課程概述

Course Introduction

https://ceiba.ntu.edu.tw/1072_Geog2017

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2019/02/18

為什麼要必修「空間分析 (計量地理學)」？先從瞭解當代地理學的發展

- 1930s 之前：環境決定論 Environmental determinism
- 1930s-50s：區域地理學 Regional geography
- **1950s-70s：地理學計量革命 Quantitative revolution**
- 1970s-90s：批判地理學 Critical geography

1990s 以後：新地理學 Neogeography (Collaborative & Crowdsourcing)

2010s 以後的地理學?

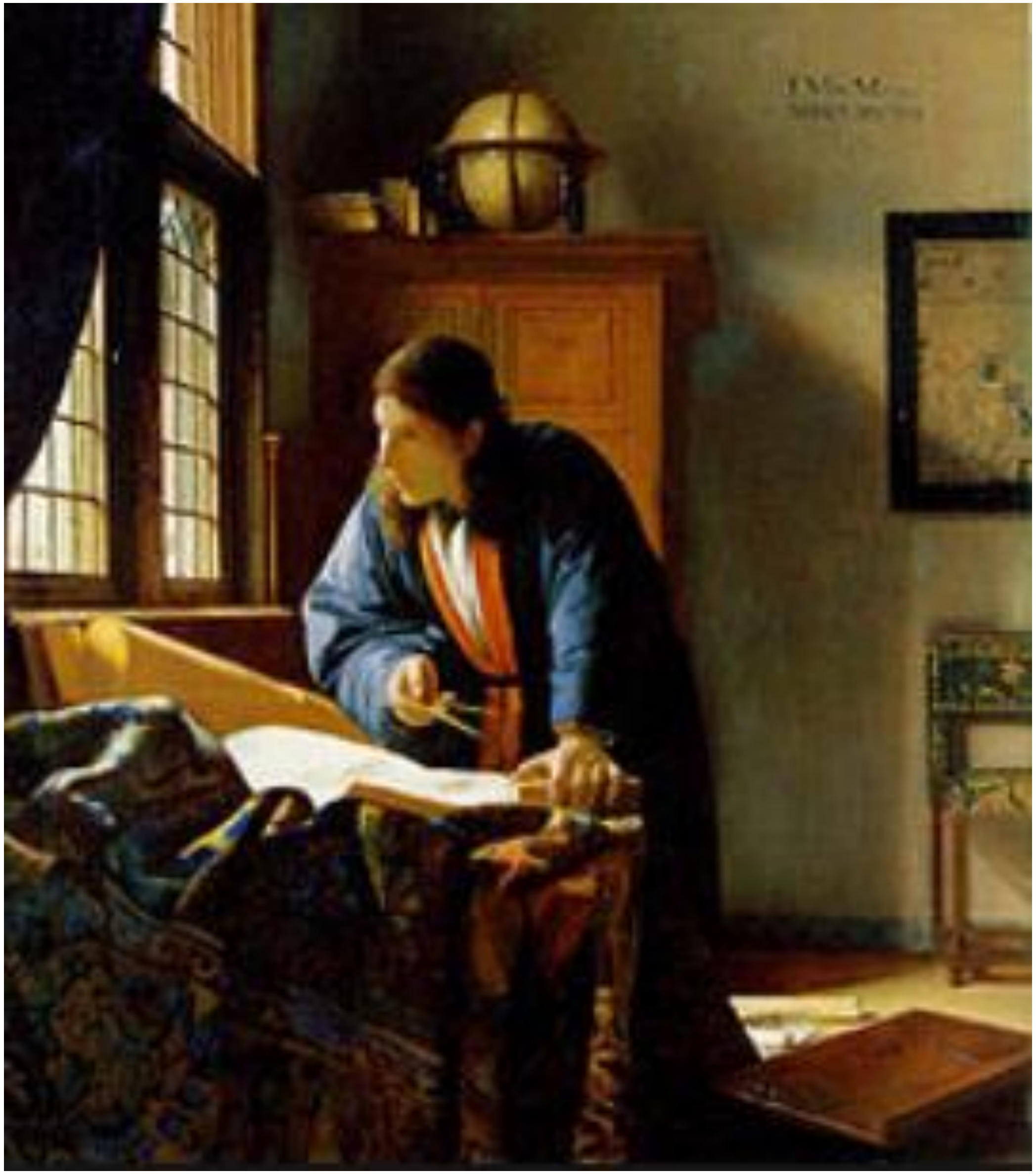
1998 Google 成立
2005 Google Earth/Maps
2007 Google Maps (Taiwan)
2011 Google 3-D 鳥瞰
2017 Google 位置分享功能

什麼是“空間分析(計量地理學)”？

- 我們需先理解：什麼是“地理學”？[區域地理學]
  - 地理學是一門解釋**地區差異**的科學。
  - 地理學關心針對地表各不同地區的各種特性，提供**正確的、有條不紊的、合理的描述與解釋**。
  - 地理學尋求**世界之地區差異來獲得完整的知識**，以及從**地理獨特性的角度，區別世界各地區之現象間的差異**。

(Hartshorne,1939)

A Geographer



維梅爾，《地理學家》，1668

1950s-70s：地理學計量革命 (Quantitative revolution)

- Hartshorne專注於地域獨特性的描述，而**忽略因果關係的探討和理論法則建立的研究途徑**，終導致地理學的發展逐漸走向孤立。
- 1950年代以美國為首的地理學家，為使地理學更為「科學」，發動一場「計量革命」。**計量革命的結果，是將「空間分析」在1960年代以後，成為地理學研究的典範，開啟「空間科學 (Spatial Science)」的專業領域。**
- 然而，空間分析典範經過1960-1970年代的實踐卻顯示，以法則追尋的研究途徑和經驗統計的研究方法，集中精力於空間現象的分析，雖然有助於因果關係的釐清，**也促使理論地理學再現**。（Guelke,1977）
- 空間分析企圖透過距離及其衍生出來的空間概念，以理論化地表上人類組織各種活動的空間結構，導致原本植根於土地的地理學家**，所看到的只有點、線、面，而沒有山、水，更沒有人；空間分析為地理學發展的數理模式，並無法有效處理地表的複雜實體。**（Gilbert,1988）其結果，終將把地理學導向"貧困"。（施添福，1990）

Quantitative revolution

From Wikipedia, the free encyclopedia

In the history of geography, the **quantitative revolution** (QR or Quantitative Revolution)[n] was one of the four major turning-points of modern geography -- the other three being environmental determinism, regional geography and critical geography). The quantitative revolution occurred during the 1950s and 1960s and marked a rapid change in the method behind geographical research, from regional geography into a spatial science.[1] The main claim for the quantitative revolution is that it led to a shift from a descriptive (idiographic) geography to an empirical law-making (nomothetic) geography.

(Note: The quantitative revolution had occurred earlier in economics and psychology and contemporaneously in political science and other social sciences and to a lesser extent in history.)

Contents [hide]

Geography

History of geography

- Graeco-Roman
- Chinese
- Islamic
- Age of Discovery
- History of cartography
- Environmental determinism
- Regional geography
- **Quantitative revolution**
- Critical geography

http://en.wikipedia.org/wiki/Quantitative_revolution nature.com

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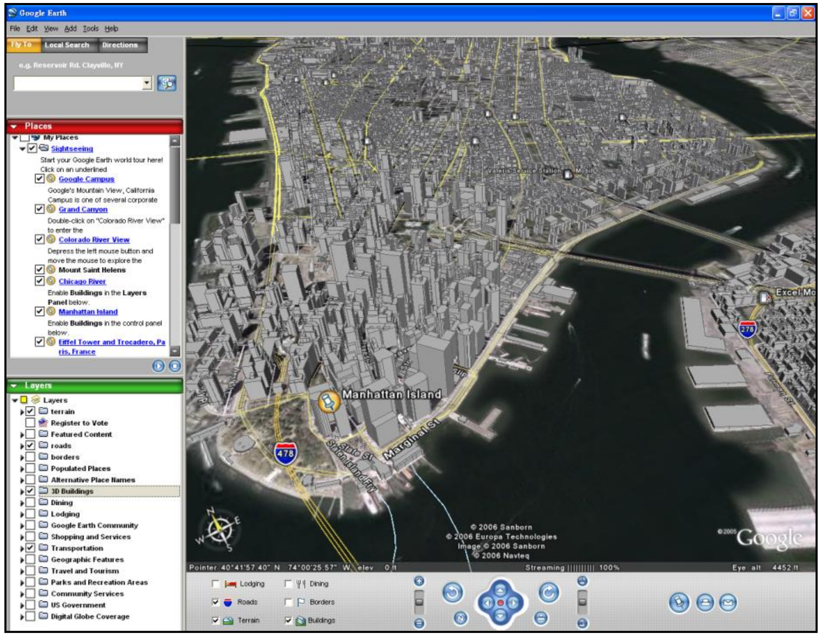
Mapping opportunities

Scientists who can combine geographic information systems with satellite data are in demand in a variety of disciplines. Virginia Gewin gets her bearings.

Earlier this year, the US Department of Labor identified geotechnology as one of the three most important emerging and evolving fields, along with nanotechnology and biotechnology. Job opportunities are growing and diversifying as geospatial technologies prove their value in ever more areas.

Nature **427** (Jan 2004)



"…It really is opening up our world, and business is booming."

Nature **439**, 776-778 (Feb 2006)

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A place for everything

More researchers must record the latitude and longitude of their data.

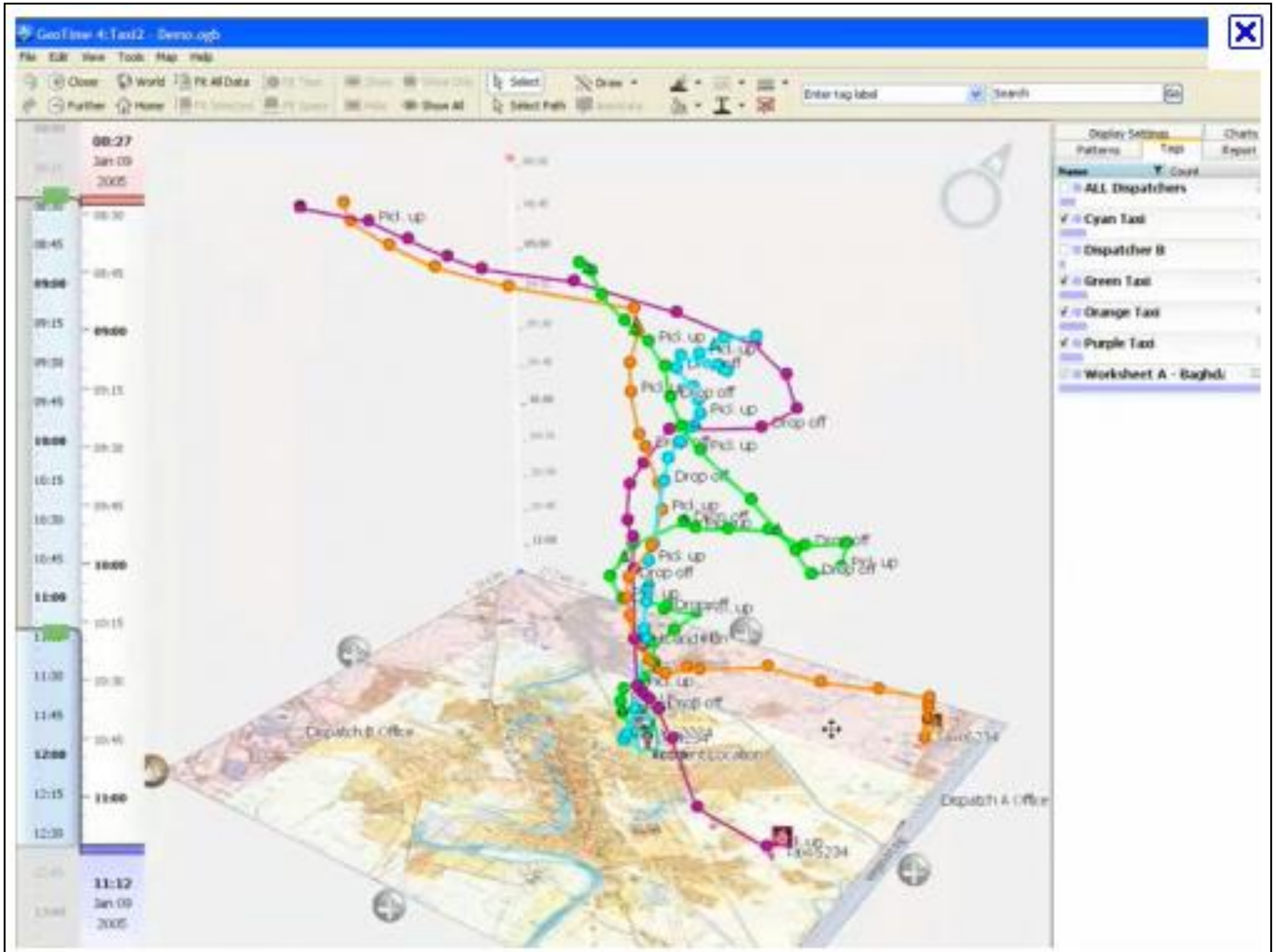
Who, what, where and when? Among the basic elements of scientific record-keeping, too often the 'where?' gets neglected. Now advances in satellite-positioning technology, online databases and geographical information systems offer opportunities to make good that neglect, and to add a much-needed spatial dimension to many types of biological research. Location data are essential for those modelling species' responses to climate change, or the spread of viruses, for example. Failure to include spatial information from the get-go may close off potentially highly productive routes to analysis — including those not yet foreseen. But those data are frequently inadequate or absent.

Many museums and herbaria are trying to make good this problem as best they can, geo-referencing their collections and putting them online. This frequently requires nightmarish work translating place names from various historical eras, languages and conventions into latitudes and longitudes. Although this is a necessary evil in matters retrospective, going forward there is a much simpler and easier answer in the form of coordinates and a time-stamp taken from the Global Positioning System (GPS) at the point of capture, or any other specified point of relevance.

This technology means that there is now much less excuse for allowing spatial data to fall by the wayside simply because they are not relevant to the data collectors' project in hand. Not only are the data easily collected, they are easily stored too. GenBank, for example, introduced fields for latitude and longitude in the metadata attached to its nucleotide sequence records in 2005. But few yet contain such information.

Gene sequence and structure databases have flourished in part because journals require authors to submit published data to them. It is worth considering a similar requirement that all samples in a published study be registered, along with GPS coordinates, in online databases such as the Global Biodiversity Information Facility. At the same time, it would behove spatial scientists to articulate to the broader research community the potential of recording and making accessible spatial data in the appropriate formats — and the painlessness of the process. ■

Space-time paths



Traffic flow in Google Maps

Google Maps gets real-time traffic, crowdsources Android GPS data

By Rick Burgess
On March 30, 2012, 5:30 PM EST

7 讚 18 +1 15 Tweet 29

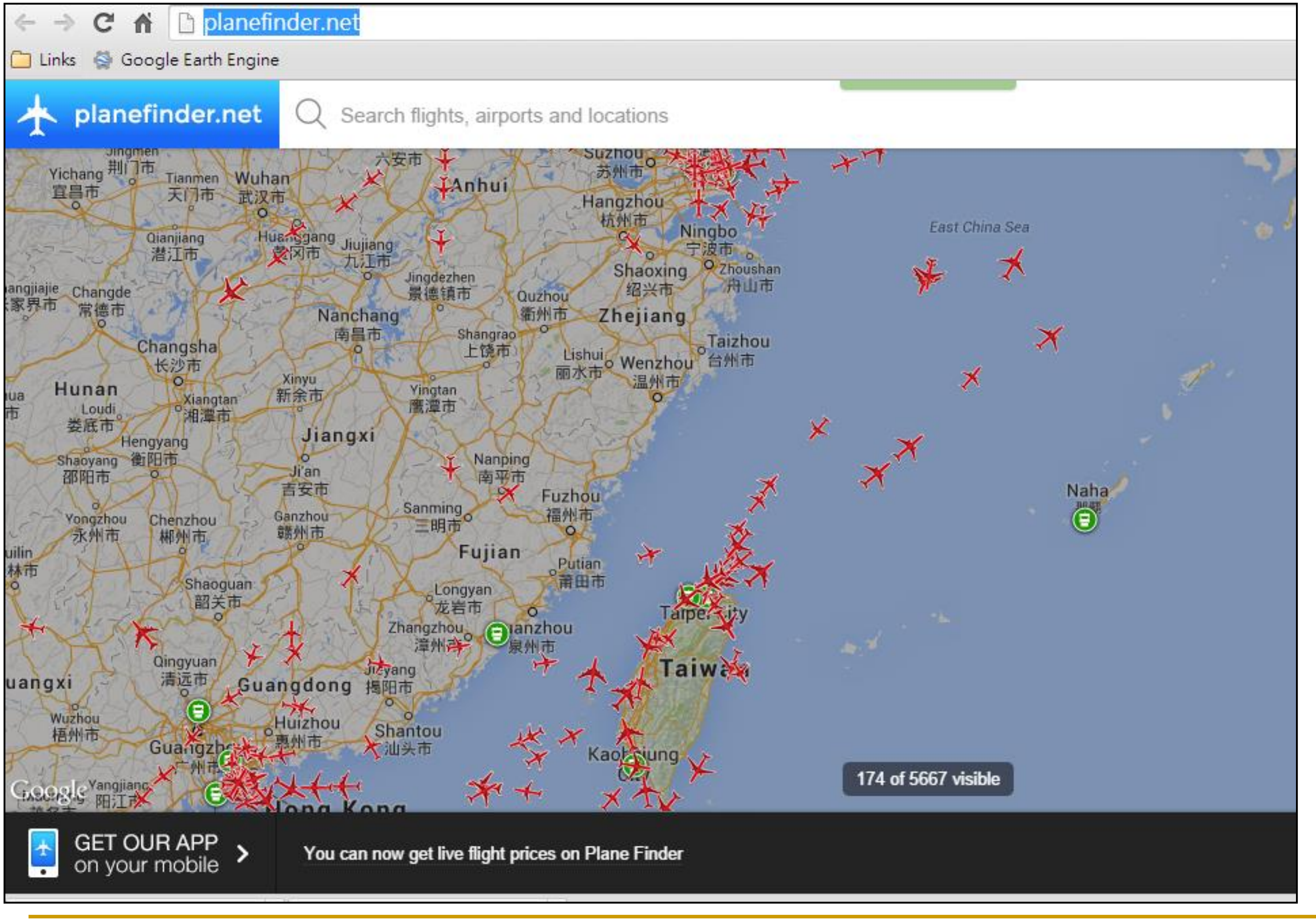
Although traffic data has been available on Google Maps for quite some time, the traffic information delivered by the popular mapping service was frequently stale or incorrect. In fact, estimated arrival times with traffic were so frequently incorrect, Google actually pulled the feature from Google Maps. As promised though, the company has finally decided to reintroduce the feature, but this time with improved real-time traffic data and far better arrival-time estimations.

Drivers will be pleased -- and privacy advocates will probably be infuriated -- to know that Google Maps will now take into account GPS data collected from Android-based smartphones. Rather than the old method of compiling historical data and making its best guesses on what traffic is like (eg. 'up to 50 minutes in traffic'), live data will be provided by the very commuters moving along (or I should say not moving?) in traffic.

The above is known as crowdsourcing, or at least a useful incarnation of it. Such techniques are already used by popular Internet-enabled GPS devices and apps. The popular crowdsourced GPS app, Waze, is a particularly pure and stunning example of this.

Source: http://www.techspot.com/news/48015-google-maps-gets-real-time-traffic-crowdsources-android-gps-data.html

Live flight tracking in the airspace

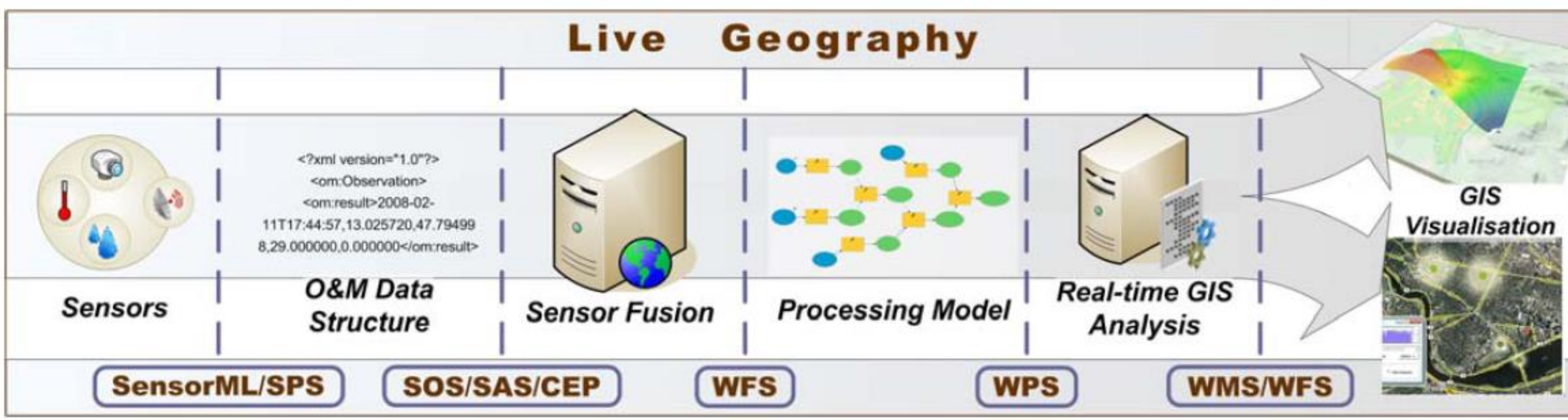


http://planefinder.net/

Mobile GPS Log at 311Tohoku Earthquake, 2011

https://www.youtube.com/watch?v=EAtp_I-tpuc

Live Geography – Embedded Sensing for Standardized Urban Environmental Monitoring



MITSloan Management Review

(2012)

Interview with Simon Thompson (Esri)

Location Analytics: Bringing Geography Back

MENU

Harvard Business Review

(2013)

DESIGN

The Importance of Spatial Thinking Now

by Kirk Goldsberry

SEPTEMBER 30, 2013

MENU

Harvard Business Review

(2014)

TECHNOLOGY

How Location Analytics Will Transform Retail

by Tony Costa

MARCH 12, 2014

Spatial Thinking Concepts

AAG
AMERICAN ASSOCIATION of GEOGRAPHERS

SKILL	DEFINITION	EXAMPLE
COMPARISON	Comparing one place with another…	e.g., rainfall, income, satellite images, maps, graphs
AURA	Describing the influence that a place can have on neighboring locations...	e.g., smoke from a factory, noise from a highway, property value near a park
REGION	Drawing a line around all places that have similar characteristics or are linked together in some way...	e.g., Corn Belt, Ozark Highlands, Polish neighbor-hood, Tornado Alley
TRANSITION	Describing what happens between two places with known conditions...	e.g., Do features change gradually or abruptly from one place to another?
ANALOGY	Finding places on other continents (or in other cities, mountains, etc.) that have similar positions and therefore have similar conditions...	e.g., Mediterranean climate, subduction zones, inner ring suburbs
HIERARCHY	Identifying a spatial hierarchy, or how 'nested' features relate to one another...	e.g., river networks, distribution hierarchies, political hierarchies (town, county, state, country)
PATTERN	Describing the arrangement of features or conditions in an area...	e.g., evenly or unevenly spaced, clusters, donuts, strings
ASSOCIATION	Identifying the extent to which features have the same map pattern...	e.g., malls and freeway exits, malaria and anopheles mosquitoes

Spatial Thinking Skills

AMERICAN ASSOCIATION of GEOGRAPHERS

SKILL	DEFINITION
COMPARISON	Comparing one place with another…
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ASSOCIATION	Identifying the extent to which features have the same map pattern…

Spatial analysis methods

Statistical tests/heterogeneity

Neighborhood effect (dependency)

Grouping/regionalization

Space-time dynamics

Grouping/similarity

Scaling issues (multi-scale)

Visualization/dependency

Regression

地理技術作為新創公司的可能 Geospatial Start-ups

- Using geospatial technologies to create innovative applications / services or art design
  - Technologies
    - Maps, location big data, location-based services (LBS), drones, apps, ibeacons, GIS/GPS, remote sensing…
  - Applications
    - Navigation, surveying, local discovery (tourism), traffic, transit and marketing

Top 100 **geospatial start-ups** and companies

GEO awesomeness

STARTUPS GEOTRENDS GEO BUSINESS JOBS PROGRAMMING KNOWLEDGE BASE GEO NEWS EVENTS

Home › Geo Business › 2019 Top 100 Geospatial Companies and Startups List

Geo Business

2019 Top 100 Geospatial Companies and Startups List

By **Muthukumar Kumar** - January 14, 2019 1

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The wait is finally over! Here is the list of the Top 100 Geospatial Companies and Startups in 2019.

2019 Top 100 Geospatial Companies and Startups List

Below is the table with the list of the companies and startup that we think are the Top 100 in 2019. Please scroll down to bottom of the page to see details regarding their tech stack, funding stage, number of employees, company summary, etc in addition to being able to filter them.

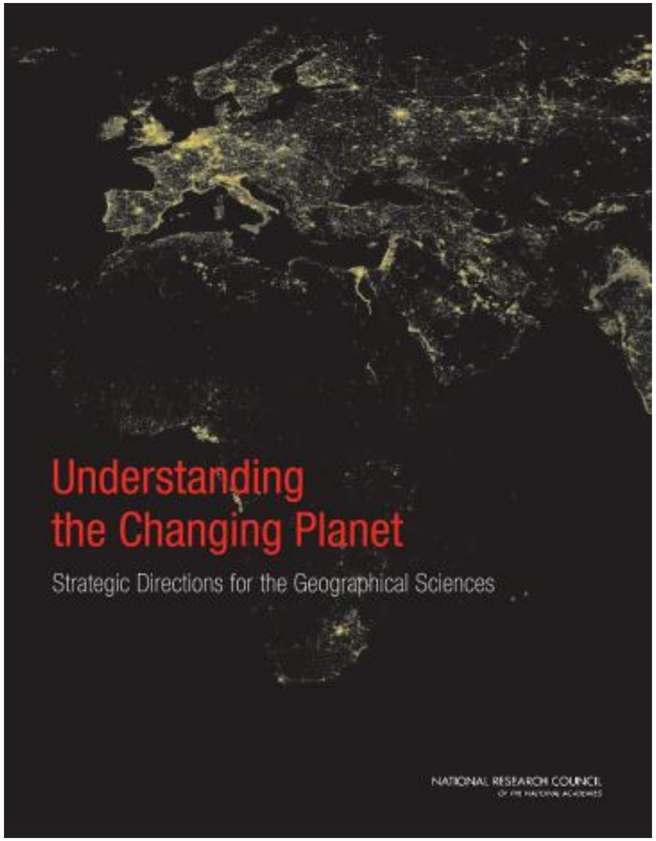
If you are a twitter fan, then here is the twitter list with all of them – "Top Geospatial Companies Twitter List".

Interested in learning more about how we determined the list, who was involved and which companies were considered? Here is the link with more details "The process behind how the Top 100 Geospatial Companies and Startups list was compiled".

http://geoawesomeness.com/2019-top-100-geospatial-companies-startups/

Keywords in geospatial companies/start-ups

美國的國家科學院-國家研究理事會於2010年所出版的報告
《瞭解變化中的星球：地理科學的策略方向》



Key Messages

A major theme in **the geographical sciences** will be how to understand and respond to **environmental change and the human role in these changes.**

Geographical research should follow **eleven strategic directions** in order to **take advantage of recent technological advancements**, inspire continued innovation, and advance understanding of the major issues facing Earth.

Leveraging technological advances will allow scientists to better observe, analyze and visualize the changing world, leading to new insights for the betterment of society and environment.

The geographical sciences could help recognize and cope with the rapid reorganization of economy and society.

Strategic directions

1. How are we changing the physical environment of Earth's surface?
2. How can we best preserve biological diversity and protect endangered ecosystems?
3. How are climate and other environmental changes affecting the **vulnerabilities of coupled human–environment systems**?
4. How and where will 10 billion people live?
5. How will we **sustainably feed everyone** in the coming decade and beyond?
6. How does **where we live affect our health**?
7. How is the **movement of people, goods, and ideas** changing the world?
8. How is **economic globalization** affecting inequality?
9. How are **geopolitical shifts** influencing peace and stability?
10. How might we **better observe, analyze, and visualize** a changing world?
11. What are the **societal implications** of citizen mapping and mapping citizens?

課程介紹

- **課程概述：**
  - 應用地理資料進行的空間分析方法為主要的授課內容，將包括：(1).複習基本觀念；(2).介紹空間分析方法及其應用的相關課題。**本學期課程將著重於空間型態分析（Spatial Pattern Analysis）。** 內容除了**分析理論方法**的講授之外，輔以利用R程式語言實作各種分析方法與案例應用，並透過期刊論文的研究成果，來導引各種分析方法的運用。
- **課程目標：**
  - 授課方式以講授及實作為主，授課內容著重於地理課題的實際應用，期使學生能夠具備**獨立解決問題**的能力。

↓

Open-book Exams (midterm and final exams)

課程設計

- 分析方法的理解（授課內容與講義）
- 資料分析的實作能力（R 統計語言）
- 實證研究與應用（論文研讀與討論）

In-class: 3 hours / week (lecture/discussion + labs)

After-class activities: 3-5 hours / week (reading + labs)

本課程的先修課程

(這些先修課程內容將視為理解本課程的基礎)

Prerequisites

大一 地圖學與地理資訊系統: 3 學分 (Cartography & GIS)

大一 程式設計: 3 學分 (Computer Programming)

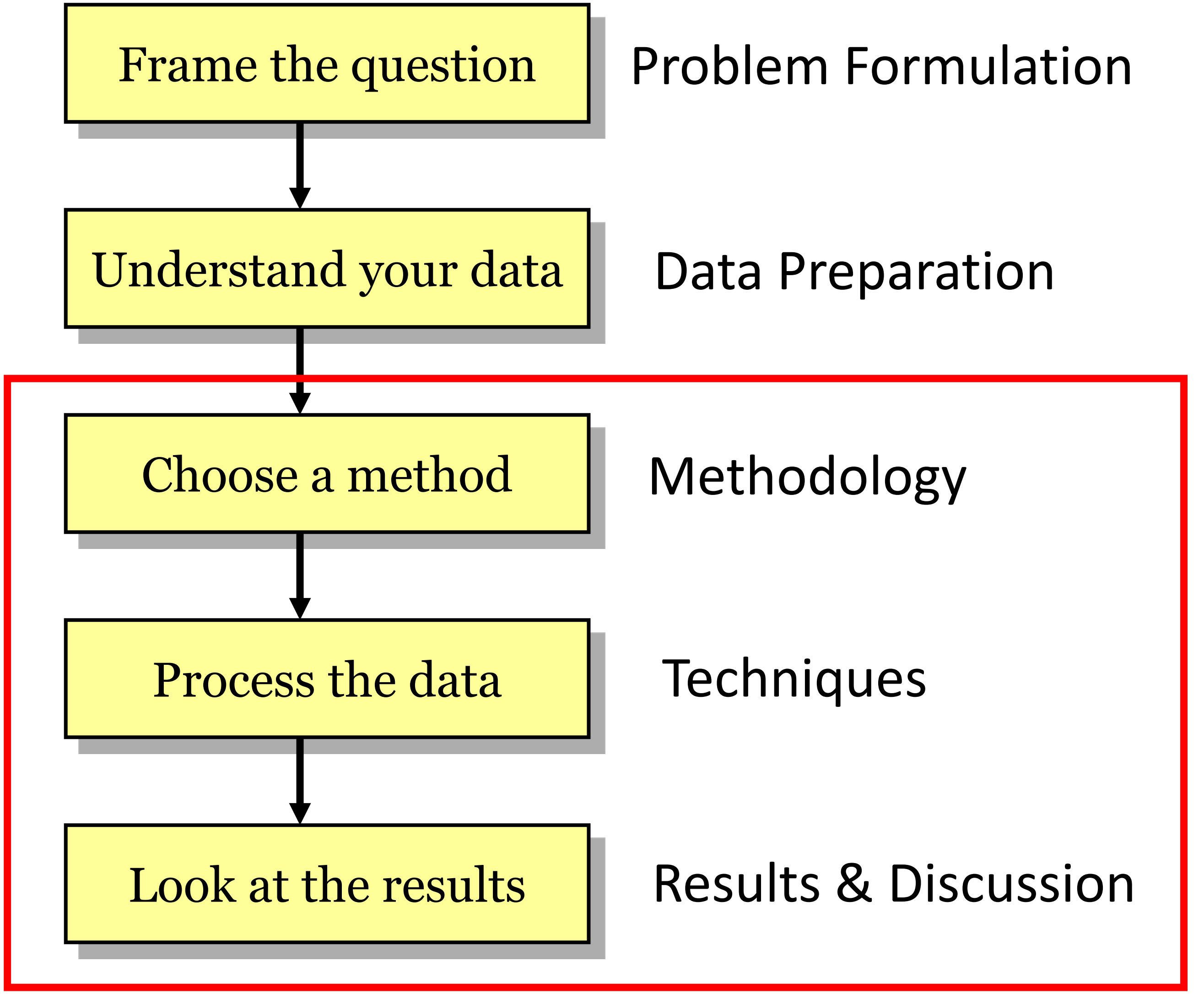
大二 統計學: 4 學分 或 6學分 (Statistics)

若尚未修習上述課程的修課同學，須 主動 找老師或助教尋求課後協助。

先修課程 (能力)

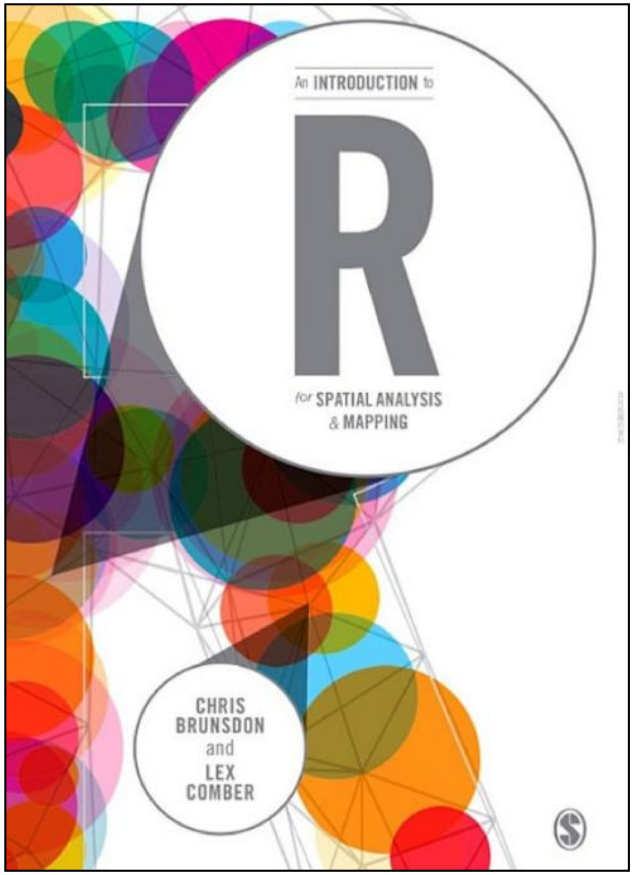
- Statistics: sampling, inference and estimation
- Cartography: coordinates and mapping concepts
- GIS: spatial data manipulation
- Programming: if-then-else, iteration (for-loop), functions & libraries

The Process of Analyzing Geographic Data



教科書

Brunsdon and Comber (2015), *An Introduction to R for Spatial Analysis and Mapping*, London: Sage Publication



Chapter 1: Introduction

Chapter 2: Data and Plots

Chapter 3: Handling Spatial Data in R

Chapter 4: Programming in R

Chapter 5: Using R as a GIS

Chapter 6: Point Pattern Analysis using R

Chapter 7: Spatial Attribute Analysis with R

Chapter 8: Localised Spatial Analysis

Chapter 9: R and Internet Data

https://uk.sagepub.com/en-gb/asi/an-introduction-to-r-for-spatial-analysis-and-mapping/book241031

授課主題 Part 1: Geo-visualization

- 第1週 2/18 Course Introduction
- 第2週 2/25 Geospatial Visualization: using ggplot2
- 第3週 3/04 Spatial Data Handling
- 第4週 3/11 Using R as a GIS
- 第5週 3/18 Web-based Interactive Mapping
- 第6週 3/25 Comprehensive Lab
- **第7週 4/01 * Mid-term Exam 1 ***

授課主題 Part 2: Point patterns

- 第8週 4/08 Description Measures
- 第9週 4/15 Quadrat Analysis
- 第10週 4/22 Nearest-Neighbor Methods
- 第11週 4/29 Distance-based Methods
- 第12週 5/06 Distance-based Methods
- **第13週 5/13 * Mid-term Exam 2 ***

授課主題 Part 3: Hotspot analysis

- 第14週　5/20　Spatial Autocorrelation
- 第15週　5/27　Localized Spatial Analysis
- 第16週　6/03　Issues of Multiple Testing
- 第17週　6/10　Oral Presentation: Term Project
- **第18週　6/17　* Final Exam ***

課程相關規定

- 課程要求：
  - 需參與課程討論與實習、論文研讀與課後作業
- 成績評量：
  - **課堂實習**：20% | **課後作業**：10% (可互相討論)
  - **期中考試 #1**：20% | **期中考試 #2**：20%
  - **期末考試**：20%
  - **期末報告**：10% (分組書面報告，**擇優口頭報告可取代期末考**)
  - 不定期的隨堂測驗：BONUS
  - 課後作業的加分題：BONUS

- 課程助教：杜承軒 r07228005@ntu.edu.tw
  江偉銘 schoolusejiang@gmail.com

期中考/期末考成績計算方式

- 每次的試題分數，總分 100 分
- 若全班有4位以上同學的成績達90分(含)以上，
  則全班分數不調整。
  (理由：90分是A+的門檻分數，全班約前10%的同學為 A+)
- 若未達四位同學的成績達90分(含)，則將成績**排序第四高**的同學成績(例如：73分)，將其調整為90分的差距(17分)，全班成績都依照此差距來調整分數 (原始分數 +17)。

學生成績評量定義表

百分數	等第	定義
90-100(95)	A+	All goals achieved beyond expectation 所有目標皆達成且超越期望
85-89(87)	A	All goals achieved 所有目標皆達成
80-84(82)	A-	All goals achieved, but need some polish 所有目標皆達成，但需一些精進
77-79(78)	B+	Some goals well achieved 達成部分目標，且品質佳
73-76(75)	B	Some goals adequately achieved 達成部分目標，但品質普通
70-72(71)	B-	Some goals achieved with minor flaws 達成部分目標，但有些缺失
67-69(68)	C+	Minimum goals achieved 達成最低目標
63-66(65)	C	Minimum goals achieved with minor flaws 達成最低目標，但有些缺失
60-62(61)	C-	Minimum goals achieved with major flaws 達成最低目標但有重大缺失
<59(含)	F	No goals achieved 所有目標皆未達成

備註：()為中位數

等第制與百分制對應表

等第制成績	GRADE POINTS	百分制分數區間	百分制分數（舊生）（取中位數）
A+	**4.3**	90-100	95
A	4.0	85-89	87
A-	3.7	80-84	82
B+	3.3	77-79	78
B	3.0	73-76	75
B-(研究生及格標準)	**2.7**	70-72	71
C+	2.3	67-69	68
C	2.0	63-66	65
C-(學士班及格標準)	**1.7**	60-62	61

作業繳交規定

- 作業通常包括兩部分，分析實作與研讀心得，打包壓縮成zip或rar 檔，上傳ceiba繳交。研讀心得的格式為PDF檔；分析實作則以R Markdown編輯成動態檔案 (html file)。**格式不符合規定，斟酌扣分**
- 研讀心得的格式與字數不拘，評分標準為文字內容的邏輯條理、個人反饋意見的思考深度。
- 每週作業，需於**下週上課之前 (2:00pm，以ceiba的上傳時間為準)**，完成上傳繳交，**作業不接受遲交或補交**。

作業 1

1. 以PDF檔繳交 (不符規定，予以扣分)
2. 繳交期限：下次上課當日的下午 2:00
3. 繳交方式：上傳 ceiba 作業區

- 實作教材 R-Short-Intro.pdf

Torfs and Brauer (2012). A (very) short Introduction to R。

自行下載與安裝 R 與 R Studio，並完成該教材各小節的ToDo練習。

(不需繳交，下週隨堂測驗類似題)

- 研讀材料與書面報告 Intro.Spatial.Analysis.pdf

ESRI. (2013). *The Language of Spatial Analysis*. New York: ESRI Press

www.esri.com/library/books/the-language-of-spatial-analysis.pdf

書面報告：舉例說明該書所提到的空間分析的七個步驟、六大類型問題如何應用在自己的學科專業。