

This course requires you to write substantial code in Python: **grading is through interactive code reviews**

The course does not teach Python. The first Python Assignment is due on github Sept 21.

In order to complete labs and submit assignments, sign up for a github account and fill out this survey:

<https://goo.gl/forms/F1R2YJ30SrMsvtrd2>

Includes those officially enrolled **and auditors!**



# Decision Support Systems

(slides from Mark Fox + other sources)

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# Introduction

- **Decision makers** (executives, managers, employees, consumers) suffer information overload and need to make decisions quickly
  - **Executives** determining market growth areas
  - **Managers** aggregating customer feedback from social media
  - **Employees** Googling to figure out the best way to implement an idea
  - **Consumers** searching for the right book for a given purpose
- The combination of the Internet and the maturation of information systems, artificial intelligence, operations research and statistics techniques, has led to sophisticated aids to support decision making under risk and uncertainty.
- DSS's have the potential to improve human decision-making!

# Decision Support System

- A Decision Support System (DSS) is an **interactive computer-based system** or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions.
- Decision Support System is a general term for any computer application that **enhances a person or group's ability to make decisions**.
- Also, Decision Support Systems refers to an academic field of research that involves designing and studying Decision Support Systems in their context of use.

# DSS Examples

- Credit/loan approval
- Range of Recommendations (not just Amazon, Netflix)
  - Problems to students in online educational tutoring
  - Information to focus on in large-scale networks (e.g., cybersecurity)
- Diagnostic Tools
  - Critical systems (generators, aircraft engines, trains)
  - Medical Diagnosis
- Transport Policy
  - Based on future growth projections
- Agricultural / Geographical Information Systems
  - How should a country allocate target crops to regions
- Scheduling of transportation, factories, flights, ...
- Siri

# Course Focus



- The course covers technologies for **building Data-driven DSS's**
  - Information Retrieval (**IR**), Machine Learning (**ML**), Recommender Systems (**REC**), Text Mining (**TM**), Data Mining and Analysis (**DMA**), Data Visualization (**DV**), Conversational Interfaces (**CI**), Social Network Analysis (**SNA**)
  - Note 1: Focus is on understanding and using technologies, breadth
  - Note 2: Contrast with Model-based DSS = inference / optimization
    - Covered in many other IE courses
- Textbooks have largely ignored rapid change in applied DSS
  - PDF readings will be distributed on Blackboard
- All projects will be in Python
  - Submission will take from of an IPython notebook on github

# DSS Terminology

- Decision support systems quite literally refer to applications that are designed to support, **not replace**, decision making.
- Unfortunately, this is too often forgotten by decision support system users, or these users simply equate the notion of intelligent support of human decision making with automated decision making.
- Automated driving is not a DSS!
  - Driver support (warnings, etc.) is a DSS



# DSS Today

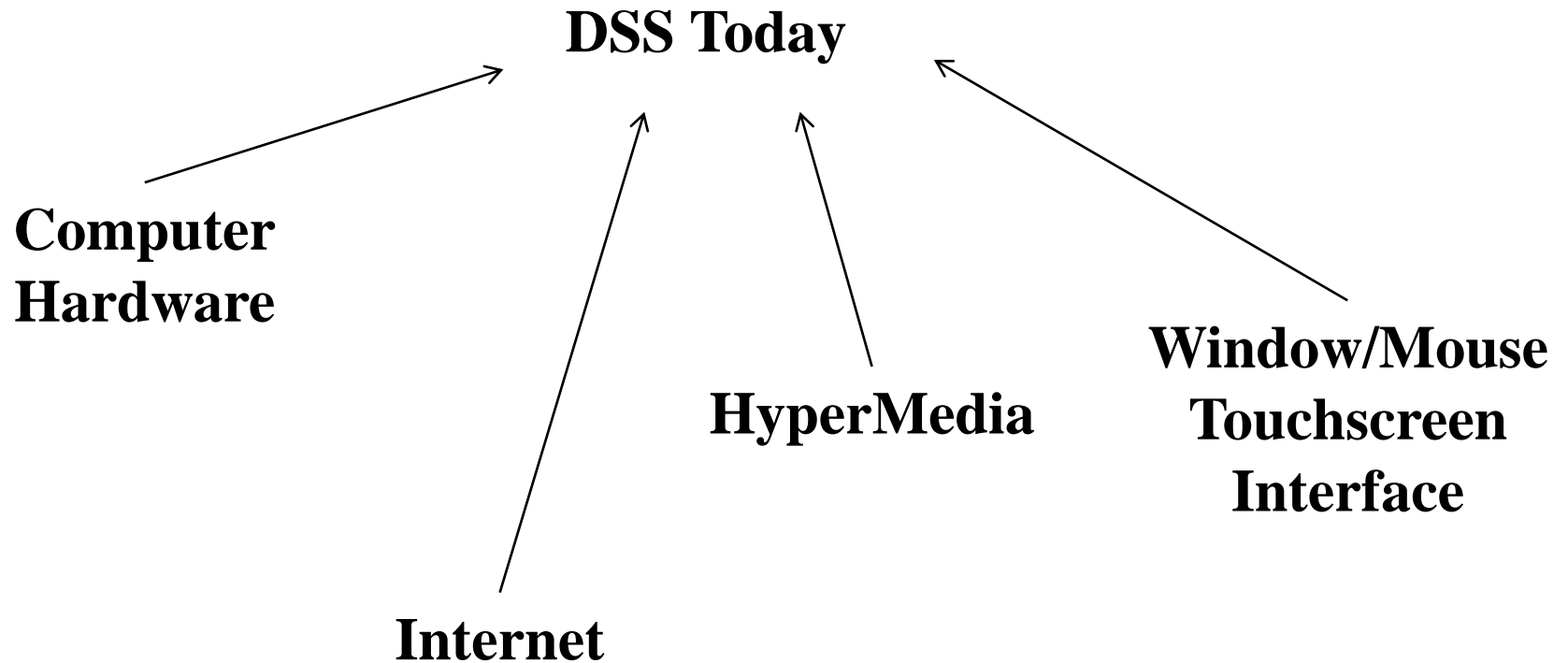


**Most Important  
DSS in Use Today?**

**Most Important  
DSS Platform?**

Google

# Convergence



## Decision Support Systems

### Technology

- Computer Hardware
- Internet
- Hypermedia
- User Interfaces

### Modelling

- Operations Research
- Statistics
- Artificial Intelligence
- Information Systems

# 50s-60s



- Mainframe computers were the only computers produced.
- Grew out of two traditions:
  - Processing census data
  - Generating ballistic tables during WWII
- A single computer occupied an entire environmentally controlled rooms.



Cambridge mathematician Professor Douglas Hartree, around 1951:

I went to see Professor Douglas Hartree, who had built the first differential analyzers in England and had more experience in using these very specialized computers than anyone else. He told me that, in his opinion, all the calculations that would ever be needed in this country could be done on the three digital computers which were then being built—one in Cambridge, one in Teddington, and one in Manchester. No one else, he said, would ever need machines of their own, or would be able to afford to buy them.

# IBM 360 circa 1965

- The IBM System/360 (S/360) was a mainframe computer system family.
- Made a clear distinction between architecture and implementation, allowing IBM to release a suite of compatible designs at different prices.
- The slowest System/360 models announced in 1964 ranged in speed from 0.0018 to 0.034 MIPS; the fastest models were 1.7 MIPS with up to 8 MB of internal main memory.
- Designed to cover both commercial and scientific applications.
  - Cover day-to-day operations (bank transaction processing, time series forecasting)



# 60s Futurists (beyond day-to-day operations)

- According to Peter Keen and Scott Morton (1978), the concept of decision support has evolved from two main areas of research:
  - the theoretical studies of **organizational decision making** done at the Carnegie Institute of Technology (especially **Herb Simon**) during the late 1950s and early 1960s, and
  - the technical work on **interactive computer systems**, mainly carried out at the Massachusetts Institute of Technology in the 1960s.
- It is considered that the concept of DSS became an area of research of its own in the middle of the 1970s, before gaining in intensity during the 1980s.

# 70s and Onward

- Minicomputers
  - Digital Vax
- Personal Computers
  - IBM PC, Apple I/II
- Handheld computers
  - Palm Pilot
- Smart Phones
  - Internet-enabled
- Key point: DSS's no longer have to be management-focused

## Decision Support Systems

### Technology

- Computer Hardware
- **Internet**
- Hypermedia
- User Interfaces

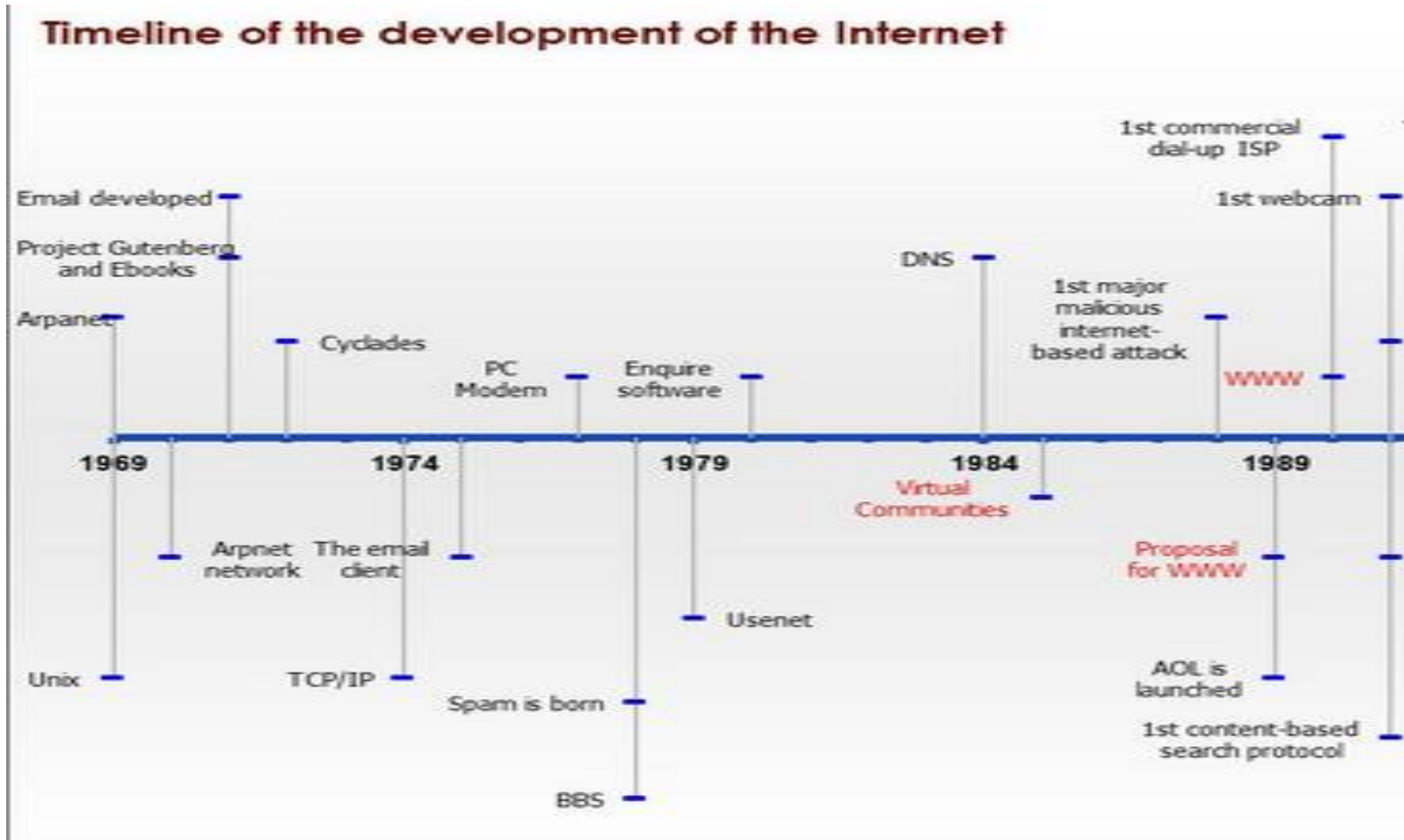
### Modelling

- Operations Research
- Statistics
- Artificial Intelligence
- Information Systems



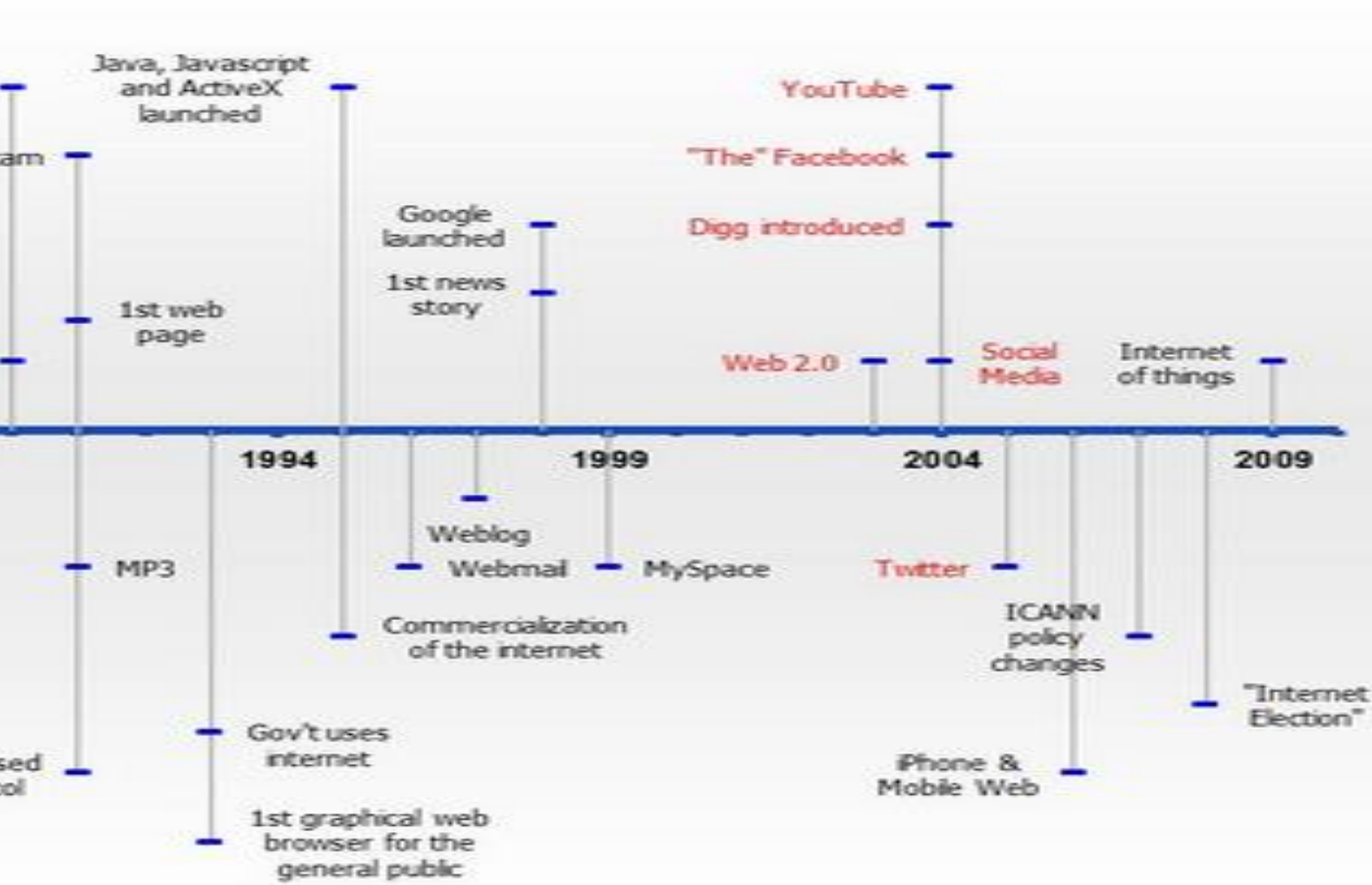
# Brief History of the Internet

Source: <http://ecoportal.org.uk/all/what-is-social-media/>



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## Decision Support Systems

### Technology

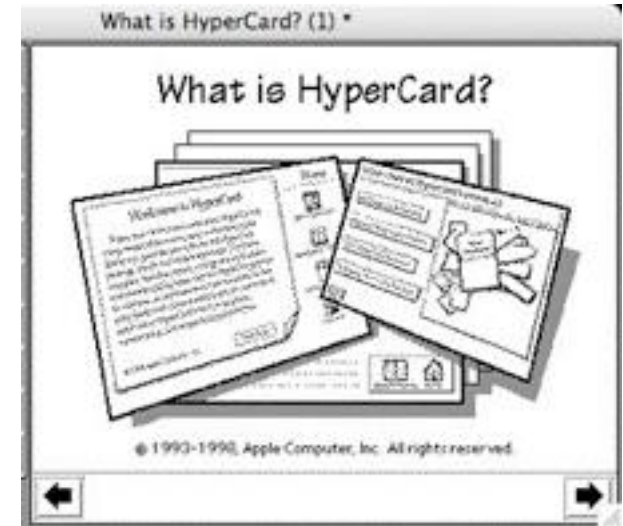
- Computer Hardware
- Internet
- **Hypermedia**
- User Interfaces

### Modelling

- Operations Research
- Statistics
- Artificial Intelligence
- Information Systems

# HyperMedia

- Memex (Bush, 1945)
  - Extremely visionary!
- Xanadu (Nelson, 1965)
- ZOG (Newell et al., 1970)
- HyperCards (Apple)
- World Wide Web (Berners-Lee)
  - Internet-based
  - Not new: but the first time the idea was widely adopted
- Blogs / Microblogs / Social networks
  - Content now rapidly published by 1 billion authors
  - Local information flow, social subscribers (friends, followers)



## Decision Support Systems

### Technology

- Computer Hardware
- Internet
- Hypermedia
- **User Interfaces**

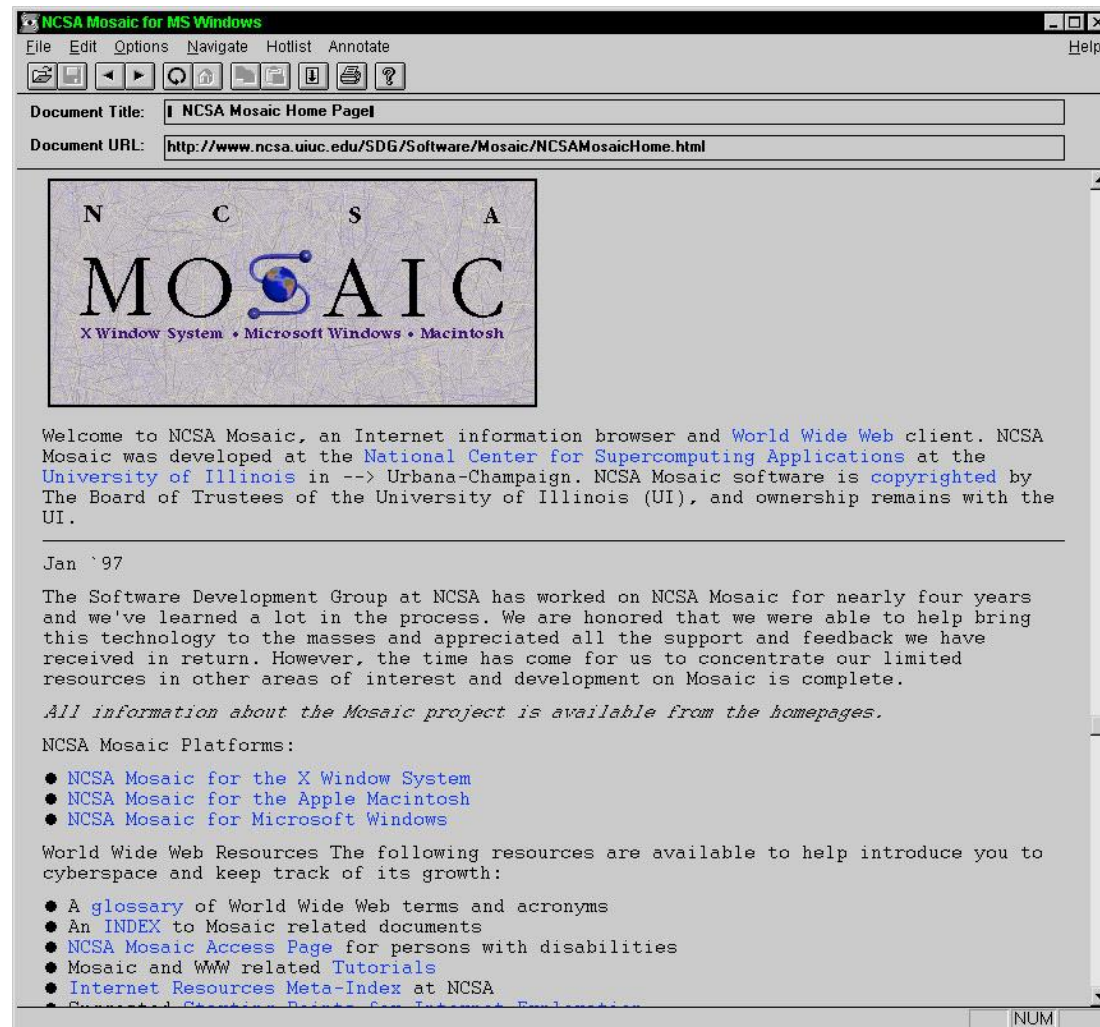
### Modelling

- Operations Research
- Statistics
- Artificial Intelligence
- Information Systems

# User Interface

- **Alto**: Xerox PARC (Palo Alto Research Center) – Alto workstation developed in the 1970s.
  - Window-based interface
  - Mouse-based point and click paradigm
- Apple Lisa/MacIntosh.
  - Steve Jobs toured PARC and “borrowed” the Alto concepts and made them commercially successful, eventually.
- **Mosaic**: University of Illinois’ Andreessen married the Alto paradigm to the World Wide Web!

# Mosaic Browser



# Fast-forward...



why|

- why **is the sky blue**
- whyy
- why **is my poop green**
- why **do men cheat**
- why **is a raven like a writing desk**
- why
- why **do dogs eat grass**
- why **am i so tired**
- why **are manhole covers round**
- whyville

Google Search    I'm Feeling Lucky

Modern life without Google?

A better interface? <https://bost.ocks.org/mike/nations/>



## Decision Support Systems

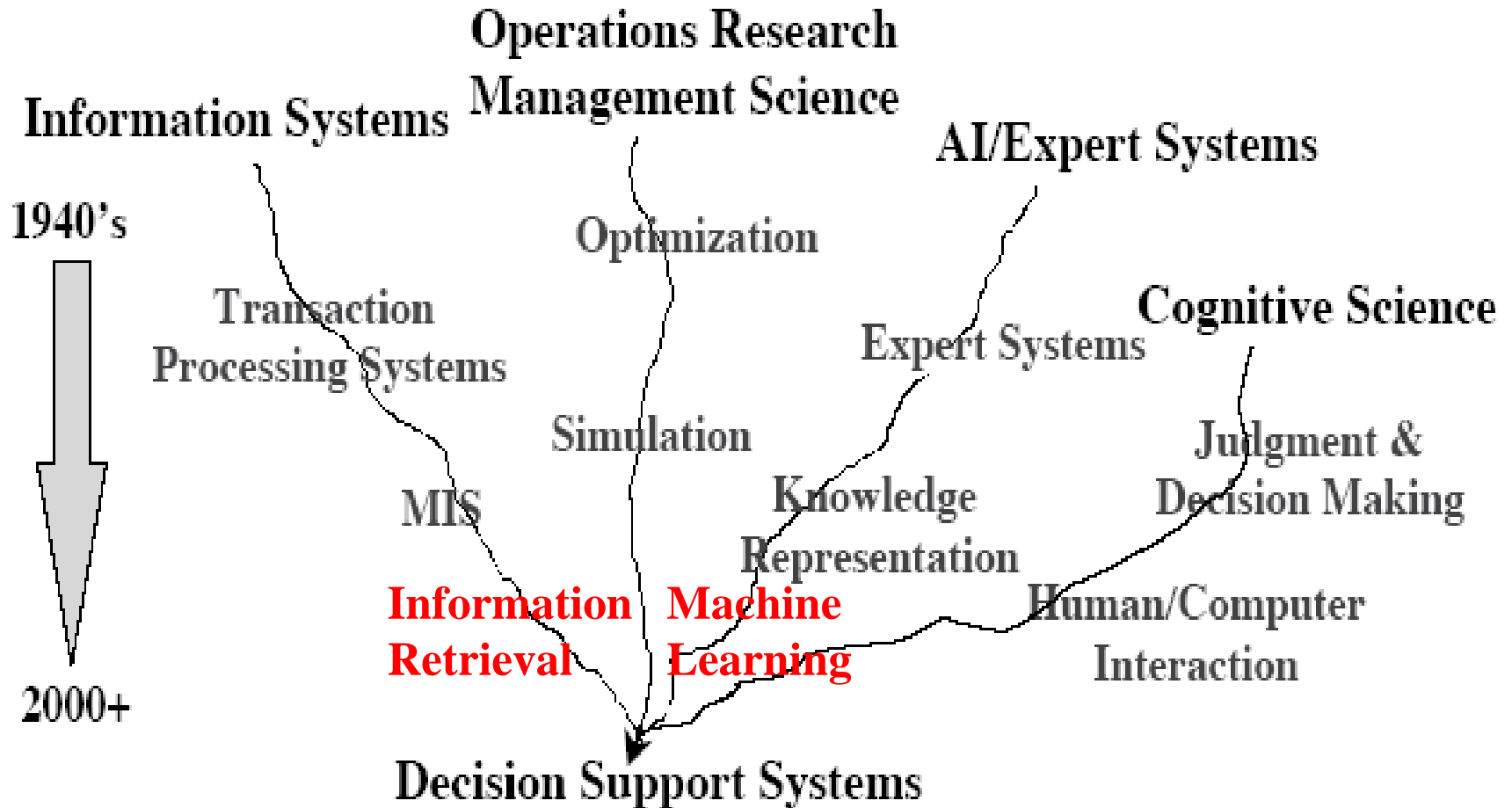
### Technology

- Computer Hardware
- Internet
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### Modelling

- Operations Research
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# History of DSS: Another View



*Goal: Use best parts of IS, OR/MS, AI & cognitive science to support more effective decision*



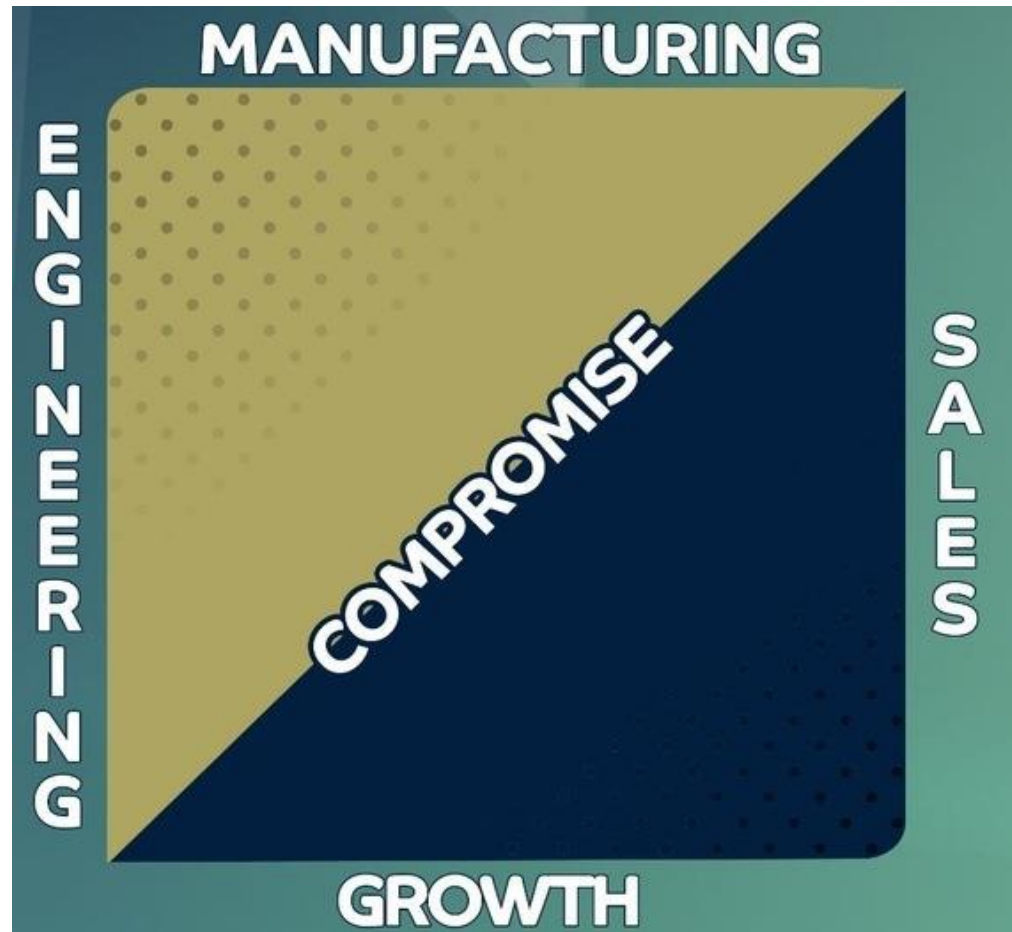
# Theory of DSS's & Decision Process

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# Modern View from CEO Jack Barker?



- Conjoined Triangles of Success & Hypotenuse of Compromise:



# Useful Diagram: AI Hierarchy of Needs



## THE DATA SCIENCE **HIERARCHY OF NEEDS**

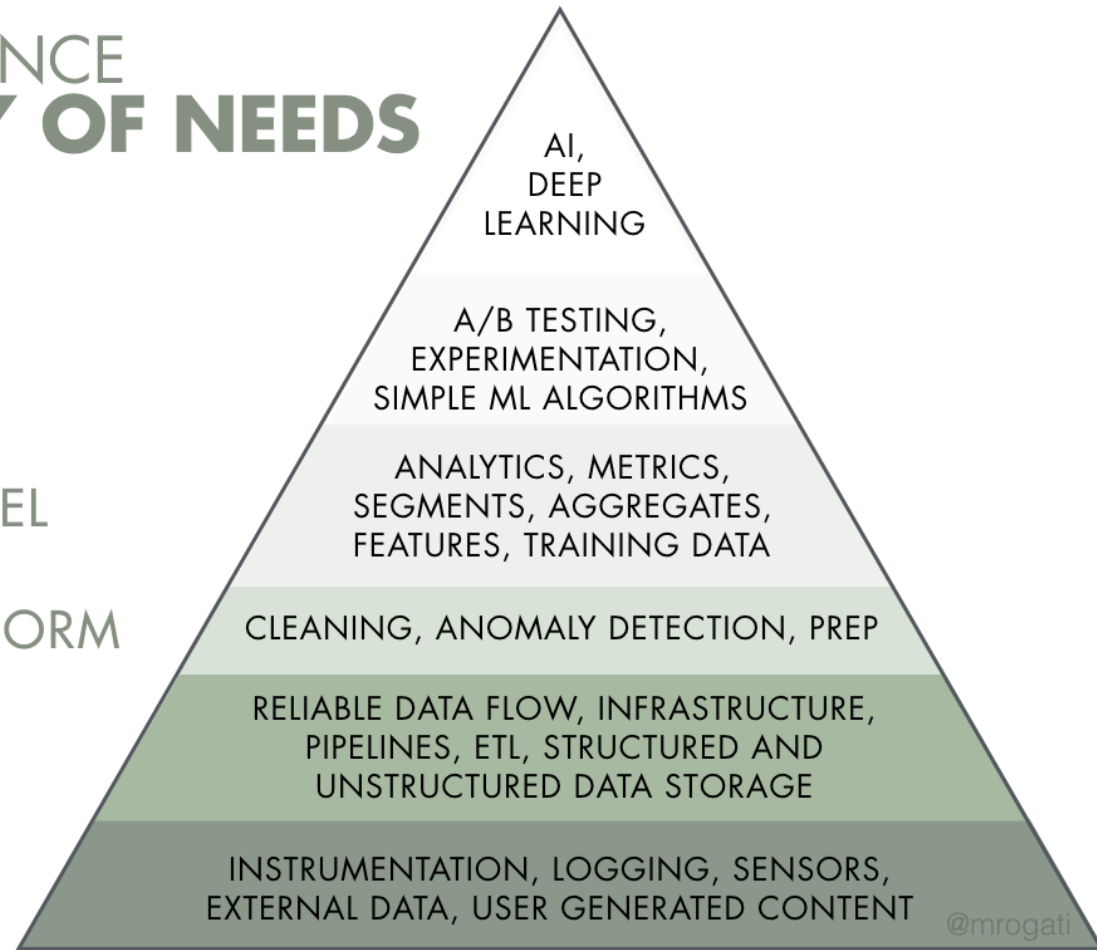
LEARN/OPTIMIZE

AGGREGATE/LABEL

EXPLORE/TRANSFORM

MOVE/STORE

COLLECT



<https://hackernoon.com/the-ai-hierarchy-of-needs-18f111fcc007>



# “Updated” Historical Perspective

- Decision Support Systems and Intelligent Systems, 7th Edition
  - Efraim Turban, University of Hawaii
  - Jay E. Aronson, University of Georgia
  - Ting-Peng Liang, Chinese University of Hong Kong

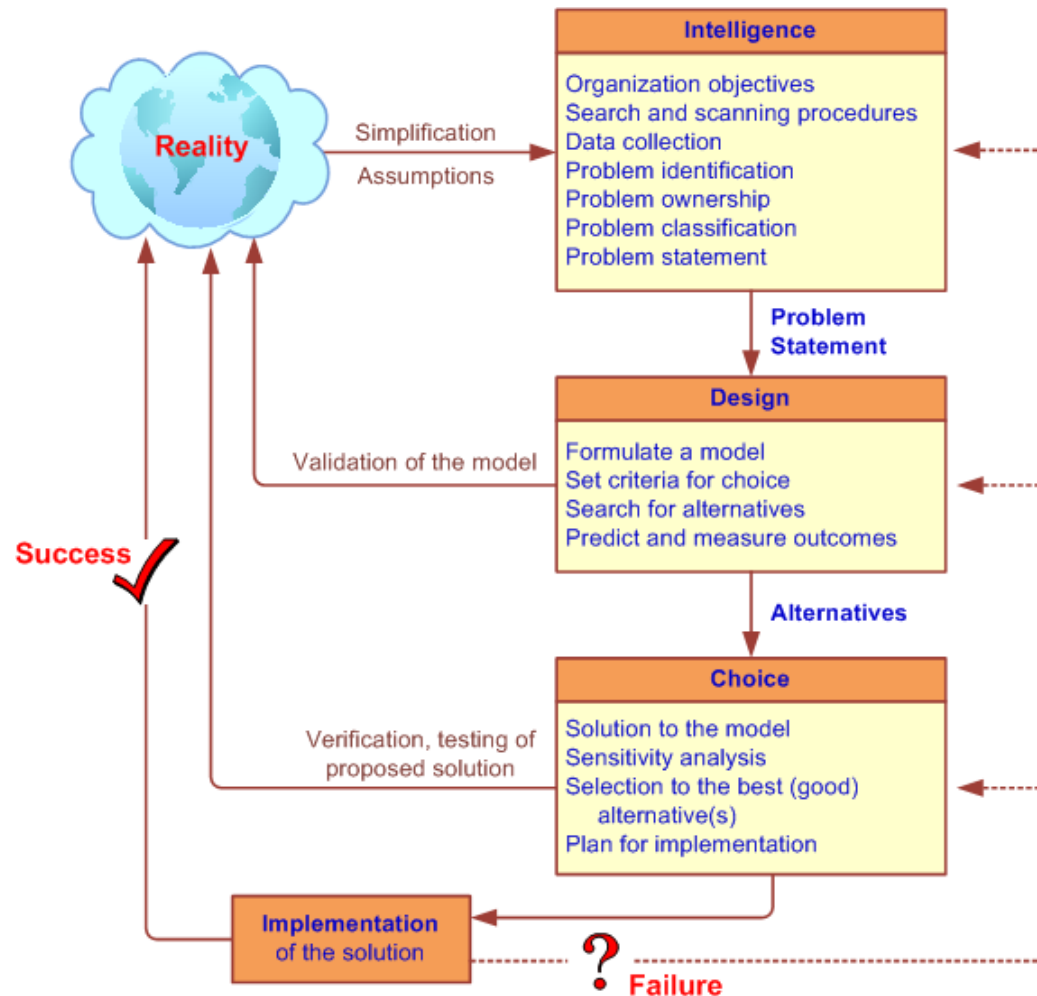
# Historical DSS Framework

(by Gory and Scott-Morten, 1971)



Type of Decision	Type of Control		
	Operational Control	Managerial Control	Strategic Planning
<b>Structured</b> Clear-cut	Accounts receivable Accounts payable Order entry 1	Budget analysis Short-term forecasting Personnel reports Make-or-buy 2	Financial management Investment portfolio Warehouse location Distribution systems 3
<b>Semistructured</b> Clear-cut but options complex	Production scheduling Inventory control 4	Credit evaluation Budget preparation Plant layout Project scheduling Reward system design Inventory categorization 5	Building a new plant Mergers & acquisitions New product planning Compensation planning Quality assurance HR policies Inventory planning 6
<b>Unstructured</b> Hard to formalize	Buying software Approving loans Operating a help desk Selecting a cover for a magazine 7	Negotiating Recruiting an executive Buying hardware Lobbying 8	R & D planning New tech. development Social responsibility planning 9

# Simon's Decision-Making Process





# Group Decision Support



- Well-formalized area of research
  - “Group Decision-making”
  - See Turban et al, “Decision Support Systems and Intelligent Systems”
- A number of stakeholders involved in decision-making
- How to understand context
- How to come to a collective decision?
- One area where managerial-oriented DSS’s still built



# Modern-DSS's and This Course

- The builders of arguably the most important DSS (Google) do not think about DSS's per se.
- DSS's built every day. But it's more about having the right tools to solve a problem and understanding how the tools can be used.
  - Every problem has to be solved on its own terms... with the right tools!
- This course focuses on the software ecosystem for rapid engineering of data-driven DSS's.
  - A few common core technologies with thousands of use cases.
  - We're going to focus on the core technologies.
- Consider what will be important in figure job interviews.

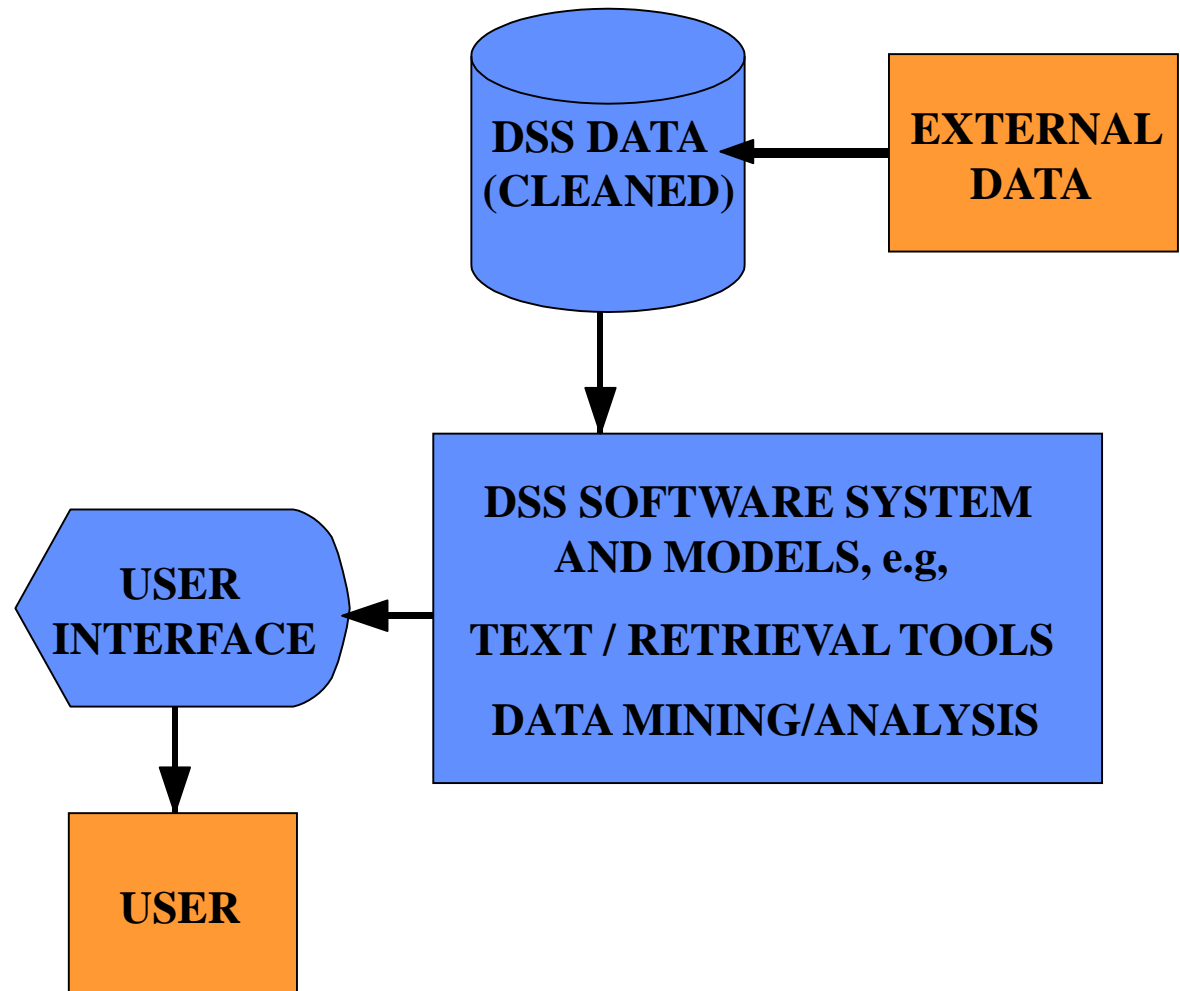


# Structure of a DSS

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# Typical Architecture

- **DSS DATA:**  
cleaned, merged data  
from external sources
- **MODEL:**  
representation of a  
problem
- **USER INTERFACE:**  
how user enters  
problem & receives  
answers



# Course Outline



- Information Retrieval (**IR**)
  - Indexing, retrieval, evaluation
- Machine Learning (**ML**)
  - Classification, regression
- Recommender Systems (**REC**)
  - Fundamental algorithms (nearest neighbor approaches), evaluation
- Text Mining (**TM**)
  - Document and linguistic processing
  - NLP (natural language processing) pipeline
- Data Science and Visualization (**DS**)
  - Fundamentals of exploratory data analysis
- Conversational Interfaces (**CI**)
  - Modeling natural language interaction and linking to data
- Social Network Analysis (**SNA**)
  - Deriving information from large social networks