



SAS FORUM | 中国用户大会暨
CHINA 2018 | 商业分析领袖峰会

Data Analytics for Business Decision Making 数据驱动下的商业决策分析

陈玉旺 | Dr Yu-wang Chen | 英国曼彻斯特大学决策科学高级讲师

Alliance Manchester Business School (AMBS), The University of
Manchester (UoM)

Email: yu-wang.chen@manchester.ac.uk

曼彻斯特大学 – The University of Manchester



“红砖”大学 - “Red brick” university



WORLD RANKING

The quality of our teaching and the impact of our research are the cornerstones of our success. We have risen from 78th in 2004* to 38th in 2017 in the Academic Ranking of World Universities (ARWU).

League table	World ranking	European ranking	UK ranking
ARWU	38	8	6
QS	34	9	7
Times Higher Education	54**	11	8

大学使命:

- World-class research,
- Outstanding learning and student experience,
- Social, economic and cultural impact.

ACADEMIC PEDIGREE

We attract the highest calibre researchers and teachers, with 23 Nobel Prize winners among our current and former staff and students.

We have been Nobel laureates on our staff – Professors Sirs Andre Guin and Rosalyn Foxworth (both Physics). And we're led by our President and Vice-Chancellor, Professor Dame Nancy Rothwell FRSE, whose research has advanced understanding and treatment of brain damage in stroke and Parkinson's.

We're also home to multi-award-winning writer, journalist and broadcaster Professor of Creative Writing, renowned historian Michael Wood (Professor of Public History) and physicist and TV presenter Brian Cox (Professor of Particle Physics).



曼彻斯特大学商学院 – Alliance Manchester Business School

- Alliance Manchester Business School (AMBS) 建于1965年，为英国最早的两所商学院之一。

Est.1965

We were one of the first two
business schools in the UK



We are the
**largest campus-based
business school** in the

1%

We are part of only 1% of business schools
worldwide to receive three international accreditations:
EQUIS, AMBA and AACSB

Over

500



academic, teaching and support staff
representing 41 nationalities

Over

6,500



students studying with us globally



135

nationalities
represented by our students



Over

50,000

alumni
in
169
countries



SAS FORUM | 中国用户大会暨
CHINA 2018 | 商业分析领袖峰会



个人简介

- 英国曼彻斯特大学决策科学高级讲师
- 上海交通大学控制科学与工程博士
- 曼彻斯特大学商学院商业分析硕士专业负责人
- 曼彻斯特大学数据科学硕士专业商业管理负责人

Decision



intelligence
analytics software
data
develops business
CA platform



[\(QS Ranking: 6th in the world & 1st in Europe and in the UK\)](#)



UoM商业分析硕士专业

- MSc Business Analytics: Operational Research and Risk Analysis

Semester 1	Semester 2	Summer
Core 1: Applied Statistics	Core 1: Risk, Performance and Decision Analysis	Dissertation *
Core 2: Mathematical Programming and Optimization	Core 2: Simulation and Risk Analysis	
Elective 1	Core 3: Data Analytics for Business Decision Making (SAS)	
Elective 2	Elective 1	

Class profile - 2017 intake



Age range: 21-31

Nationalities: 19



GENERAL MOTORS

PERSONAL DATA. EXPERT INSIGHT.

UoM商业分析硕士专业 – Features and Facts

- 从传统运筹管理到商业分析和数据科学的转变。
- 重点培养学生应用定量方法(e.g., optimisation, statistics) 和数据分析方法 (e.g., simulation, decision and risk analysis, data analytics) 的技能。
- 使用专业软件分析工具，包括SAS, Risk Solver, Minitab, Simul8, IDS。
- 优秀的UK PTES (Postgraduate Taught Experience Survey) 评价结果。
- QS世界大学商业分析硕士专业排名全球第六欧洲第一。

Rank	University	City	Country
1	MIT (Massachusetts Institute of Technology) Master of Science in Business Analytics	Cambridge, MA	USA
2	Texas (UT) Dallas Master of Science in Business Analytics	Austin, TX	USA
3	UC (University of California) Berkeley Master of Science in Business Analytics	Los Angeles, CA	USA
4	Minnesota (Carlson) Master of Science in Business Analytics	Minneapolis, MN	USA
5	Monash Master of Business Analytics	Melbourne	Australia
6	Manchester (Alliance) MSc Business Analytics	Manchester	UK

商业与数据分析 – Trend analysis



https://www.youtube.com/watch?v=9hDnO_ykC7Y



Top 5 analytics
predictions for 2015

- **Business analytics programs will continue to grow.** 100+ business schools in the United States that have, or have committed to launch, curriculum at the undergraduate and graduate levels with degrees or certificates in business analytics <http://www.analytics-magazine.org/>
- **Data scientists will be the head-hunter's best friend.** The past year 2015 has seen the number of advertised data scientist jobs in the UK increase by 22 percent, in addition to the push from the nation's tech sector for 'data scientist' to be added to the UK's skills shortages list.



Four analytics trends to watch in 2016

<http://www.itproportal.com/2016/01/08/four-analytics-trends-to-watch-in-2016/>



SASFORUM CHINA 2018 | 中国用户大会暨
商业分析领袖峰会



商业与数据分析 – Trend analysis cont.



- **6 Predictions in 2017 For The \$203 Billion Big Data Analytics Market.**

 - The creation and consumption of data continues to grow by leaps and bounds and with it the investment in big data analytics hardware, software, and services and in data scientists and their continuing education.

<http://www.forbes.com/sites/gilpress/2017/01/20/6-predictions-for-the-203-billion-big-data-analytics-market/>
- **10 Predictions For AI, Big Data, And Analytics in 2018**

 - **25% of enterprises will supplement point-and-click analytics with conversational interfaces.**
 - **Data engineer will become the hot new job title.** 13% of data-related job postings on Indeed.com are for data engineers, versus less than 1% for data scientists, reflecting the trend of big data initiatives becoming mission-critical and the need to provide broader support to the business analyst.

<https://www.forbes.com/sites/gilpress/2017/11/09/10-predictions-for-ai-big-data-and-analytics-in-2018/>



商业与数据分析 – UK & Manchester



<https://invest.great.gov.uk/us/industries/technology/data-analytics/>



<https://www.turing.ac.uk/>



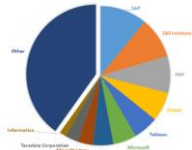
<http://www.datascience.manchester.ac.uk/>

SAS – UK & Manchester

- 支持商业决策分析的数据分析方法和技术



EXHIBIT 1: 2016 ANALYTICS AND BI APPLICATIONS MARKET SHARES SPLIT BY TOP 10 ANALYTICS AND BI VENDORS AND OTHERS, %



FLAGSHIP UNIVERSITIES

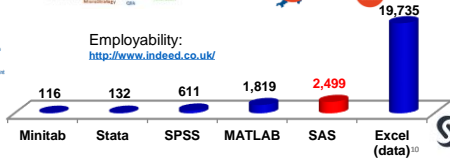


Geoffrey Taylor

Head of Academic Engagement,
SAS UK & Ireland

Employability:

<http://www.indeed.co.uk/>



SASFORUM CHINA 2018 中国用户大会暨商业分析领袖峰会



商业决策分析问题与方法

- 战略层，战术层，运作层的决策问题

- **Strategic planning**
 - New business opportunities
 - Competition strategies
 - Technology adoption
 - Strategic partnership ...
- **Managerial control**
 - Financial control
 - Project control
 - Quality control
 - Risk control...
- **Operational control**
 - Task scheduling
 - Process control
 - Production optimization
 - Fault diagnosis
 - System reliability ...

1 in 3

Business leaders frequently make decisions based on information they don't trust, or don't have

60%

of CEOs need to do a better job capturing and understanding information rapidly in order to make swift business decisions

IBM, Big Data Analytics, Academic Days Conference, Frankfurt, May 2012



SASFORUM | 中国用户大会暨
CHINA 2018 | 商业分析领袖峰会

- 传统的决策理论方法

Purchase of Real Estates: Apartment, Office or Warehouse?

Decisions (Purchase)	States of Nature (Economy)		
	Better	Stable	Worse
Apartment	£40,000	£35,000	£30,000
Office	£100,000	£40,000	-£40,000
Warehouse	£50,000	£45,000	£10,000



商业决策分析案例

- Design selection, risk & safety analysis



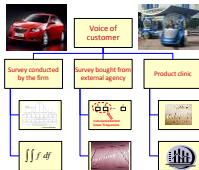
- Supplier assessment and selection

Supplier Assessment
Quality
Supply Chain Evaluation
Technical Competence evaluation
Total Cost Evaluation
General Factors Evaluation
After Sales Evaluation
Enviroethical
Leadership and Strategy
Project Management
Customer Needs
E - Readiness



1. Quality
1.5 Quality Performance of Supplier
1.5.1 Are quality costs measured, monitored and published?
Answers:
1- No
2- Yes, occasionally
3- Yes, with improvement plans provided
4- Yes, with management review done regularly

- Prioritise voices of customer



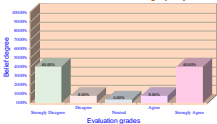
- Target identification



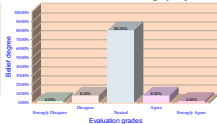
商业决策分析挑战与机遇

• 数据均值的缺陷

Att-1: Interior of GM-A looks high quality



Att-1: Interior of GM-B looks high quality



- Frequencies of customer responses from external surveys
- Is GM-B of the same priority to GM as GM-A in future design?



The Flaw of Averages distorts everyday decisions in many areas

销售预测 – Sales forecasting

- 商业决策问题：零售数据的销售预测
Forecasting the 6 weeks of daily sales for 1,115 stores in Germany
More reliable sales prediction leads to increasing profitability & productivity
- 研究方法：Data processing, predictive modelling, visualisation, etc.
- 硕士生: MSc Business Analytics students

kaggle



MANCHESTER
1824
The University of Manchester
Alumni Manchester Business School

1,115 store across Germany

Assortment

	a	b	c	Total
a	381	-	221	602
b	7	9	1	17
c	77	-	71	148
d	128	-	220	348
Total	593	9	513	1,115



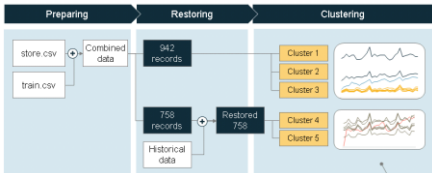
2.5 Years of sales (2013, 2014 and first semester of 2015)



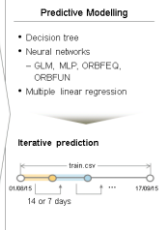
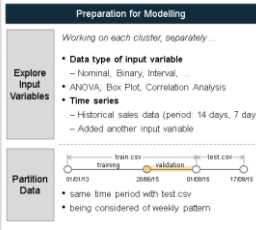
SAS FORUM 中国用户大会暨
CHINA 2018 商业分析领袖峰会

sas

销售预测 – Analytical solution



- **Transformation into durations**
 - Competition open since month and year
 - Promo2 since week and year

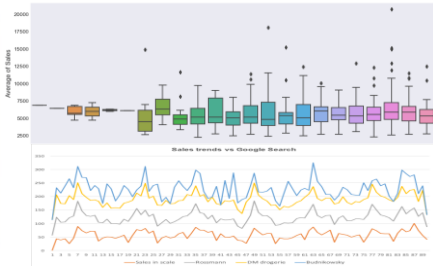


销售预测 – Analytical findings

Contributing input variables					
Cluster ¹⁾ →	1	2	3	4	5
↓ Input variables	AA,CA CC, DA,DC	BA, BC	BB	AA,AC,CA CC,DA,DC	BB
Day of week	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Open	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
State holiday	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Promo	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
School holiday ¹	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Compet. distance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Compet. duration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Promo 2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Promo2 duration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Promo interval	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Historical sales	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Implication

- Store type B** should consider
 - Distance of competitors
 - Duration of competitor stores' open days
 - Promotion 2
- Store type B & Assortment B** should consider
 - Duration of promotion 2
 - Promo interval
 - more important than implementation of promotion
- School holiday: not influential input



消费者偏好建模与预测

- 商业决策问题：消费者偏好建模与预测
Customer preference modelling and prediction
- 研究方法：Predictive modelling, 置信规则库模型 – Belief rule-based model
- 博士毕业生: Dr. Emanuel-Emil Savan



Unilever

Designer:
What's in it?



Product profile



Random samples

Consumer:
Do you like it?



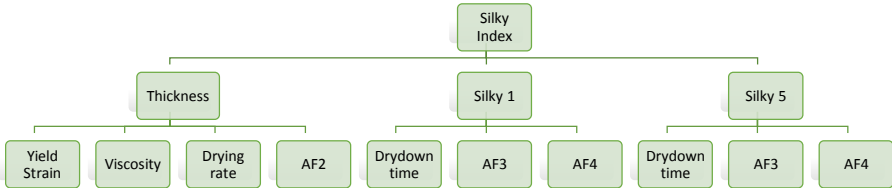
Consumer rating



How are they linked?



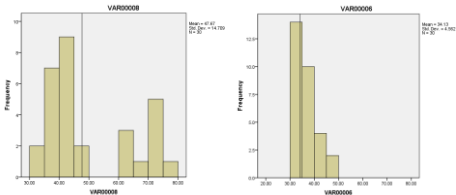
消费者偏好建模 – Sensory attributes



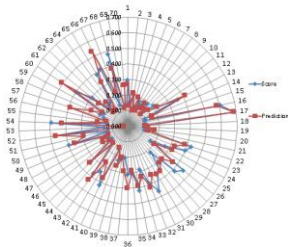
消费者偏好预测 – Distributed customer likings



Preliminary results for Silky: Score vs Predicted



Distributions of customer likings on the sensory attribute of Thickness assessment from consumers for two different prototype products



消费者行为细分与预测

- 商业决策问题：消费者行为细分与预测
Data-driven Segmentation and Prediction of Consumers' Purchase Behaviour in the Retail Industry
- 研究方法：数据聚类分析 – Clustering analysis, 马尔可夫链 – Markov chain
- 博士毕业生: Dr. Cheng Luo, 硕士毕业生: Mr. George Carmichael



消费者行为细分与预测 – Formulation

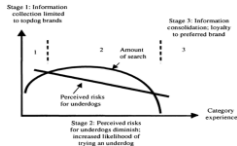
- 消费者行为描述: **promotion proneness** & **variety seeking** with store scanner data.
- 分析数据: **IRI marketing dataset** - 589 consumers with 169678 purchase records for a US salt-snack market market, (Bronnenberg et al., 2008).
- 理论基础: **Brand choice model** (Bucklin et al., 1998) - segment consumers based on their reactions to sales promotion in brand choice. **Variety seeking** (Heilman et al., 2000) - inverted U-relationship between expected value of information and the amount of market knowledge.

Promotion proneness – prevalence of promotion

Prevalence of promotion = $\frac{\text{The total number of purchases on promotion in a period}}{\text{The total number of purchases in the period}}$

Variety seeking - expected value of information

Expected value of information = Knowledge about a product market * The unit value of information = $-I(M)p \cdot \log_2(I(M)p) - (n/N) \cdot \log_2(n/N)$

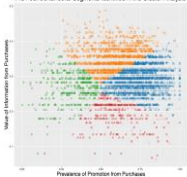


Dynamic choice process (Heilman et al., 2000)



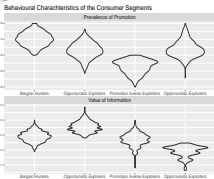
消费者行为细分与预测 – Clustering analysis

The Four Behavioural Segments Identified in the Cluster Analysis



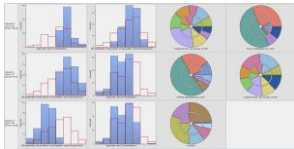
Segment Type
 1 Bargain Hunters
 2 Opportunistic Explorers
 3 Promotion Averse Exploiters
 4 Opportunistic Exploiters

Size
 0 100
 200 300
 400 500

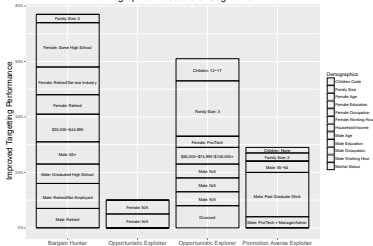


Segment Name	Prevalence of Promotion	Value of Information	Definition
Bargain Hunters	High (0.75)	Medium (0.29)	Actively looking for promotions to maximise the immediate purchase value.
Opportunistic Explorers	Medium (0.58)	High (0.35)	Motivated to try new brands. Promotions are used to enable this market exploration.
Promotion Averse Exploiters	Low (0.32)	Medium (0.26)	Purchase brands that are well known to them. Unwilling to risk new brands regardless of promotions.
Opportunistic Exploiters	Medium (0.6)	Low (0.19)	Purchase items that they are familiar with to reduce the risks involved whilst taking advantages of promotions where possible.

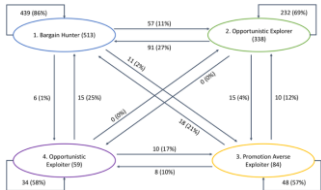
消费者行为细分与预测 – Profiling and prediction



Demographic Indicators of Segments

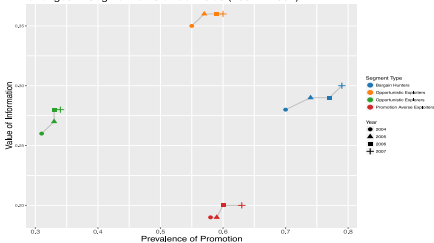


消费者行为细分与预测 – Behavioural evolvement



Segment transitions between two consecutive years

Changes in Segment Cluster Centroids (2004 – 2007)

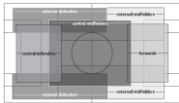


Cluster centroid tracking over four years

足球数据分析 – Football Analytics

wyscout®

- 商业决策问题：球员打法功能性分类，辅助转会市场中的商业决策。
Discovering function-based categories of footballers
- 研究方法：数据聚类分析 – Clustering analysis
- 博士生: Mr. Orbay Unsoy



SASFORUM 中国用户大会暨
CHINA 2018 商业分析领袖峰会



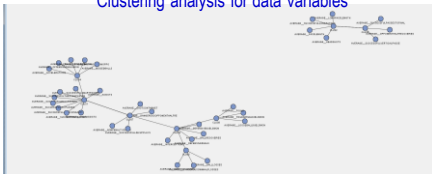
足球数据分析 – Variable clustering

Variable label	Variable type
Accelerations	on the ball
Assists	on the ball
Ball losses	on the ball
Ball recoveries	off the ball
Dangerous opponent half recoveries	off the ball
Dangerous own half losses	on the ball
Defensive duels	off the ball
Defensive duels won	off the ball
Distance from opponent goal	on the ball
Aerial duels won	off the ball
Fouls	off the ball
Head shots	on the ball
Interceptions	off the ball
Longest length	on the ball
Lost possession	on the ball
Minutes played	off the ball
Non-penalty goals	on the ball
Offensive duels won	on the ball
Opponent half recoveries	off the ball
Own half passes	on the ball
Pass weight	on the ball
Shot events	on the ball
Shots on target	on the ball
Successful attacking actions	on the ball
Successful back pass	on the ball
Successful crosses	on the ball
Successful dribbles	on the ball
Successful key pass	on the ball
Successful link up play	on the ball
Successful long passes	on the ball
Successful passes to final third	on the ball
Successful short passes	on the ball
Successful through pass	on the ball
Successful vertical pass	on the ball

Data variables

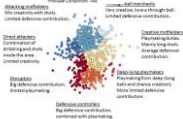
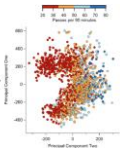
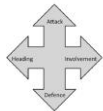


Clustering analysis for data variables



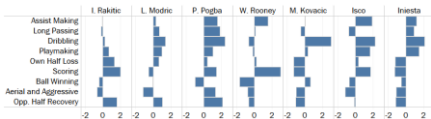
足球数据分析 – Clustering

Principal components



Cluster No.	Assist Making	Long Passing	Dribbling	Playmaking	Own Half Loss	Scoring	Ball Winning	Aerial and Aggressive	Opp. Half Recovery
1	-0.66	0.06	-0.26	-0.27	0.86	-0.35	0.75	0.45	-0.38
2	-0.45	-0.11	-0.08	-0.70	0.38	1.36	0.19	1.92	0.60
3	0.25	-0.24	0.02	0.10	-0.24	-0.15	-0.55	-0.50	0.15
4	-0.44	0.44	-0.76	-0.57	-0.66	-0.37	0.21	-0.36	-0.65
5	-0.21	0.91	-0.49	1.09	-0.46	-0.63	0.63	-0.29	0.56
6	0.19	0.35	1.06	1.50	0.47	0.23	0.01	0.22	1.83
7	0.94	-1.07	0.36	-0.63	-0.65	1.73	-1.45	-0.07	-0.24
8	1.51	-0.75	1.41	0.13	-0.19	-0.26	-1.00	-0.92	-0.34

Low High
Component mean scores for variable clusters



Component mean scores for representative players



SAS FORUM | 中国用户大会暨
CHINA 2018 | 商业分析领袖峰会

Thank you !

Email: yu-wang.chen@manchester.ac.uk



SAS FORUM | 中国用户大会暨
CHINA 2018 | 商业分析领袖峰会

激发非凡

INSPIRE
THE EXTRAORDINARY