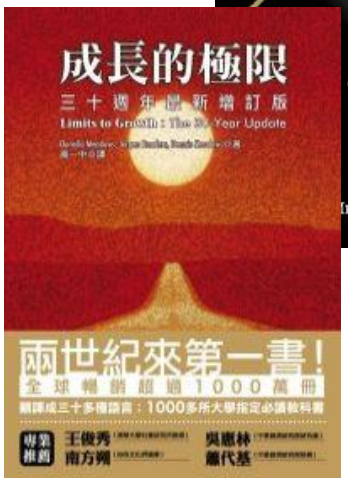


Limits to Growth: The 30-Year Update



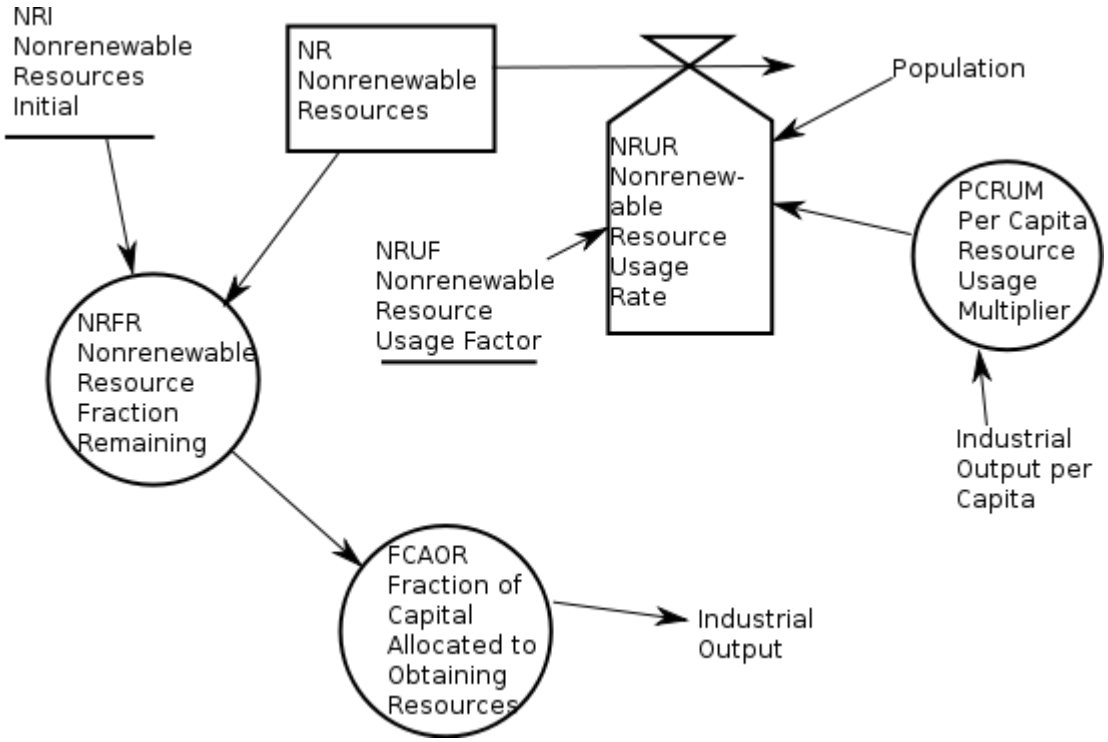






World3 Model

- The food system, dealing with agriculture and food production,
- The industrial system,
- The population system,
- The non-renewable resources system,
- The pollution system.



9 Alternative Scenarios

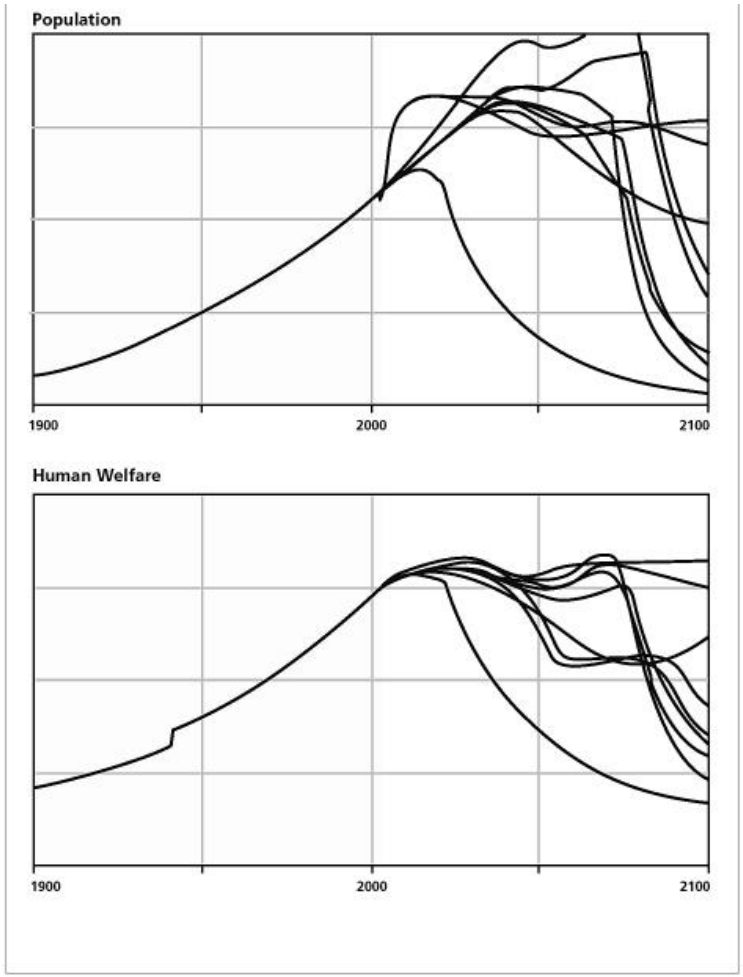
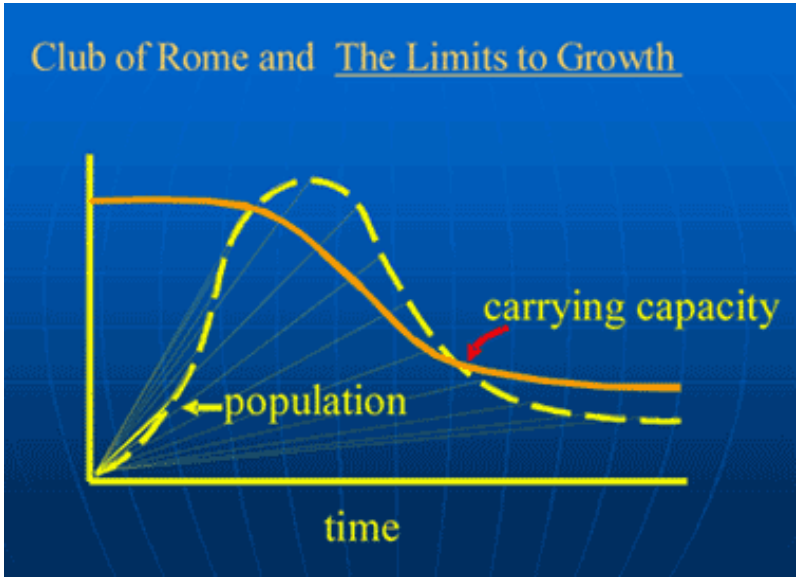
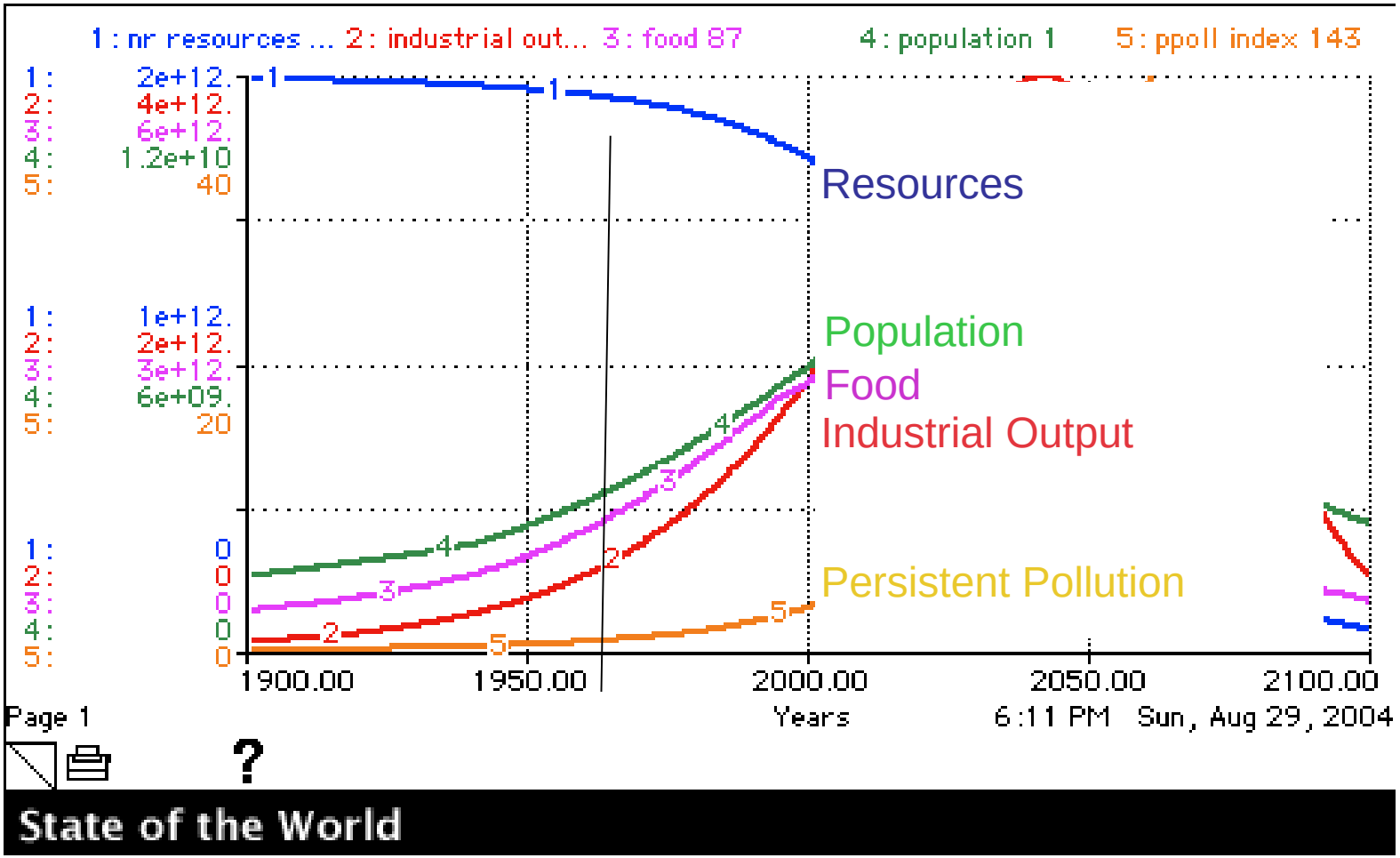


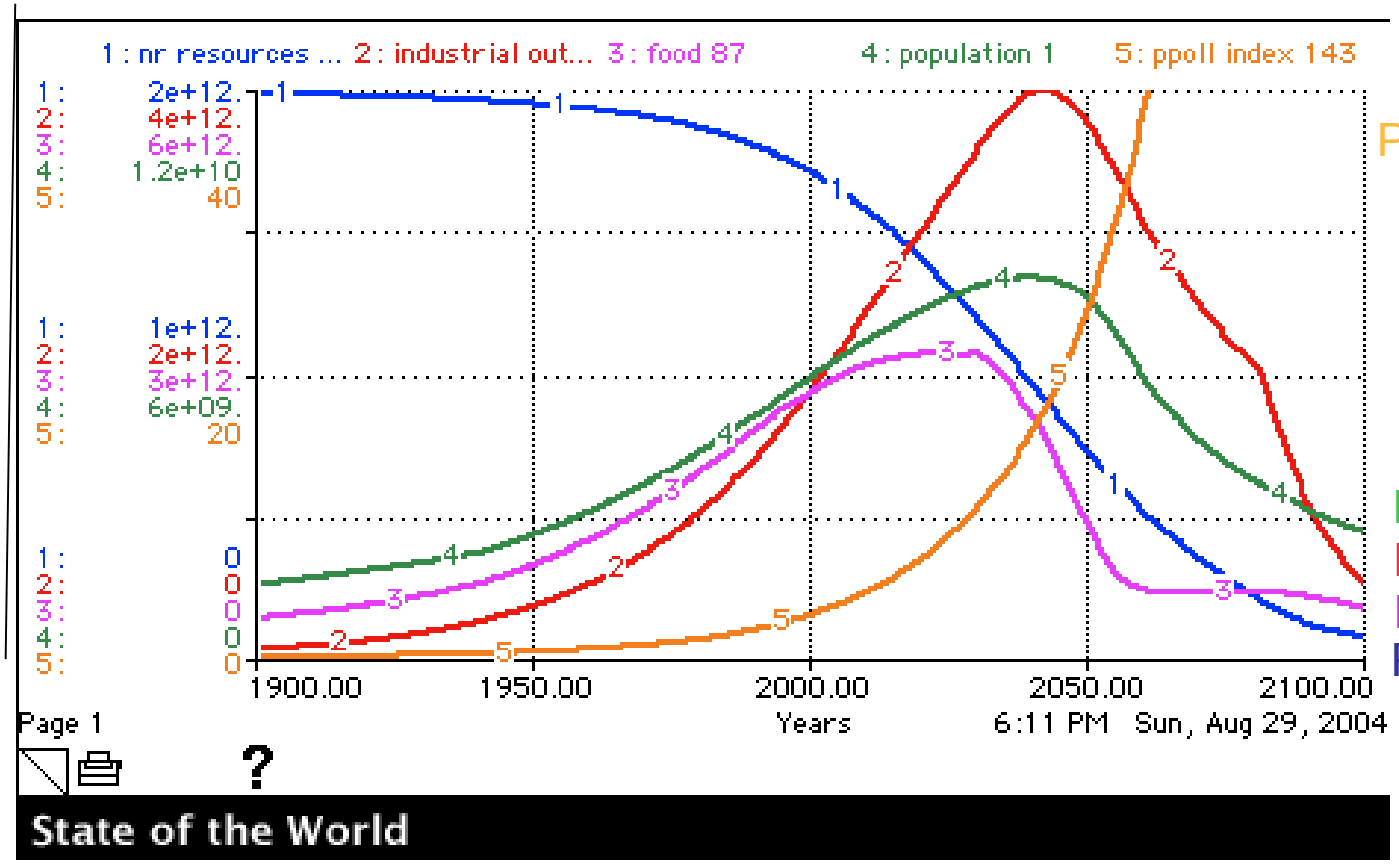
FIGURE 1-4 Alternative Scenarios for Global Population and Human Welfare
This figure superimposes all relevant World3 scenarios shown in this book to illustrate the wide range of possible paths for two important variables—population and average human welfare (measured as an index combining per capita income with other indicators of well-being). Most scenarios show decline, but some reflect a society that achieves a stable population and high, sustainable human welfare.



2004 Projection for 1900-2000



2004 Projection for 1900 - 2100



Pollution

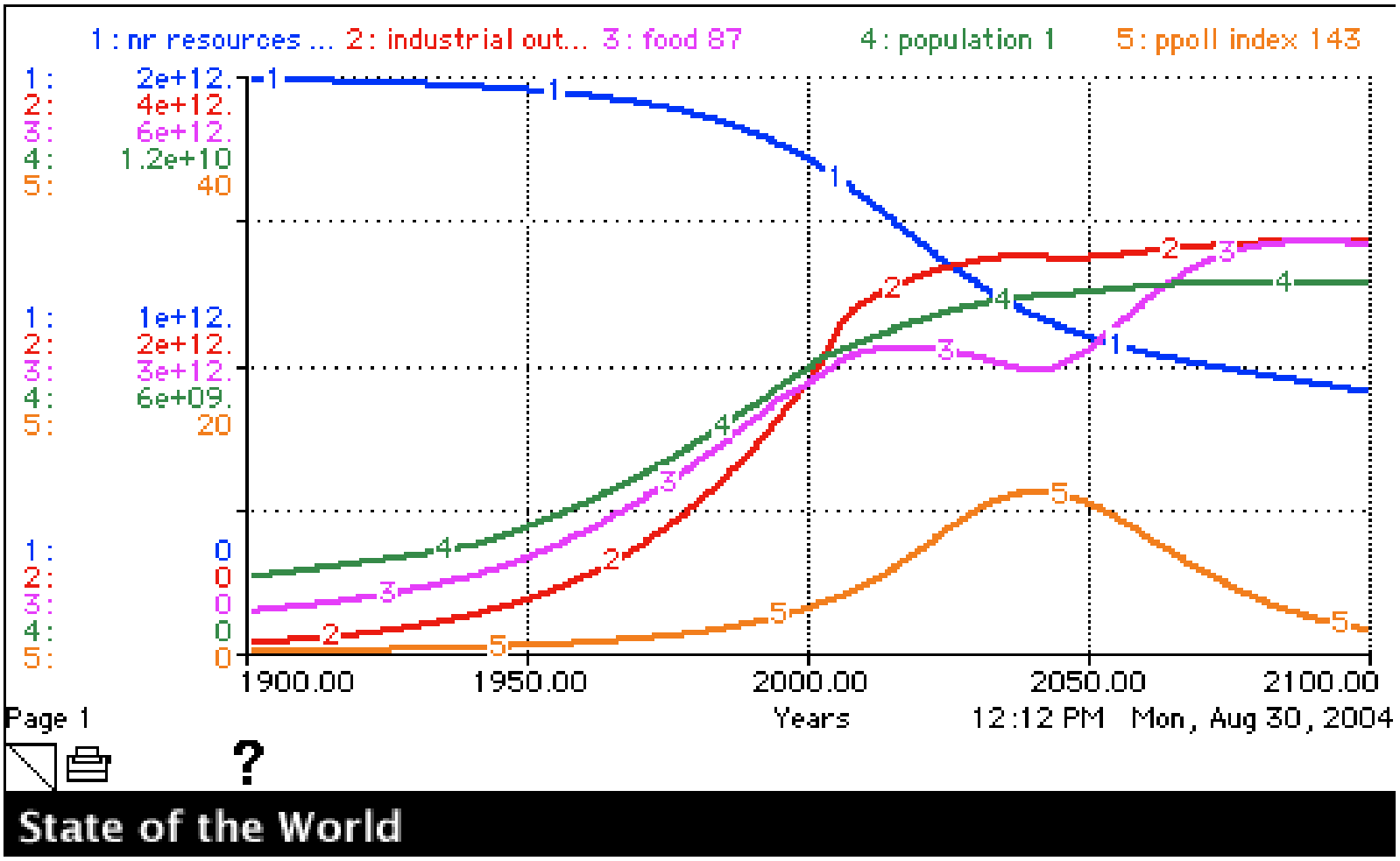
Population

Industrial Output

Food

Resources

Sustainable Development



Prediction? Doomsday Prophecy?

In 2008 Graham Turner at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia published a paper called "A Comparison of `The Limits to Growth` with Thirty Years of Reality".[8][9] It examined the past thirty years of reality with the predictions made in 1972 and found that changes in industrial production, food production and pollution are all in line with the book's predictions of economic and societal collapse in the 21st century.[10] In 2010, Peet, Nørgård, and Ragnarsdóttir called the book a "pioneering report". They said that, "its approach remains useful and that its conclusions are still surprisingly valid... unfortunately the report has been largely dismissed by critics as a doomsday prophecy that has not held up to scrutiny."[11]

Positive Feedback

创造和发展
新的服务和
内容

发展服务的机会

有吸引力的内容
和服务

内容供应商的内容
收益
付给DoCoMo的传
输收益

更多的用户

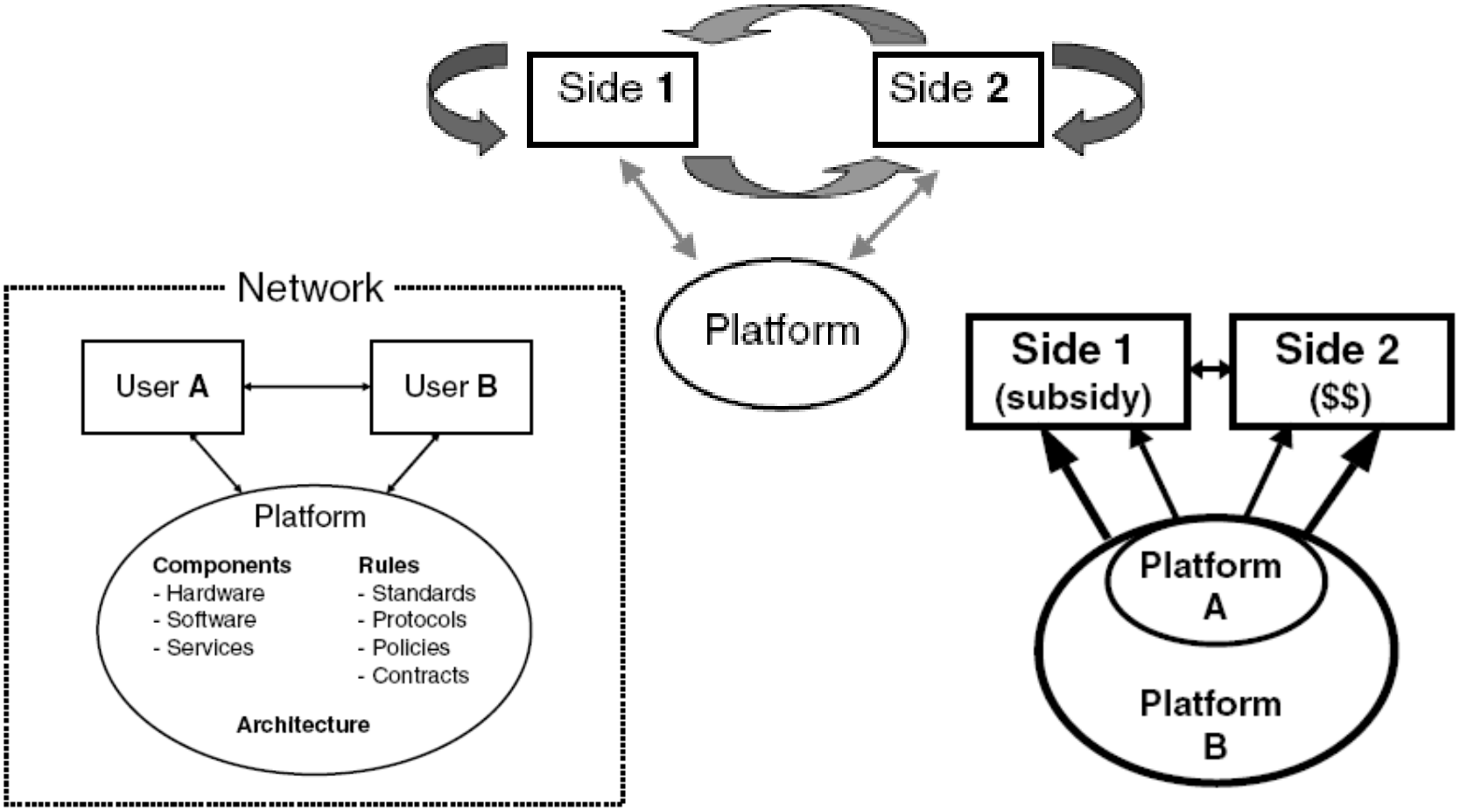
用户吸引内容供应商

售卖内容和服务的机会

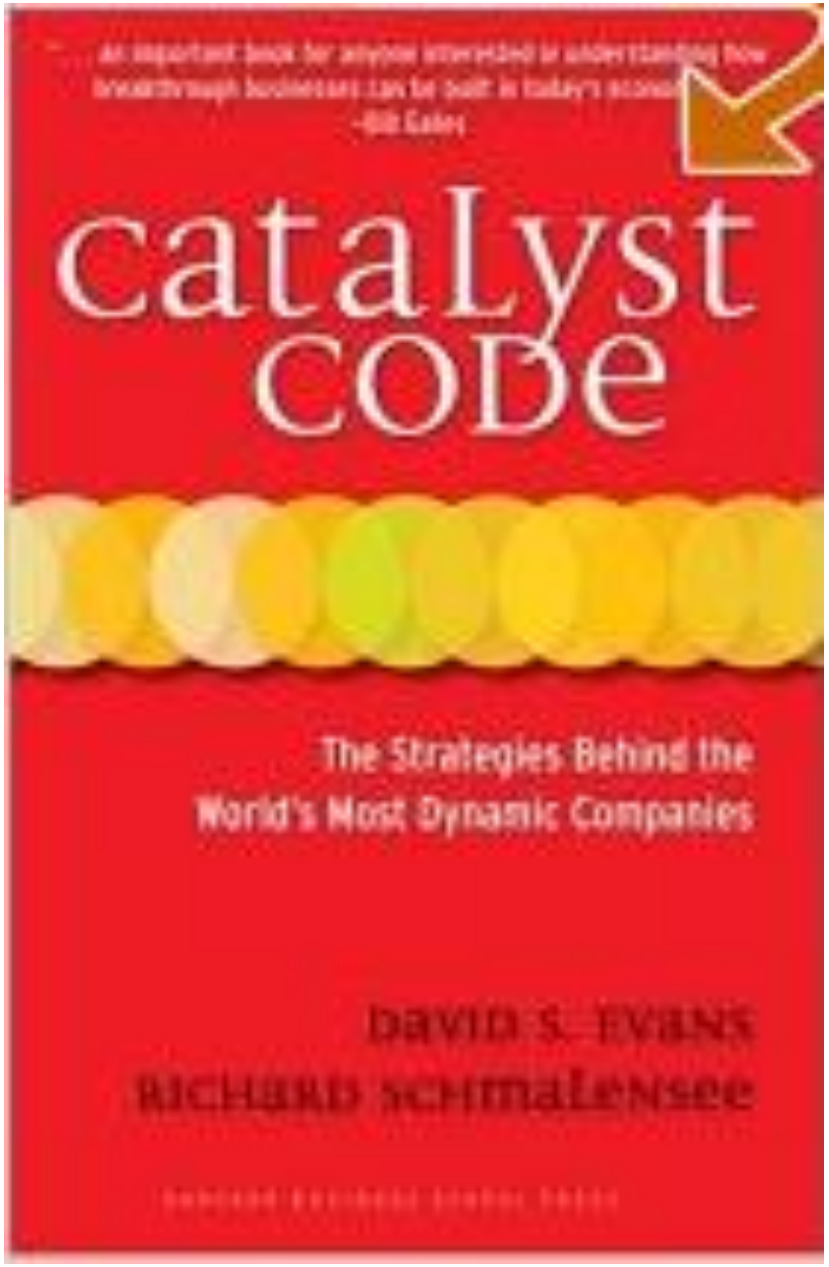
大的社团

来源: Sonera (2002)

Platform-Mediated Networks



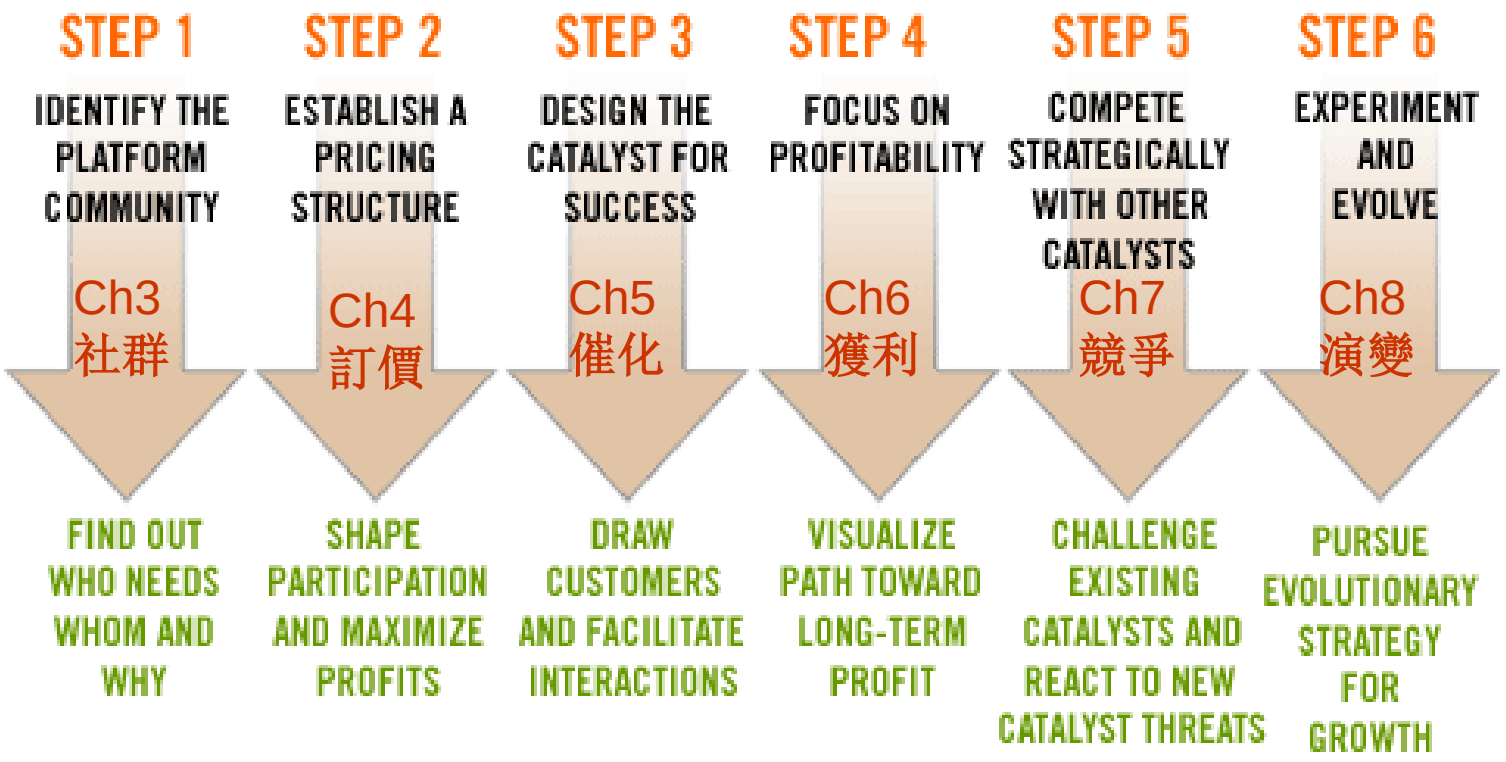

企業 觸媒策略
3C


catalyst
code
The Strategies Behind the
World's Most Dynamic Companies
DAVID S. EVANS
RICHARD SCHMALENSEE

Framework of *Catalyst Code*

Ch2

- Create a Value Proposition 创造价值主张
- Facilitate Search and Provide Information 协助搜寻与提供讯息
- Devise Rules and Standards 制定规则与标准



Types of Catalysts 催化剂的类型

Most cases are hybrid catalysts. 大多数情况下都是混合功能的催化剂。

Matchmakers *Objective: To facilitate transactions* 牵线搭桥 *目标：促成交易*	**Audience Makers** *Objective: To assemble eyeballs* 创建受众群体 *目标：吸引关注*	**Cost-Minimizers** *Objective: To increase efficiency* 最大限度节省成本 *目标：提高效率*
eBay	*Paris Match*	Palm OS
Yahoo Personals	Google	Windows
Marche Bastille	Conde Nast	Symbian
Myspace.com	TiVo	Sony PlayStation
Manheim Auto Auction	Reed Elsevier	Xbox
Odaiba	*Wall Street Journal*	SAP Enterprise Software
NASDAQ	BBC	Linux

Reprinted from *Catalyst Code*

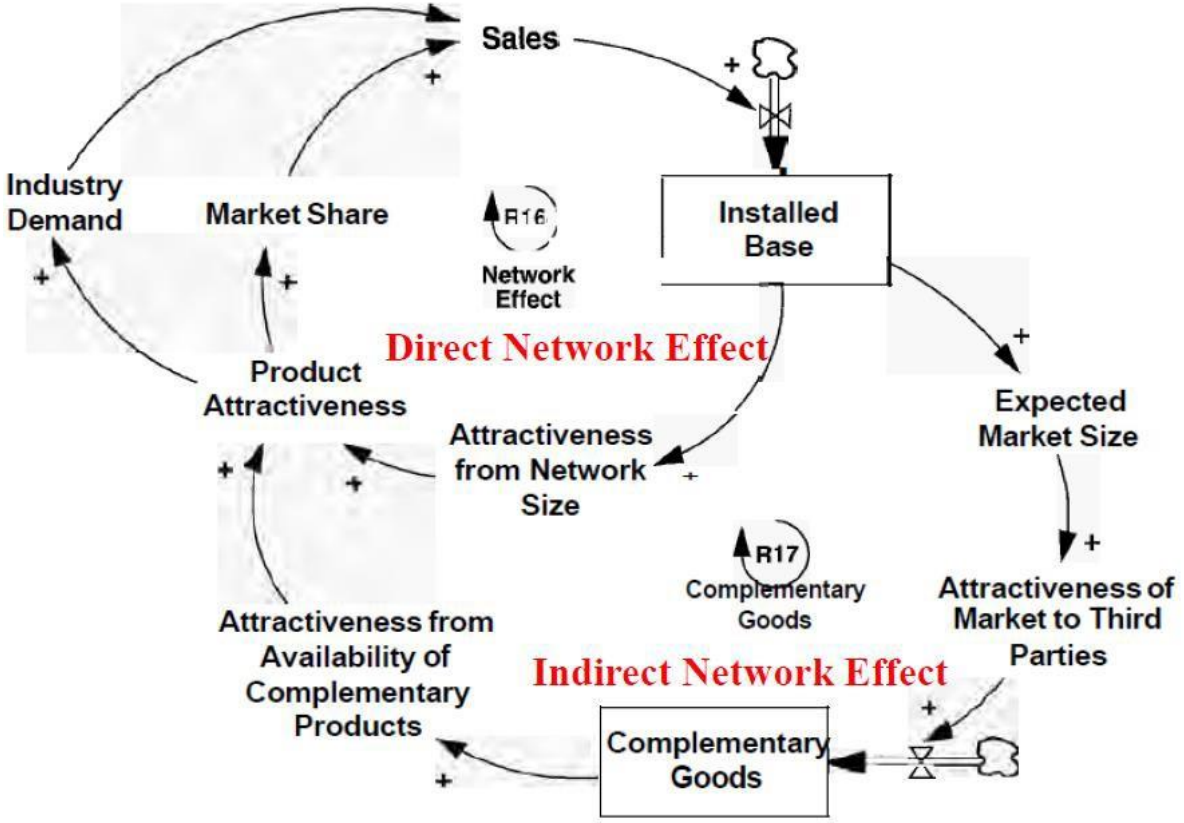
Categorization

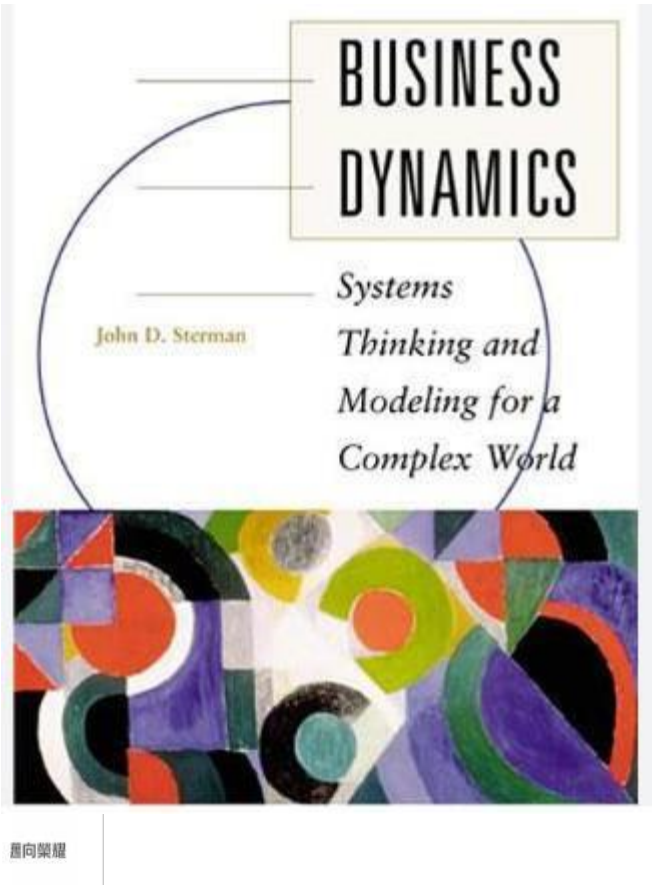
Market makers (Matchmakers) To facilitate transactions	Audience makers (Audience Builders) To assemble eyeballs	Demand coordinators (Cost Minimizers) To increase efficiency
• Auction houses (e.g., Sotheby's, eBay and PEFA) • Securities and futures exchanges (e.g., NYSE, NASDAQ, LME and CME) • Matchmaking services (e.g., Yahoo! Personals, 104 Bank and Craigslist) • Malls (e.g., Amazon's shop and Second Life)	• Radio and television (e.g., CNN and ICRT) • Newspapers and magazines (e.g., WSJ, NYT and Google News) • Directory services (e.g., Yellow Pages, Google Map & AdWord/AdSense) • Internet portals (e.g., Yahoo! and Apple Store) • Web2.0 (e.g., YouTube and Facebook)	• Financial data and analysis delivery (e.g., Reuters and Bloomberg) • Video games (e.g., Nintendo and Sony) • Operating systems (e.g., Palm PDA, Microsoft) • Payment systems (e.g., credit cards, debit cards, stored-value cards, and Paypal)

Single-Sided vs. Multiple-Sided Business

One-sided	Two-sided	One going on two
KFC where customers don't care who else eat there	Edward Lloyd's Coffee house (17^{th} century): meeting place for shipping insurance deal making	Silicon Valley coffee shops: meeting places for entrepreneurs and venture capitalists
Apple's iPod/iTunes platform buys and resells music.	Microsoft's digital media S/W platform relies on H/W makers and content providers.	Google Video sells digital videos and provides an online exchange for people
Relay is an airport book seller	*Vogue* attracts fashion readers and advertisers	Amazon.com sells books and operates online shopping mall.
The Sears card lends money to shoppers to buy and pay at Sears.	VISA operates a payment system in which millions of cardholders can transact with millions of merchants.	Wal-Mart issues cards to its customers that can be used in the Discover Network.
DIRECTV buys TV shows and makes these available to subscribers.	Fox TV buys and develops content that attracts viewers and advertisers	TiVo offers a service to skip over commercials for viewers and makes its subscriber base available for advertisers.

Network and Compatibility Effects





Decision Making

Decision Making

Know-What, Know-Why, Know-How
Objective? Scientific? Feasible?

Would it help?

Prescriptive D-M:
How decisions could be made better?

Action
主觀, 意志

實踐檢驗真理
能抓老鼠是好貓
模著石子過河
論證與試點

可行
目的
方法

Know-How
(Feasible?)
Prescriptive

→實踐可行

怎麼辦?

Harvard DBA 哈佛企管博士學位
Entrepreneurship 創業家精神
Harvard Business Review 期刊

是甚麼?

實然

客觀
描述
實證

→客觀實證

Know-What
(Objective?)
Descriptive

?

→科學因果

Know-Why
(Scientific?)
Normative

應然

科學
推理
因果

為甚麼?

Descriptive D-M:
How decisions are made?

Normative D-M:
How decisions should be made?

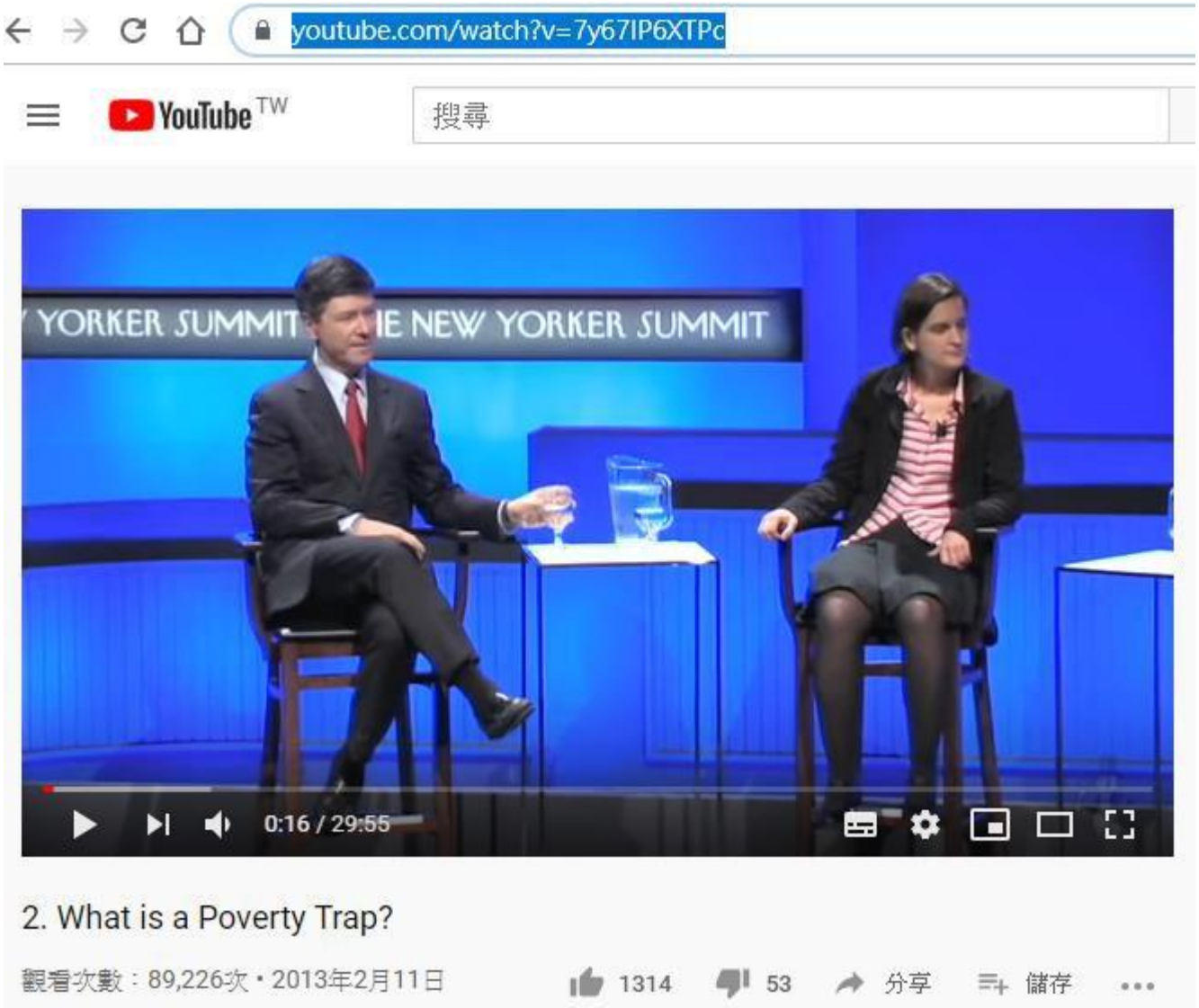
Descriptive, Normative, Prescriptive
描述性的, 規範性的, 處方(可行)性的

- Descriptive D-M: How decisions are made
  - How do people actually think and behave? What are the differences in thought patterns for people of different cultures, genders, and experiences?
  - Good descriptive analyses lead to good predictions of actual behavior. The work is a highly empirical and clinical work.
  - Scholars can study this domain without any concern whatsoever for trying to modify behavior, influence behavior, or moralize about behavior.
- Normative D-M: How decisions should be made
  - How idealized, rational, super-intelligent people should make decisions. Such analyses abstract away known cognitive concerns of real people.
  - The theories are elegant. Empirical veracity is sacrificed on the altar of theoretical parsimony.
- **Prescriptive D-M: How decisions could be made better**
  - Prescriptive advice should be evaluated by its pragmatic value and tuned to the differential needs, capabilities, psyches, foibles, fallibilities, and emotional makeups of the individuals; advice should promote an understanding of problems, confidence in decisions, justification for decisions, and satisfaction with consequences.
  - Prescriptive analysis should be informed by descriptive and normative theories.

Natural Experiment for Cause and Effect (Causal Relationships) in Social Sciences

- Natural Sciences and Social Sciences
  - (Evidence-Based) Medicine, Economics (Nobel Prize in Economic Sciences) , etc.
  - 理論研究 & 實證研究 (實際證明, Positivism 實證主義, Empirical research)
  - Correlation and Causation
  - Randomized Testing
  - Internal Validity and External Validity
  - Exploratory and Confirmatory Research
  - 研究對象: 可操控? 人有自由意志, 倫理問題
  - 干擾因素: 複雜度, 可排除?
- Natural Experiment
  - Causal Inference mainly based on Observed Data
  - Identification Strategy
  - 政策變革, 法律規定, 風俗習慣

Poverty Trap:
J. Sachs (2022 Tang) vs. E. Duflo (2019 Nobel)

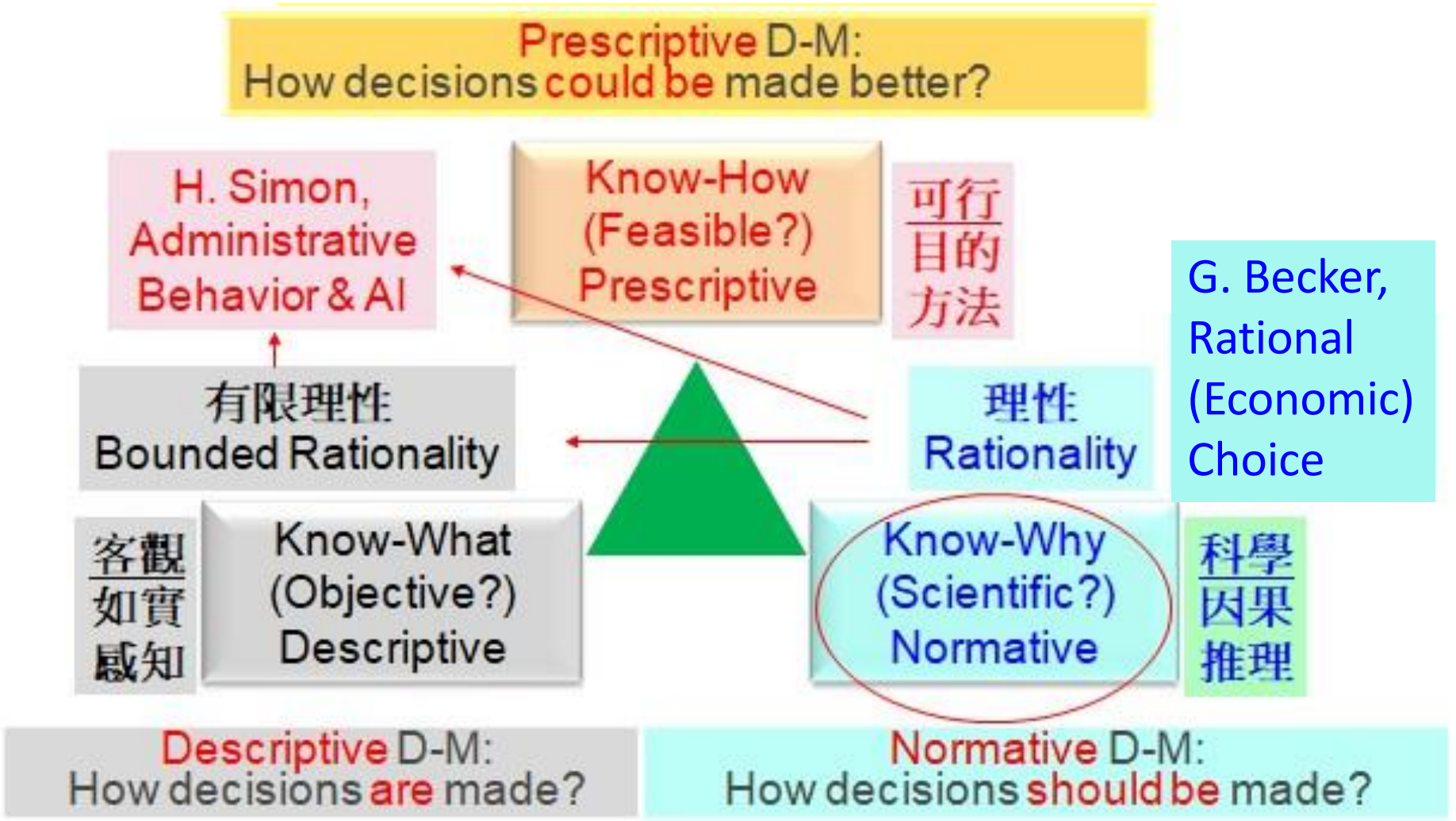


學術研究與實務研究
Academic Research & Practical Research

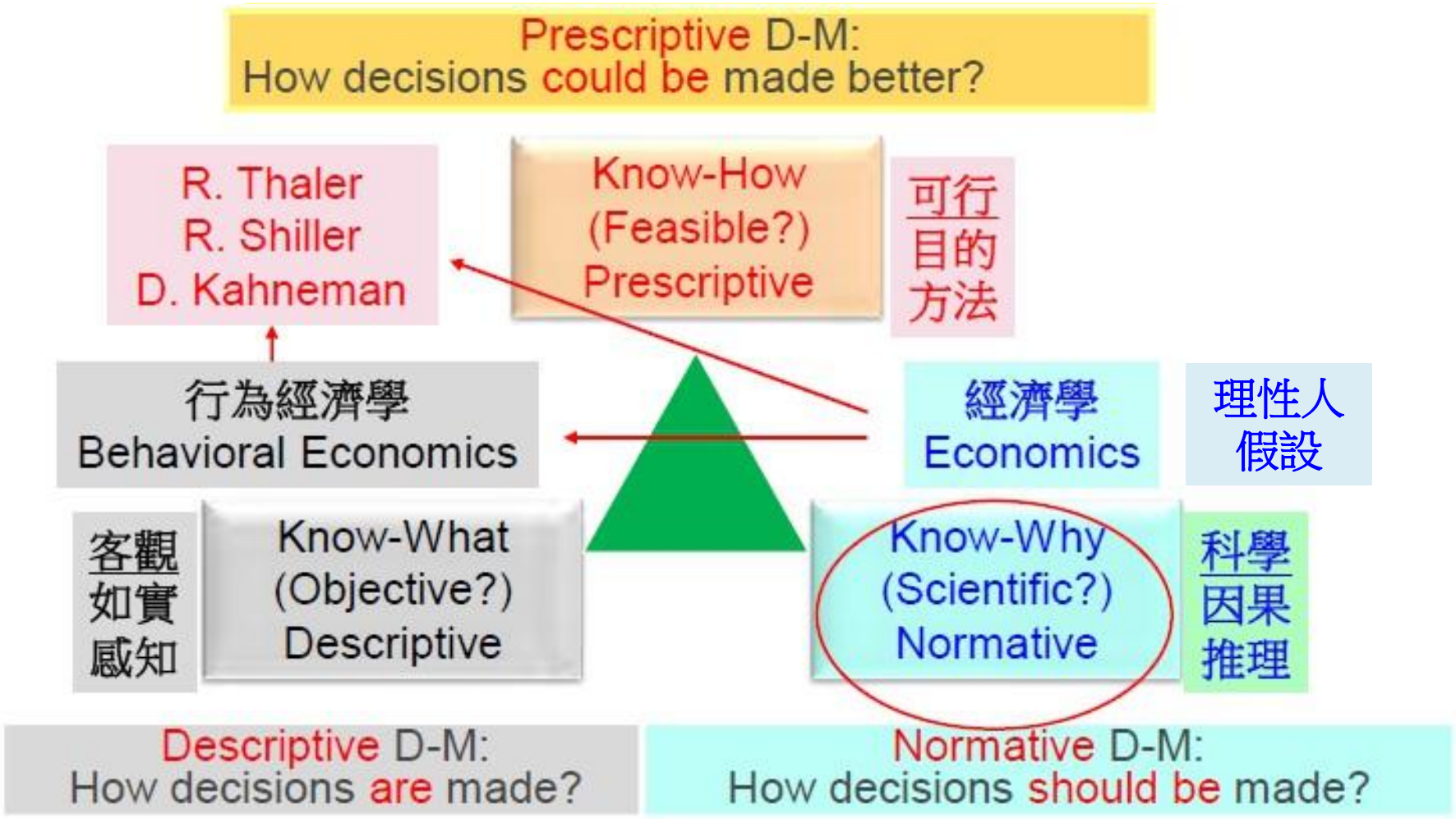
學術研究 常偏重		實務研究 常偏重
研究 Why		研究 How
研究 Past		研究 Future
發現真相		目標導向
抽離時空 建立 Models	⟺	進入時空 發展 Scenarios
多用 分析性工具 (e.g., statistics)		多用 操作性工具 (e.g., game theory)
個人或小團隊進行		團體與系統工程
較無時間壓力		重時效性

Source: 張榮豐

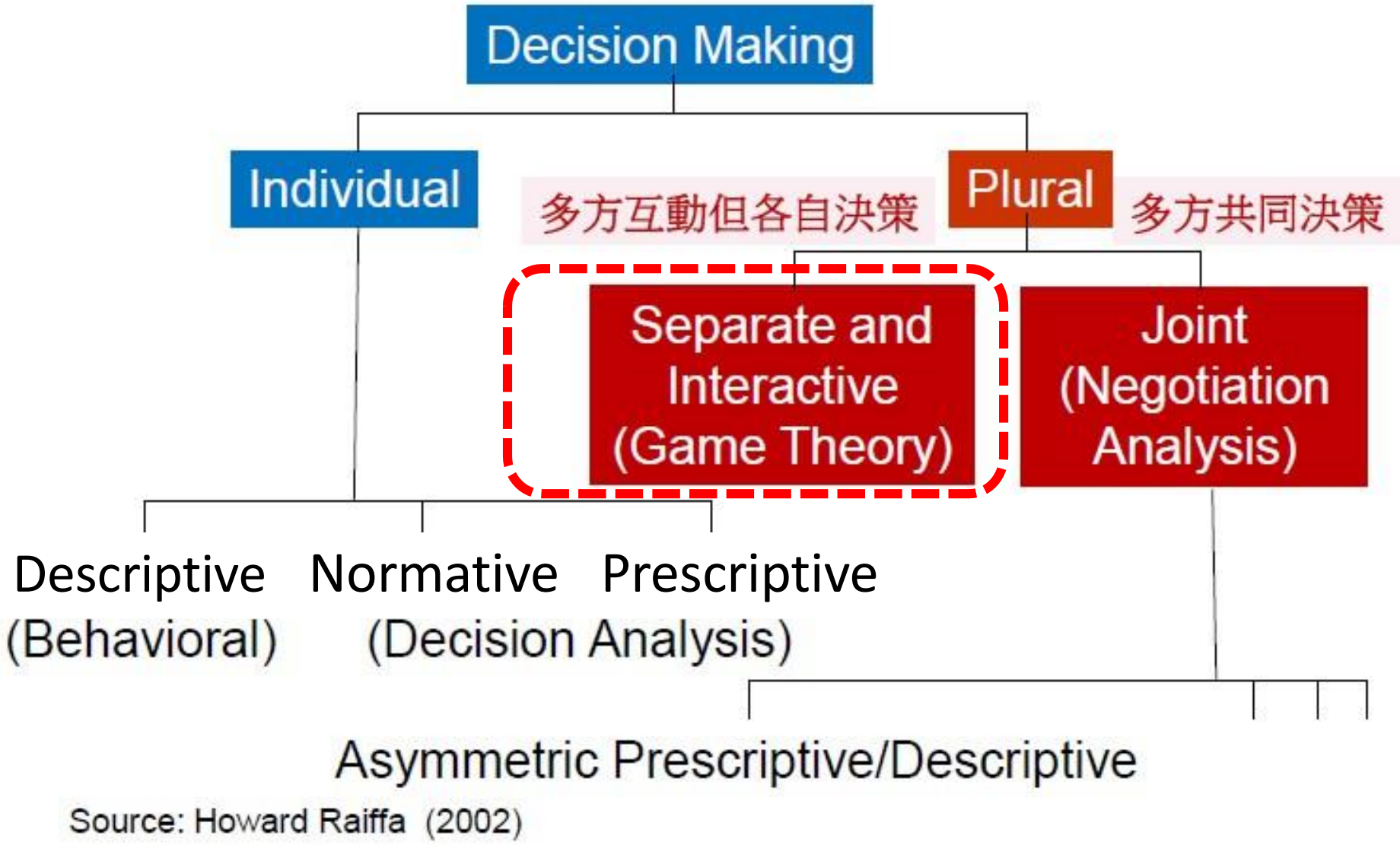
Rationality and Bounded Rationality
Becker (1992) and Simon (1978)



Economics and Behavioral Economics
Kahneman (2002), Shiller (2013), Thaler (2017)



Individual and Plural Decision Making



Source: Howard Raiffa (2002)

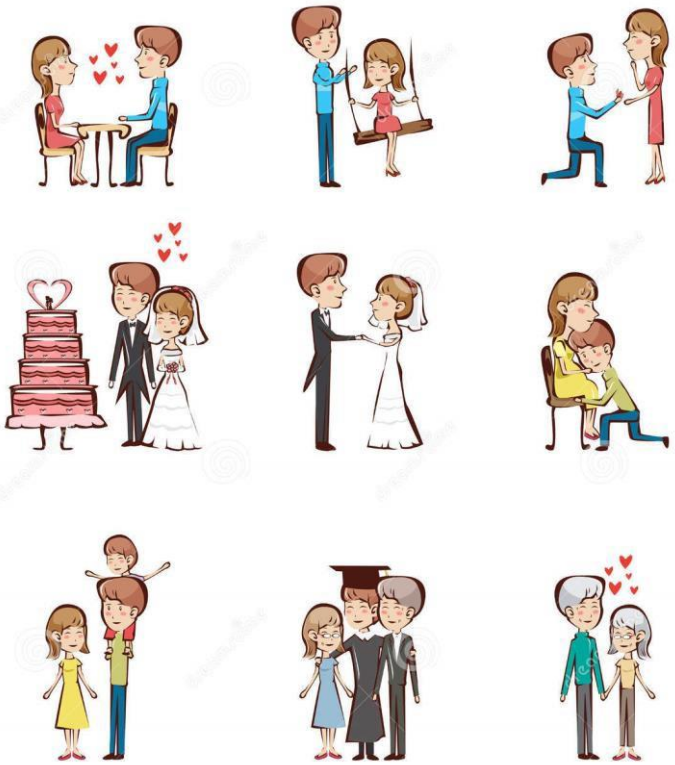
(4) 從婚前的甜蜜約會，到婚禮時的海誓山盟，到婚後夫妻失和成冤家，到對簿公堂打離婚官司.

甜蜜約會：協調賽局 coordination game

海誓山盟：保證賽局 assurance game

夫妻失和成冤家：囚犯困境 prisoner's dilemma

對簿公堂打離婚官司：懦夫(或鬥雞)賽局 chicken game



Games and Equilibria 賽局與均衡

Sequence / Information	Static Game 靜態	Dynamic Game 動態
Complete Information 完全信息	Nash Equilibrium Nash (1950, 1951)	Subgame Perfect Nash Equilibrium Selten (1965)
Incomplete Information 不完全信息	Bayesian Nash Equilibrium Harsanyi (1967-1968)	Perfect Bayesian Nash Equilibrium Selten (1975), Kreps & Wilson (1982), Fudenberg & Tirole (1991)

C⁴ISR: 指揮,管制,通信,資訊,情報,監視,偵查
Command,**C**ontrol,**C**ommunications,**C**omputers,
Intelligence,**S**urveillance,**R**econnaissance

Evolutionary Game, Simulation, Reputation, Credibility, etc.

Information Economics 信息經濟學

Game of Asymmetric Information 非對稱信息賽局

	Hidden Action 隱藏行為	Hidden Information (or Characteristics) 隱藏信息或特性
Ex ante 合約合意之前	G. Akerlof →	Adverse Selection 逆(不利)選擇
	M. Spence →	Signaling Model 信號傳遞
	J. Stiglitz →	Screening Model 甄別 (篩選)
Ex post 之後	Moral Hazard 道德風險	Moral Hazard 道德風險

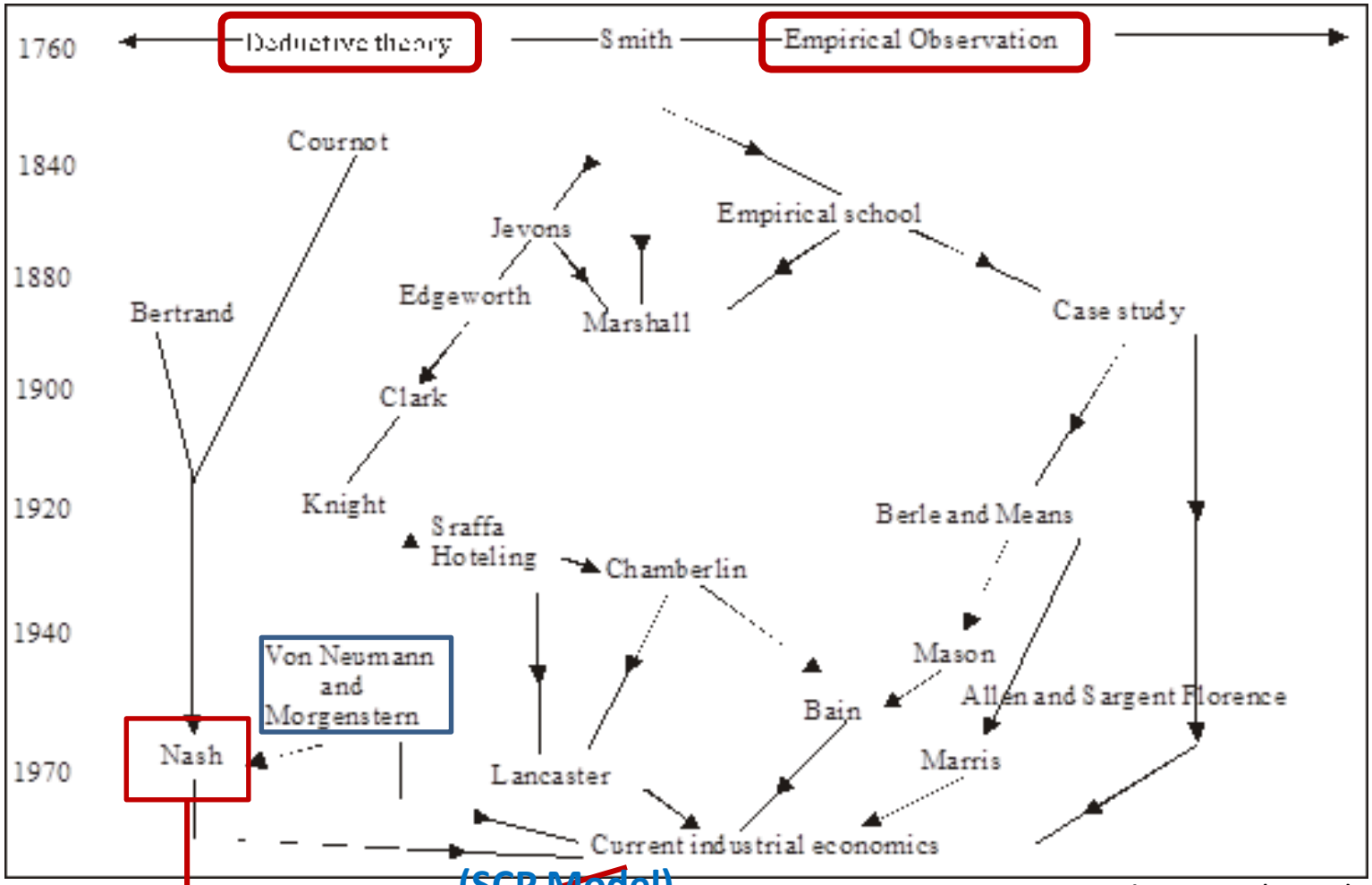
J. Mirrlees → **Principal-Agent Model 委託-代理模型**

Principal (uninformed 缺信息) versus Agent (informed 有信息)

Mechanism Design 機制設計

Participation Condition 參與條件 + Incentive Compatibility 誘因相容

From “Empiricism without Theory” to…



Source: Hay and Morris (1991)

(SCP Model)
(Structure, Conduct, Performance)

Tirole (1988)

Nobel Prize in Economic Sciences 1994


John C. Harsanyi

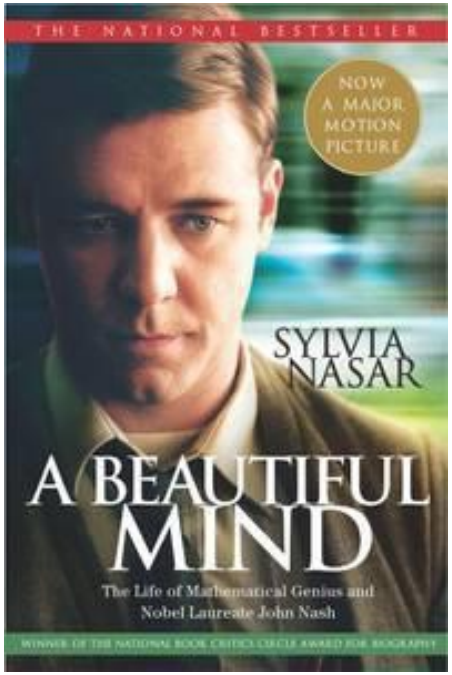

John F. Nash Jr.


Reinhard Selten

"for their pioneering analysis of equilibria in the theory of non-cooperative games"

安息吧... Nash仉儷

- Abel Prize for his work on nonlinear partial differential equations (2015/03) 非線性偏微分方程式



2015大師論壇

提霍勒 JEAN TIROLE

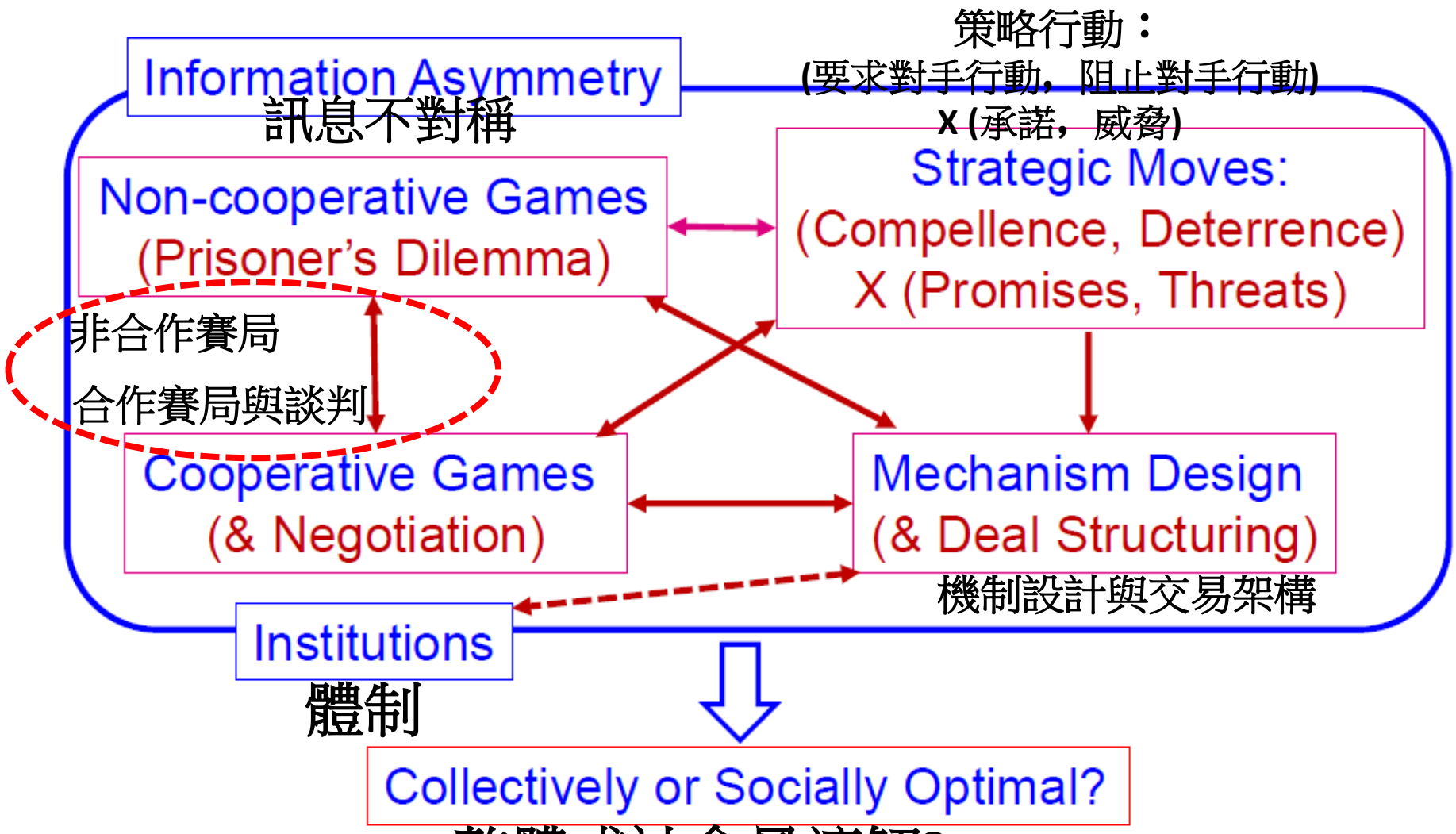
2014諾貝爾經濟學獎得主

日期：2015年10月19日（一）

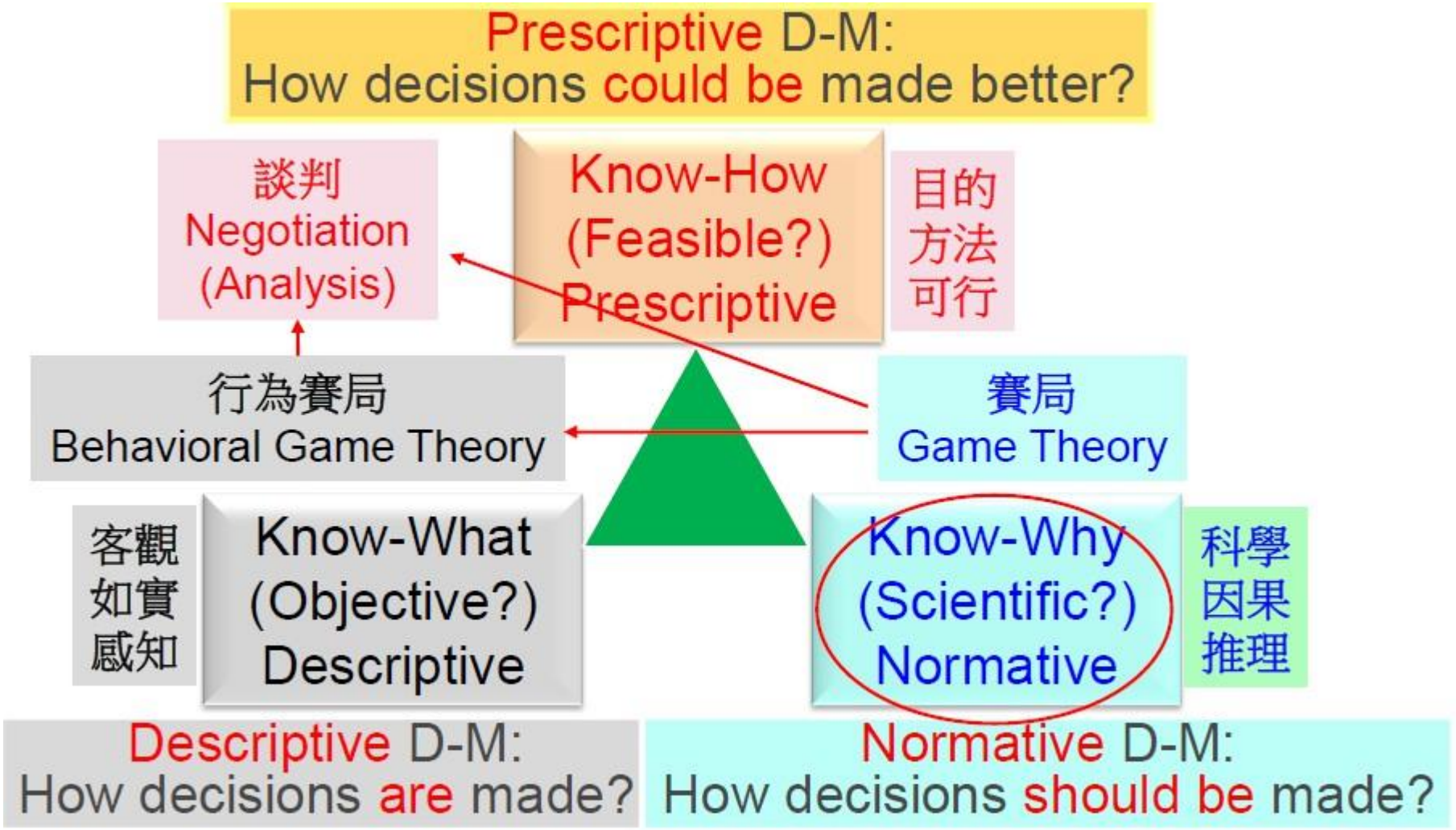
地點：台北國際會議中心201(台北市信義區信義路五段1號)

時間	內容
08:30-09:30	報到
09:30-09:45	《貴賓致詞》馬英九 總統
09:45-10:15	《主辦單位致詞》 致詞人：王文杉／聯合報系董事長 梁啟源／中華經濟研究院董事長 李國夫／中國建設銀行台北分行行長
10:15-11:15	《專題講座一》 氣候變遷與公共政策 主講人：提霍勒／2014諾貝爾經濟學獎得主
11:15-12:15	《專題講座二》數位金融發展的衝擊與銀行業的轉型 主講人：黃　毅／中國建設銀行副行長
12:15-14:00	中午休息
14:00-15:00	《專題講座三》經世致用：提霍勒的大師治學典範 主講人：江炯聰／國立台灣大學工商管理系暨商學研究所教授
15:00-15:20	中場休息
15:20-17:00	《與大師對談》從全球經濟局勢看金融風險與產業競爭 主持人: 吳中書／中華經濟研究院院長 與談人: 提霍勒／2014諾貝爾經濟學獎得主 江炯聰／國立台灣大學工商管理系暨商學研究所教授 徐旭東／遠東集團董事長 李國夫／中國建設銀行台北分行行長

Game Theory博弈論 Related Fields



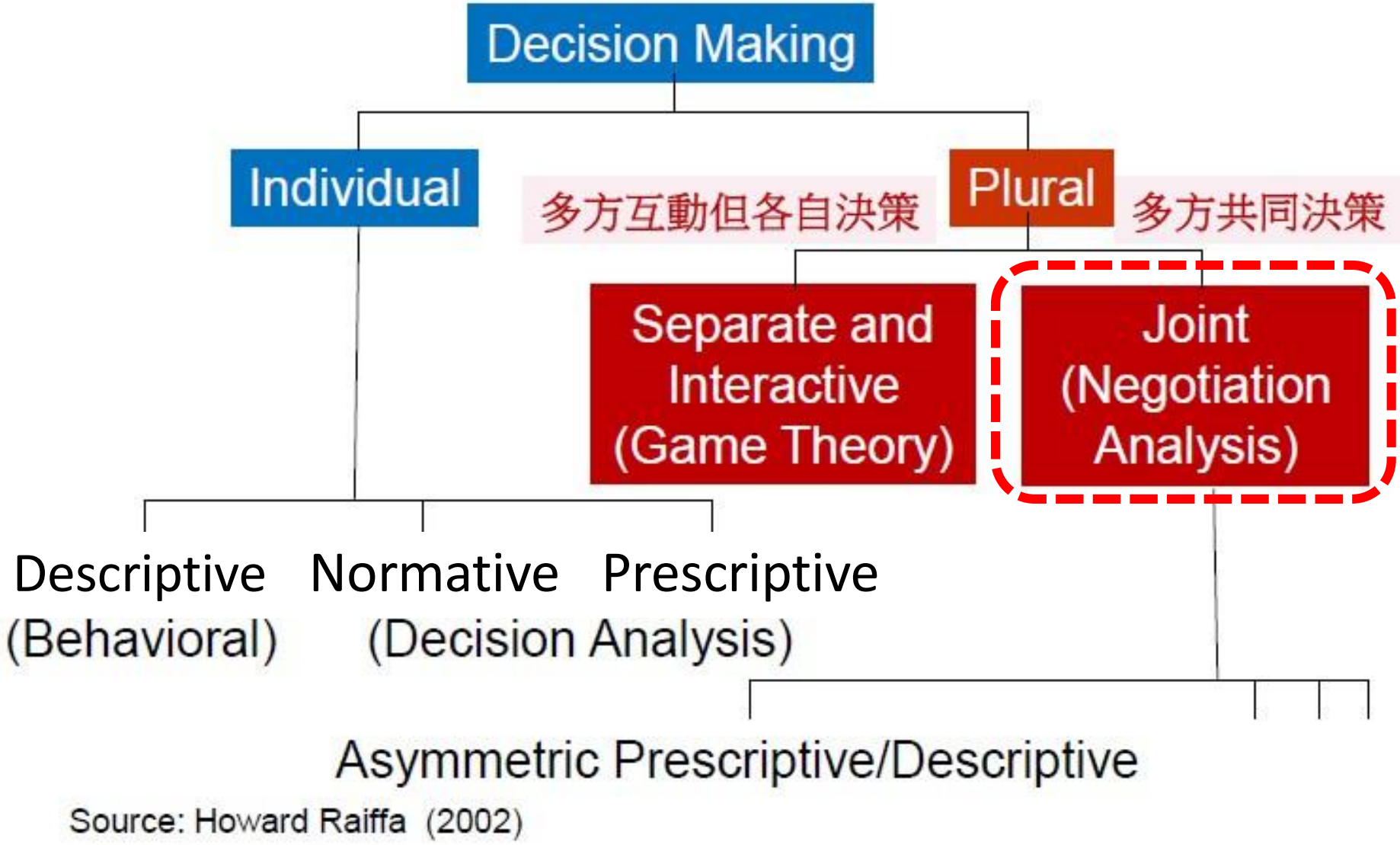
Research/Study:
Descriptive, Normative, Prescriptive



Game Theory 賽局
Behavioral Game Theory 行為賽局
Negotiation (Analysis) 談判(分析)

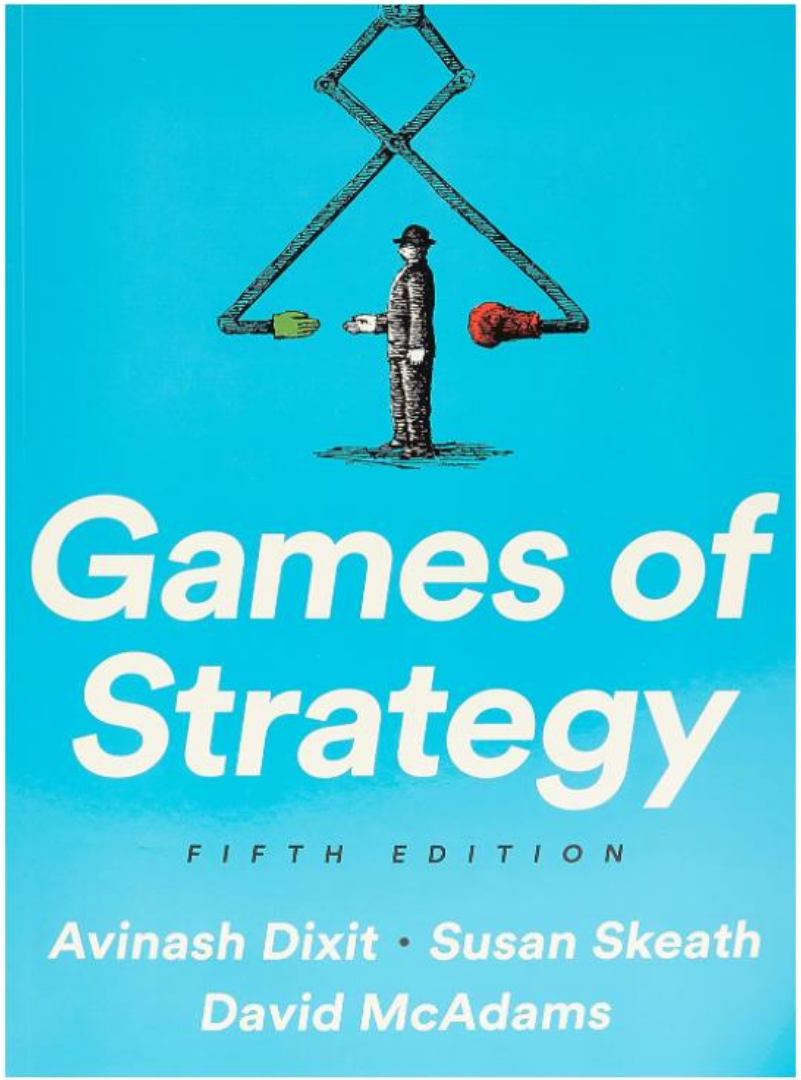
- **Normative**: what should be done
  - How emotionless geniuses should play games
  - Mathematical, deductive, and limits (e.g., coordination games)
  - Game theory
- **Descriptive**: what is done
  - How average people with emotions and limited foresight actually play games
  - Experimental, psychological, inductive and deductive, mathematical (statistical methods to deal with real world behavior)
  - How does an equilibrium arise? (to learn or to evolve or…)
  - Behavioral game theory (of normal strategic behavior)
- **Prescriptive**: what realistically could be done to improve matters
  - Applications
  - Negotiation (Analysis)

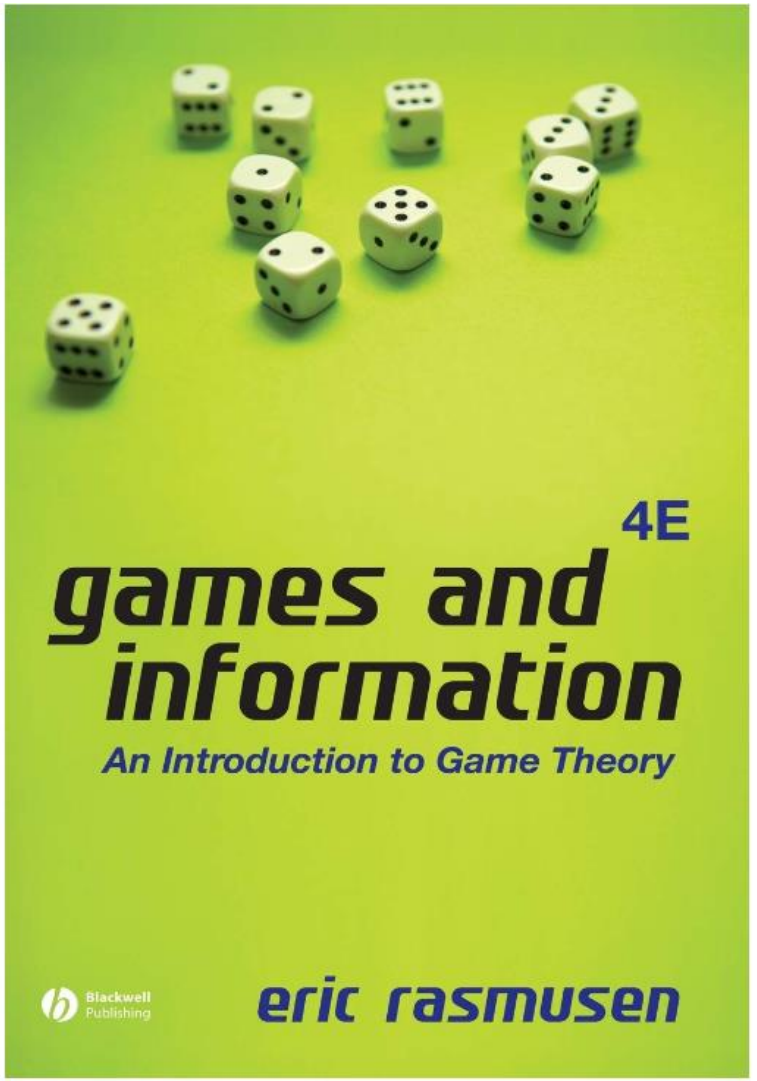
Individual and Plural Decision Making



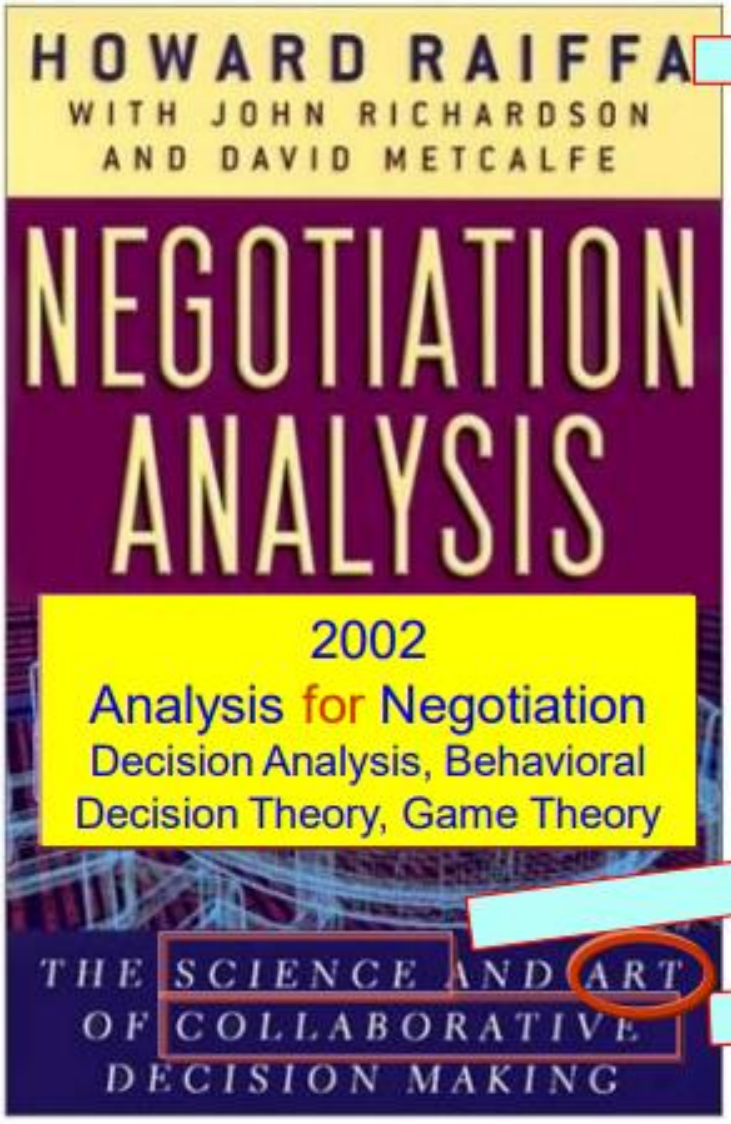
Source: Howard Raiffa (2002)

Game Theory & Information Economics





Harvard Legacy 哈佛传承



- (1957)*Games and Decisions*(co-author Luce R.D.)
- (1972~75) Founding Managing Director of International Institute for Applied Systems Analysis (IIASA)
- (1982)*The Art and Science of Negotiation*, (systematic and conscious thinking for practitioners)
- (1985~)*The Negotiation Journal*
- Harvard Negotiation Program (Joint Program of Business, Law and Government Schools)

Computer-Aided Simulation

Coordination and Cooperative Games (Mechanism Design)

International Institute for Applied Systems Analysis (IIASA)

Directorate

Past Directors

1972-1975	Professor Howard **Raiffa**
1975-1981	Dr. Roger **Levien**
1981-1984	Professor C.S. **Holling**
1984-1987	Professor Thomas H. **Lee**†
1987-1990	Dr. Robert H. **Pry**
1990-1996	Dr. Peter E. **de Jánosi**
1996-2000	Professor Gordon J. **MacDonald**†
2000-2002	Professor Arne B. **Jernelöv** (Acting Director)

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Power and Negotiation
Economic Negotiation
PINPoints Newsletter

Processes of International Negotiation

Summer 2010 Roadshow

Negotiation Day, Diplomatic Academy, Vienna

18 June 2010, IIASA

March 2009 IIASA Policy Brief

Negotiating with Terrorists (pdf)

The official line is that public authorities do not negotiate with terrorists. However, governments frequently do end up negotiating with hostage talkers and kidnappers and with political groups classified as terrorists. Clearly there are negotiations and negotiations, just as there are terrorists and terrorists. While this briefing does not necessarily advocate negotiating with terrorists, it outlines the practicalities of such negotiations, providing a guide to deciding how, when, and with whom to negotiate.

This IIASA Policy brief is based on the soon to be published PIN book project Negotiating with Terrorists (ToC).

New Issue of PINPoints

The Fall Issue 2009 (pdf) of PINpoints focuses on the role of science in international policymaking. The application of scientific knowledge in international decision making and regime-building has been the goal of PIN and IIASA in the past which should be enhanced. However, the effective use of scientific knowledge in international policy-making is a complex area in its own right. Therefore, processes and dynamics involved should be considered.

The Spring Issue 2009 (pdf) of PINpoints underscores producing academic insights that are of practical use to society in general and the policy world in particular.

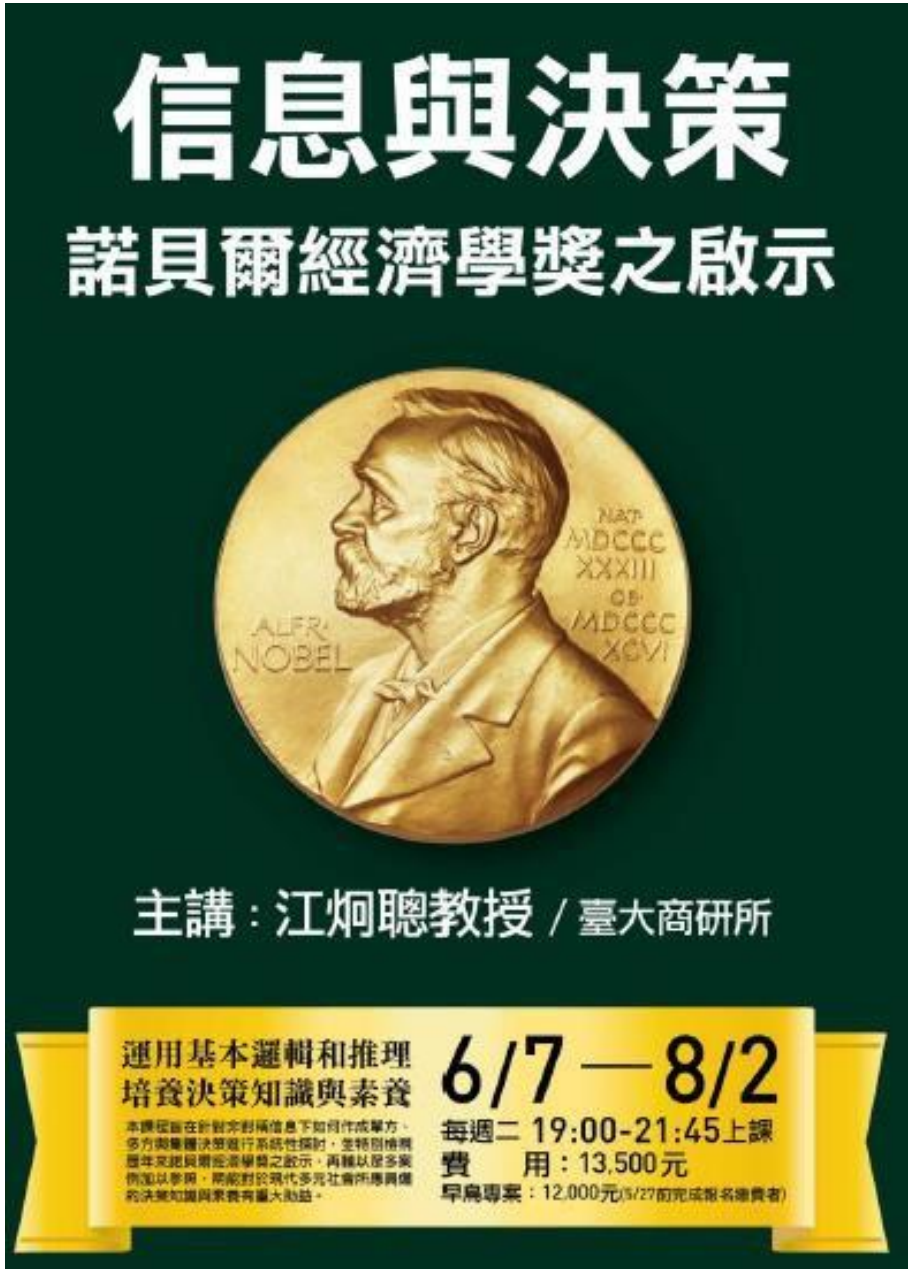
Negotiation with Terrorists

IIASA
International Institute for Applied Systems Analysis

Hostage Taker vs. Government

Hostage Game		Target Government Established Policy	
		No Ransom	Flexible Response
Hostage Taker (Immediate) Objectives	Material (Extortion Tactic)	Non-Negotiable (Very Probably)	Negotiation (ZOPA, BATNA)
	Political (Influence Tactic)	Chicken Game, Brinkmanship	Negotiable (Very Probably)

- Negotiation
  - ZOPA (Zone Of Possible Agreement)
  - BATNA (Best Alternative To No Agreement)
- Chicken game (and Brinkmanship)
  - Played to affect attitudes, beliefs, and perceptions, thus gaining largely unquantifiable and indivisible assets such as credibility, prestige and reputation
  - No bargaining range, unable to achieve a mutually acceptable outcome
- Mass media coverage
- Feasibility of government forceful action against the perpetrators
- Feasibility of secret deals (in free, open societies?)



國立臺灣大學進修推廣學院管理碩士學分班選修課

信息與決策:諾貝爾經濟學獎之啟示

Information and Decision Making:
Implications from Nobel Prize in Economics
(Fall Semester, 2019)

授課教師： 莊正民(台大國際企業系教授)
王文宇(台大法律系教授),
馮勃翰(台大經濟系副教授)
江炯聰(台大商研所名譽教授)

授課時間：每週五晚 7:00-9:45, 共15週, 2019/09/06~12/27

課程綱要與進度：(含期中、期末考，共計15週)

週數:日期	單元主題	諾貝爾經濟學獎年度
1: 09/06	賽局與策略行動(1/2)	John F. Nash Jr. (1994) Reinhard Selten (1994)
2: 09/20	賽局與策略行動(2/2)	Robert J. Aumann (2005) Thomas C. Schelling (2005)
3: 09/27	不對稱訊息(1/3): 逆選擇與其解方	George Akerlof (2001) Michael Spence (2001)
4: 10/04	不對稱訊息(2/3): 道德風險與其解方	Joseph Stiglitz (2001) John C. Harsanyi (1994)
5: 10/18	不對稱訊息(3/3): 道德風險與其解方	James A. Mirlees (1996) Bengt Holmstrom (2016)
6: 10/25	拍賣、配對與市場設計(1/2)	William Vickrey (1996)
7: 11/01	拍賣、配對與市場設計(2/2)	Lloyd S. Shapley (2012) Alvin E. Roth (2012)
8: 11/08	交易成本、廠商疆界與合約(1/2)	Ronald H. Coase (1991) Douglass North (1993)
9: 11/15	交易成本、廠商疆界與合約(2/2)	Oliver E. Williamson (2009) Oliver Hart (2016)
10: 11/22	判斷、決策與行為經濟學(1/2)	Daniel Kahneman (2002)
11: 11/29	判斷、決策與行為經濟學(2/2)	Richard Thaler (2017)
12: 12/06	公共選擇、社會選擇與政治經濟學(1/2)	James M. Buchanan Jr. (1986) Kenneth J. Arrow (1972)
13: 12/13	公共選擇、社會選擇與政治經濟學(2/2)	John Tirole (2014) Eleanor Ostrom (2009)
14: 12/20	新結構經濟學 綜合討論	林毅夫
15: 12/27	學員期末報告	

討論　結論
謝謝

jtchiang@ntu.edu.tw