Topic 9: Data Analysis, Interpretation and Presentation

SECV2113 Human-Computer Interaction

Faculty of Computing

Universiti Teknologi Malaysia

Goals

- Discuss the difference between qualitative and quantitative data and analysis
- Enable you to analyse data gathered from:
  - Questionnaires
  - Interviews
  - Observation studies
- Make you aware of software packages that are available to help your analysis
- Identify common pitfalls in data analysis, interpretation, and presentation
- Enable you to interpret and present your findings in a meaningful and appropriate manner

01 QUANTITATIVE AND QUALITATIVE

02 BASIC QUANTITATIVE ANALYSIS

03 BASIC QUALITATIVE ANALYSIS

04 ANALYTICAL FRAMEWORKS

05 TOOLS TO SUPPORT DATA ANALYSIS

06 INTERPRETING AND PRESENTING FINDINGS

QUANTITATIVE AND QUALITATIVE

Quantitative and Qualitative

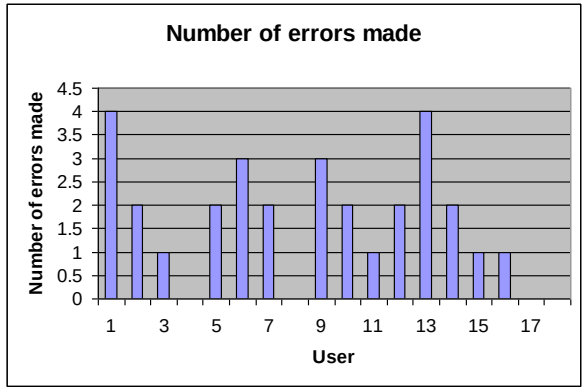
- **Quantitative data:** Expressed as numbers
- **Qualitative data**: In the form of words and images. Can be expressed as numbers, but not always meaningful to do so
- **Quantitative analysis:** Numerical methods to ascertain size, magnitude, or amount
- **Qualitative analysis:** Expresses the nature of elements and is represented as themes, patterns, or stories

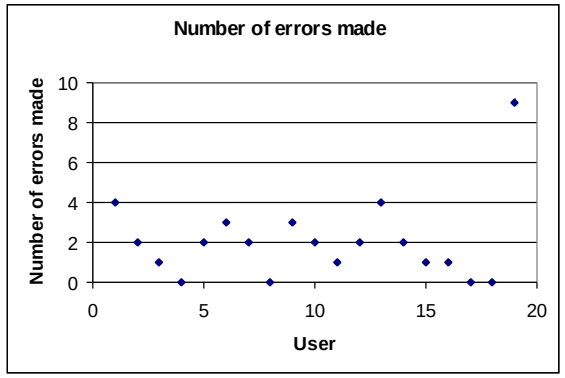
Be careful how you manipulate data and numbers!

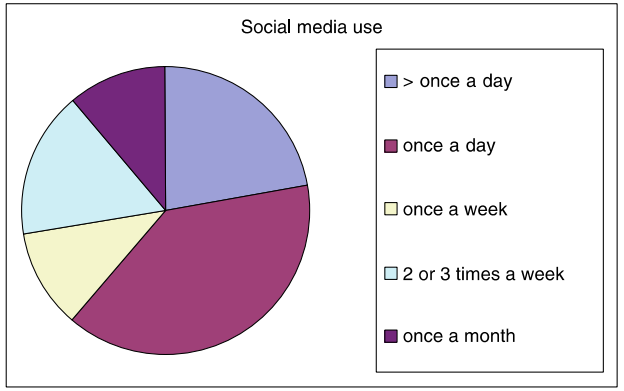
BASIC QUANTITATIVE ANALYSIS

Basic Quantitative Analysis

- **Averages:**
  - **Mean:** Add up values and divide by number of data points
  - **Median:** Middle value of data when ranked
  - **Mode:** Value that appears most often in the data
- **Percentages**
- Be careful not to mislead with numbers!
- Graphical representations give overview of data







Visualising Log Data

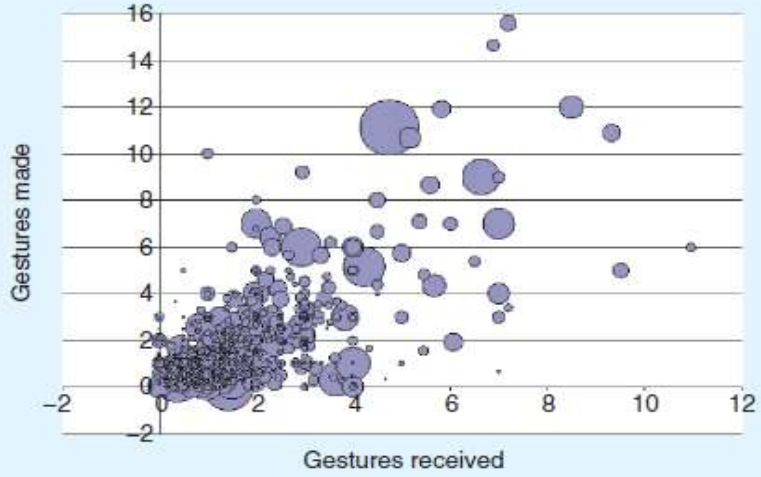


Figure 8.6 Interaction profiles of players in the cantina

Source: N. Ducheneaut and R.J. Morris (2004): "The social side of gaming: a study of interaction patterns in a massively multiplayer online game" in *Proceedings of CSCW 04.* ©2004 Association for Computing Machinery, Inc. Reprinted by permission.

Interaction profiles of players in online game

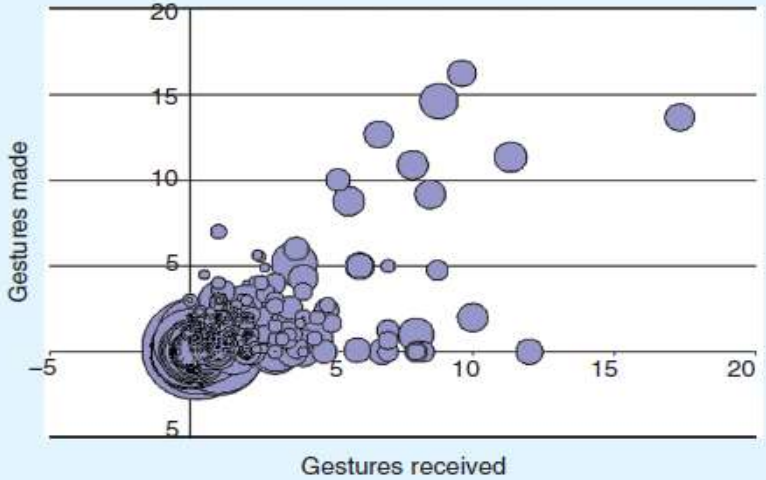
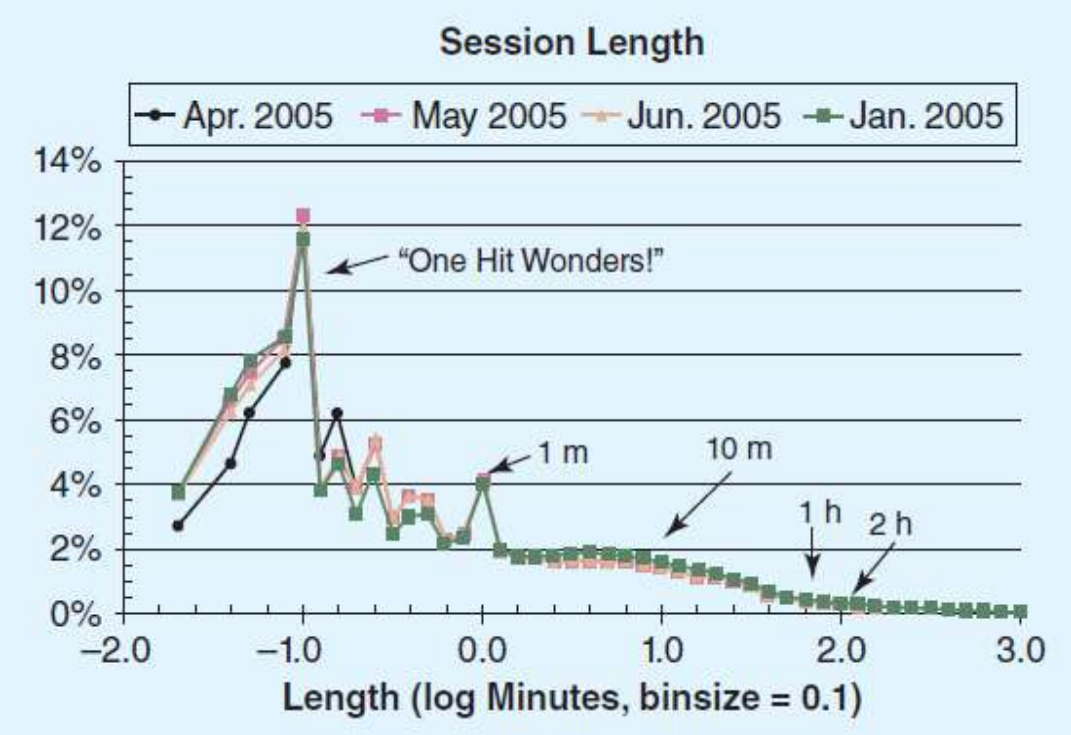


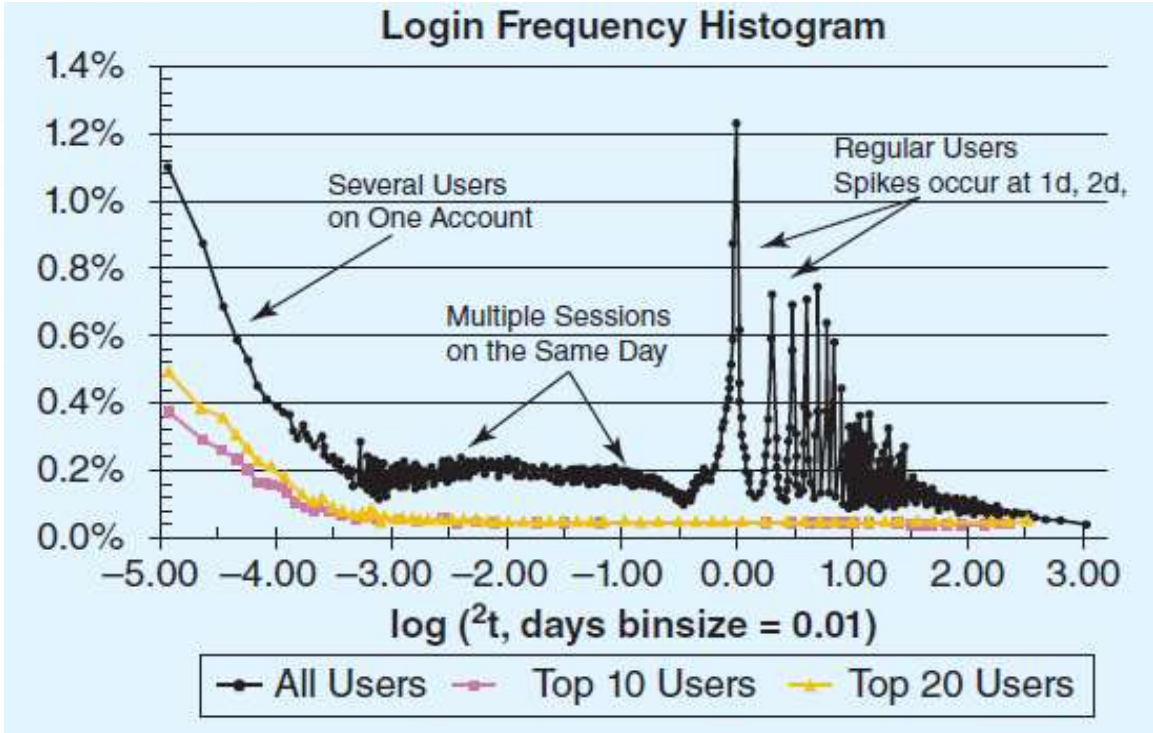
Figure 8.7 Interaction profiles of players in the starport

Source: N. Ducheneaut and R.J. Morris (2004): "The social side of gaming: a study of interaction patterns in a massively multiplayer online game" in *Proceedings of CSCW 04.* ©2004 Association for Computing Machinery, Inc. Reprinted by permission.

Log of web page activity

Web Analytics





session length data of four different months from Teachers' Domain (NSDL)

Source: Khoo, M., Pagano, J., Washington, A. L., Recker, M., Palmer, B., and Donahue, R. A. (2008) Using web metrics to analyze digital libraries. *Proceedings of Joint Conference on Digital Libraries*, Pittsburgh, June 16–20. ©2008 Association for Computing Machinery, Inc. Reprinted by permission.

Question Design Affects Data Analysis

- **Open question:** Each answer analysed separately
- **Closed question:** Can be analysed quantitatively
- **Fixed alternative answers** restrict what can be said in findings

BASIC QUANTITATIVE ANALYSIS

Basic Qualitative Analysis

- Coding is central to qualitative analysis
  - Inductive (bottom-up) and Deductive (top-down)
  - Meaningful codes that don't overlap
  - What level of granularity is appropriate?
- Identifying themes
  - Emergent from data, dependent on observation framework if used
  - Inductive analysis
- Categorising data
  - Categorisation scheme pre-specified
  - Deductive analysis
- Combination of inductive and deductive is common

QUALITATIVE ANALYSIS

ANALYTICAL FRAMEWORKS

Conversation Analysis

- Examines the semantics of a conversation in fine detail

01	SUS	i'd like to play beat the intro in a minute
02	LIA	[oh no::]
03	SUS	[**alexa**][**(1.1)**] **beat the in**[**tro**
04	CAR	[°yeah°]
05	LIA	[°no:::...°
06	CAR	(0.6) it's mother's day? (0.4)
07	SUS	it's ( ) yep (.) listen (.) you need to keep
08		on eating your orange stuff (.) liam
09		(0.7)
10	CAR	and your green stuff
11	SUS	**alexa (1.3) alexa (0.5)**=
12	CAR	=°and your brown stuff°
13	SUS	**play beat the intro**

An extract of the conversation between a family and Alexa

Discourse Analysis

- Focuses on dialogue; that is, the meaning of what is said and how words convey meaning
- Assumption that there is no objective scientific “truth”
- Language is viewed as a constructive tool
- Discourse analysis is useful when trying to identify subtle meaning
- Time-consuming but tools can help as long as context isn’t lost

Content Analysis

- Involves classifying data into themes or categories and studying their frequencies
- Can be used for any “text”: video, newspapers, advertisements, images, and sounds
- Often used in conjunction with other techniques

Simple Qualitative Analysis

Figure 8.8 Building the affinity diagram of Indian ATM usage

Source: Figure 1, A. DeAngeli, U. Athavamker, A. Joshi, L. Coventry and G.I. Johnson (2004) "Introducing ATMs in India: a contextual inquiry", *Interacting with Computers* 16(1), 29–44. Reproduced with permission.

Interaction Analysis

- A way to investigate and understand interactions between people and between people and artefacts
- Based on empirical observations such as videos
- Inductive process in teams, collaboratively
- Contents of the material is logged
- Materials are extracted, classified, or removed
- Instances of a salient event are assembled and played one after the other
- The team of researchers studies the assemblage together

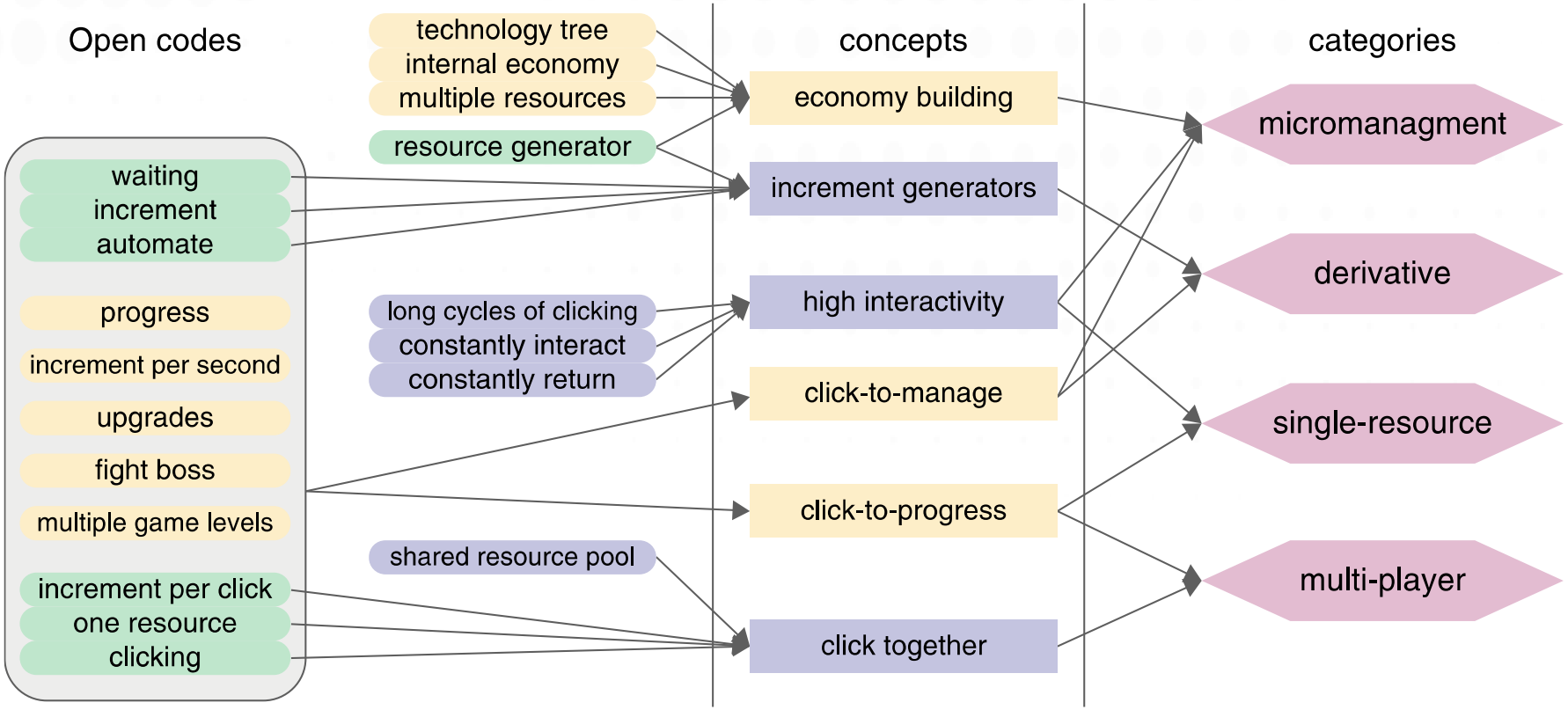
Grounded Theory

- Seeks to develop theory from systematic analysis of empirical data
- Three levels of coding
  - **Open:** Identify categories
  - **Axial:** Flesh out and link to subcategories
  - **Selective:** Form theoretical scheme
- Researchers are encouraged to draw on their own theoretical backgrounds to inform analysis
- Analytic tools to help stimulate thinking:
  - Question the data
  - Analyse words, phrases or sentence
  - Comparisons between objects or abstract categories

Illustration of Open Coding

Game Feature	Observations
Game name	*AdVenture Capitalist* [G38]
Play description	You start CLICKING on a lemonade stand and collect money. Spend money to make upgrades, INCREASE PRODUCTION PER CLICK. Start hiring workers and INCREASE PRODUCTION PER SECOND. When you have enough money, you can buy new businesses, automate all your businesses to INCREMENT more money, and leave the game progress.
Game mechanics	Click to gain money, AUTOMATE production, make upgrades to DAMAGE/SEC.
Rewards	ONE CURRENCY, which is money, is rewarded in return.
Interface	GRAPHICAL
Interactivity level	7
Progress rate	9
Overview	This is a SINGLE-PLAYER game, which requires LONG CYCLES OK CLICKING at the start, and making a number of upgrades. Production rate reaches $390/sec in less that 10 minutes and you gain 1M in cash making the game progress faster.

Development of Open Coding

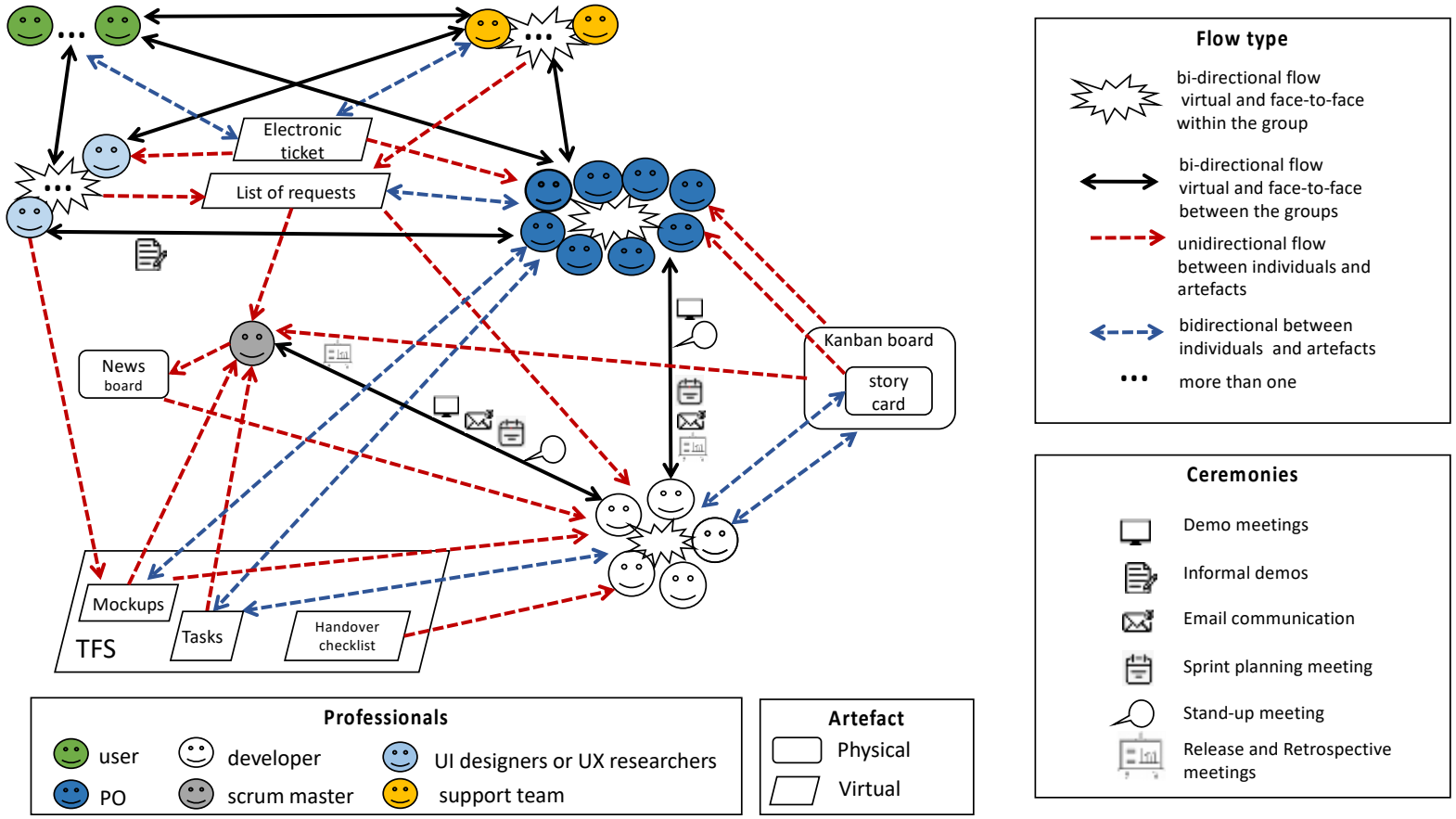


The analysis process that developed the incremental games super-category (each category above is part of incremental games). The process started with open coding of observations on idle games: multiple codes are created. Concepts are discovered through analyzing the open codes and identifying common features. This is an iterative process, where new codes are added, combined, or deleted. Each code is connected to one or more games and can be combined to form new concepts. Concepts are analyzed to find common relationships, and, thus, categories emerge. In the diagram, coloration is only to aid in reading. The left grouping is to show that all contained codes are part of click-to-manage and click-to-progress.

Source: Alharti et al (2018)

System-based Frameworks

- Understanding a whole socio-technical system requires different analytical framework
- Socio-technical Systems Theory
- Distributed Cognition of Teamwork



Source: Zaina et al. (2021)

Which Analytical Framework?

Framework	Data	Focus	Expected outcomes	Level of granularity
Conversation analysis	Recordings of spoken conversations	How conversations are conducted	Insights into how conversations are managed and how they progress	Word-level, or finer, for instance, pauses and inflection
Discourse analysis	Recordings of speech or writing from individuals or several participants	How words are used to convey meaning	Implicit or hidden meanings in texts	Word, phrase, or sentence-level
Content analysis	Any form of "text" including written pieces, video and audio recordings, or photographs	How often something is featured or is spoken about	Frequency of items appearing in a text	A wide range of levels from words, to feelings or attitudes, to artifacts or people
Interaction analysis	Video recordings of a naturally-occurring activity	Verbal and non-verbal interactions between people and artifacts	Insights about how knowledge and action are used within an activity	At the level of artifact, dialogue, and gesture
Grounded theory	Empirical data of any kind	Constructing a theory around the phenomenon of interest	A theory grounded in empirical data	Varying levels, depending on the phenomenon of interest
Systems-based frameworks	Large-scale and heterogeneous data	Large-scale involving people and technology, such as a hospital or airport	Insights about organizational effectiveness and efficiency	Macro-level, organizational level

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An Observational Study for Developing Digital Technology in the Museum

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ABSTRACT
This study aims to understand the behaviour of visitors of the Negeri Sembilan State Museum, Malaysia based on visitor demographic information and activity patterns. 30 volunteers were observed during their visit to investigate how they interact with tangible objects that are exhibited in the museum space. All participants were never exposed to any digital technologies in the museum before. A qualitative approach was adopted where an evaluation toolkit for museum practitioners and observation framework was used for data collection. Our findings indicated that dioramas received much more attention from the participants than the artefacts and labels display. This pointed to the inadequacy of the exhibition style where it did not capture nor attract the participants to stop, interact or obtain information from the artefacts. The gap may be filled in by the usage of digital technology in museum exhibitions as it has the potential of providing interactive features that would attract visitors and create engagement with the artefacts in the museum.

Author keywords
HCI; Digital technology; Museum; Observation.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Digital technologies in museums have seen massive growth in the last few years given the big effort in producing a more comprehensible system to give visitors the best museum experience.

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To improve engagement with visitors, many museums nowadays take advantage in the use of a variety of applications and technology to make the visiting experience more impactful [2].

The use of digital technologies allows the museum to create a new experience and to look for ways to create their exhibition more exciting in order to meet visitors' expectations, especially in this digital age [3, 4]. With the evolution of technologies combined with the innovative abilities of many converging media forms such as games, mobile application, virtual and mix-reality environments [5], the museum has changed from a static exhibition towards a non-linear, interactive and immersive environment [6].

This evolution occurred to fulfil the needs to attract visitors, especially the young generation. Nowadays, museum managers realised the importance of giving attention to accommodate visitor needs and expectation while touring the museums. This approach is also a part of a method to make visitors feel engaged with the exhibition and have good experience during the visit. In this technological era as well, visiting museums can also happen through a website, social media and cyberspace, especially for visitors who are not able to attend physically [7, 8]. Museum managers need to plan on technology application to interact and communicate with visitors and potential visitors. By adopting digital technology in the context of a museum exhibition physically or virtually, visitors can easily get access to the exhibition presented by the museum.

The rapid advancement in the digital world has contributed to changes in the modes of visiting the museums from something bored to something thrilling. This development of technology has given impact to visitors' expectation to explore and engage with the museum. Visitors can enhance and transform their experience beyond the physical objects exhibited [3, 9]. At the moment, there are many digital applications developed and are available in the museum in order to enhance visitors' experience and engagement with the museum collections [10]. For example, iMuse, which is a mobile type of digital technology that contains a virtual presenter which can expand visitors' experience by assisting

Method used

The observation framework is integrated with nine elements suggested by Robson which are space, actors, activities, objects, acts, events, time, goals and lastly, feelings, as in Table 1. By using this framework, Robson is encouraging the observer to focus on the context of the activity [15].

Space	What is the physical space like and how is it laid out?
Actors	What are the names and relevant details of the people involved?
Activities	What is the actor doing and why?
Objects	What are physical objects are present, such as furniture?
Acts	What are specifics individual actions?
Events	Is what you observe part of a special event?
Time	What is the sequence of the event?
Goals	What is the actor trying to accomplish?
Feelings	What is the mood of the group and individuals?

Table 1. The Observation Framework [15].

TOOLS TO SUPPORT DATA ANALYSIS

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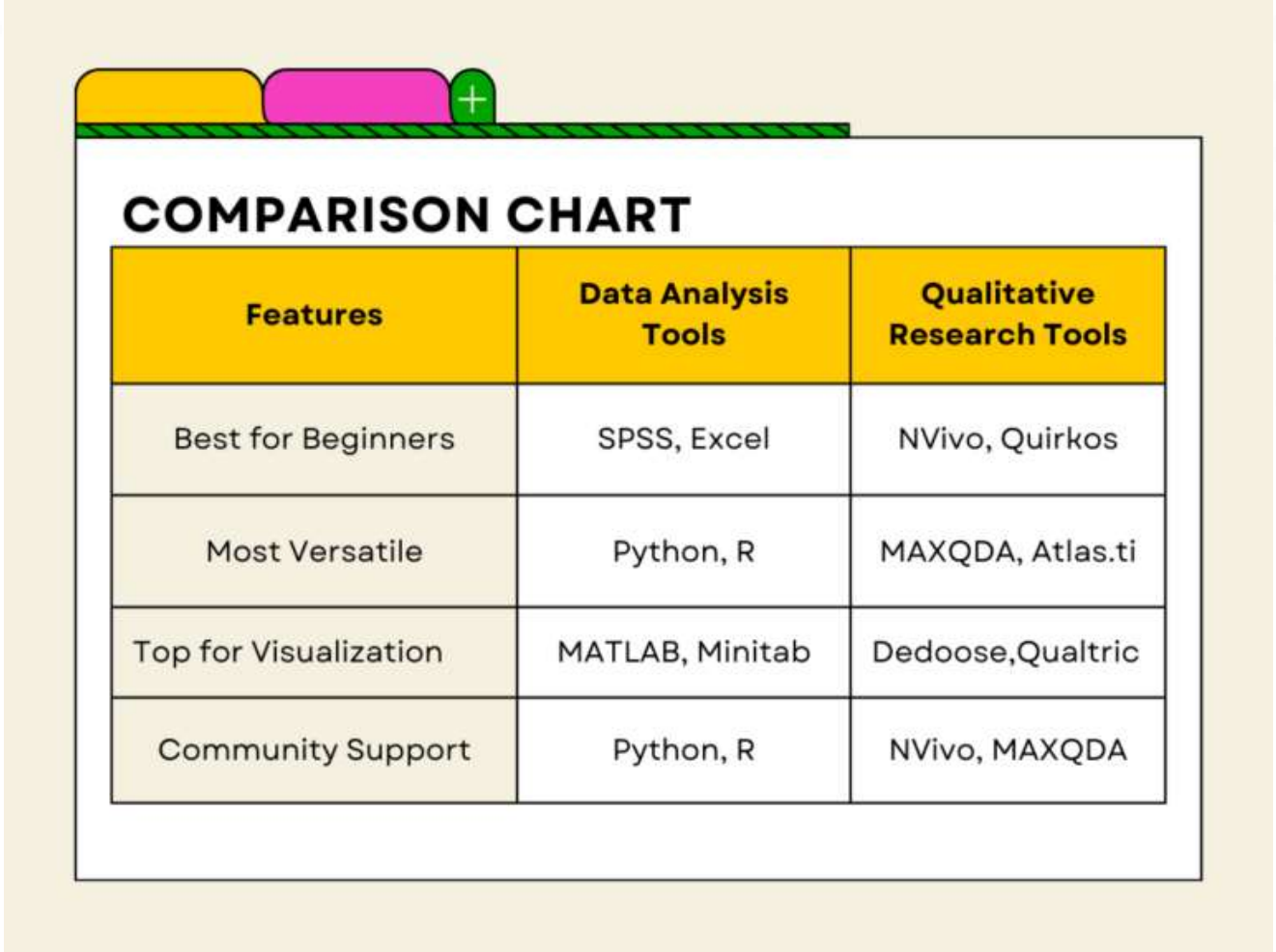
Tools Support

- **Spreadsheet** — Simple to use, basic graphs
- **Statistical packages**, for example, R and SPSS

- **Qualitative data analysis tools**
  - Categorisation and theme-based analysis
  - Quantitative analysis of text-based data
- Nvivo and Dedoose support qualitative data analysis
- Computer Assisted Qualitative Data Analysis (CAQDAS) Networking Project, based at the University of Surrey

Tools Support (Cont.)



COMPARISON CHART

Features	Data Analysis Tools	Qualitative Research Tools
Best for Beginners	SPSS, Excel	NVivo, Quirkos
Most Versatile	Python, R	MAXQDA, Atlas.ti
Top for Visualization	MATLAB, Minitab	Dedoose,Qualtric
Community Support	Python, R	NVivo, MAXQDA

Source: https://www.smartresearcher.me/phd-students-20-tools-for-qualitative-and-quantitative-research/

Tools Support (Cont.)

Quantitative data analysis tools:

- https://contentsquare.com/guides/quantitative-data-analysis/software/
- https://www.ibm.com/products/spss-statistics
- https://www.mathworks.com/products/matlab.html

Qualitative data analysis tools:

- https://lumivero.com/products/nvivo/
- https://www.maxqda.com/
- https://www.dedoose.com/

INTERPRETING AND PRESENTING FINDINGS

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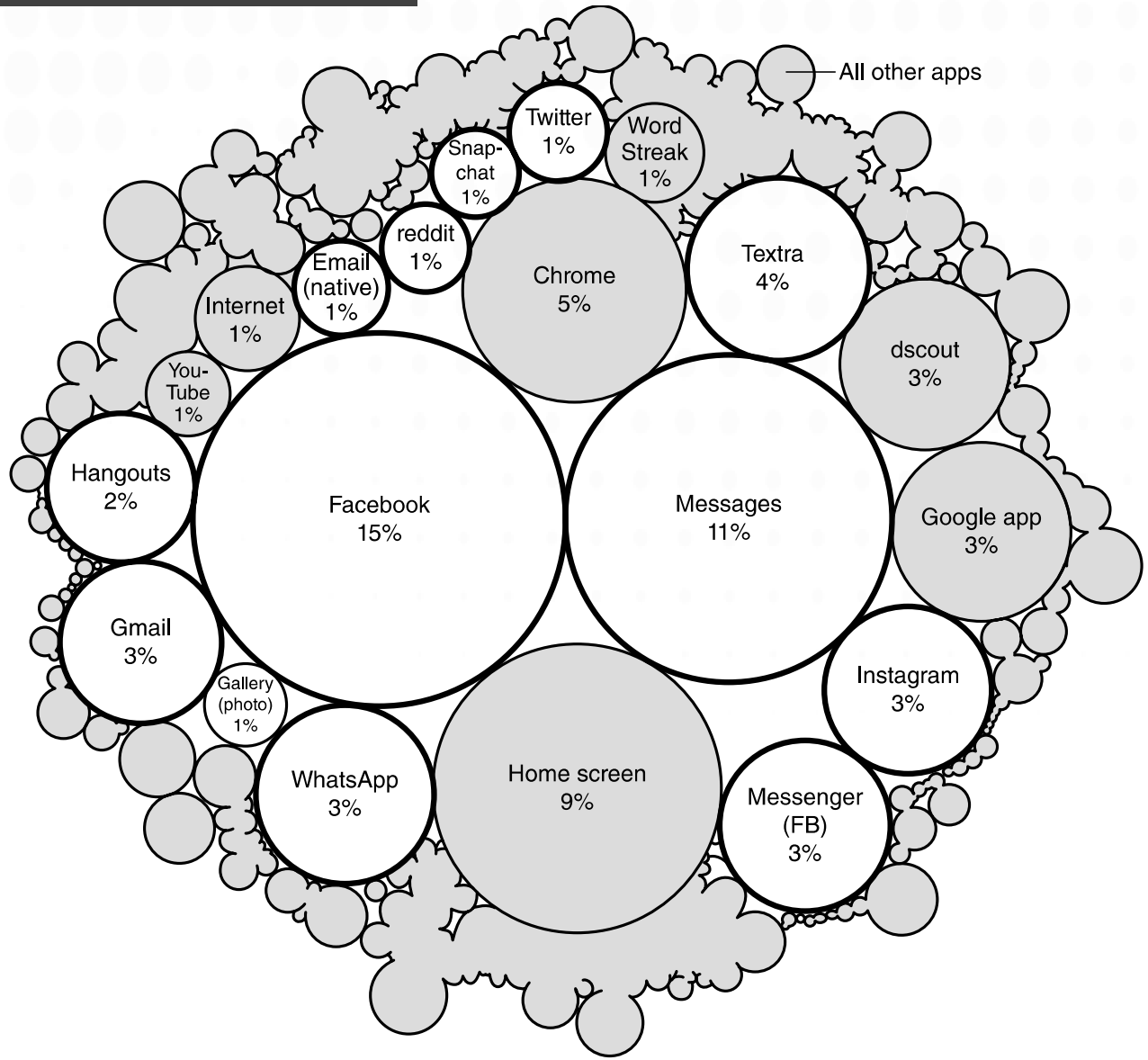
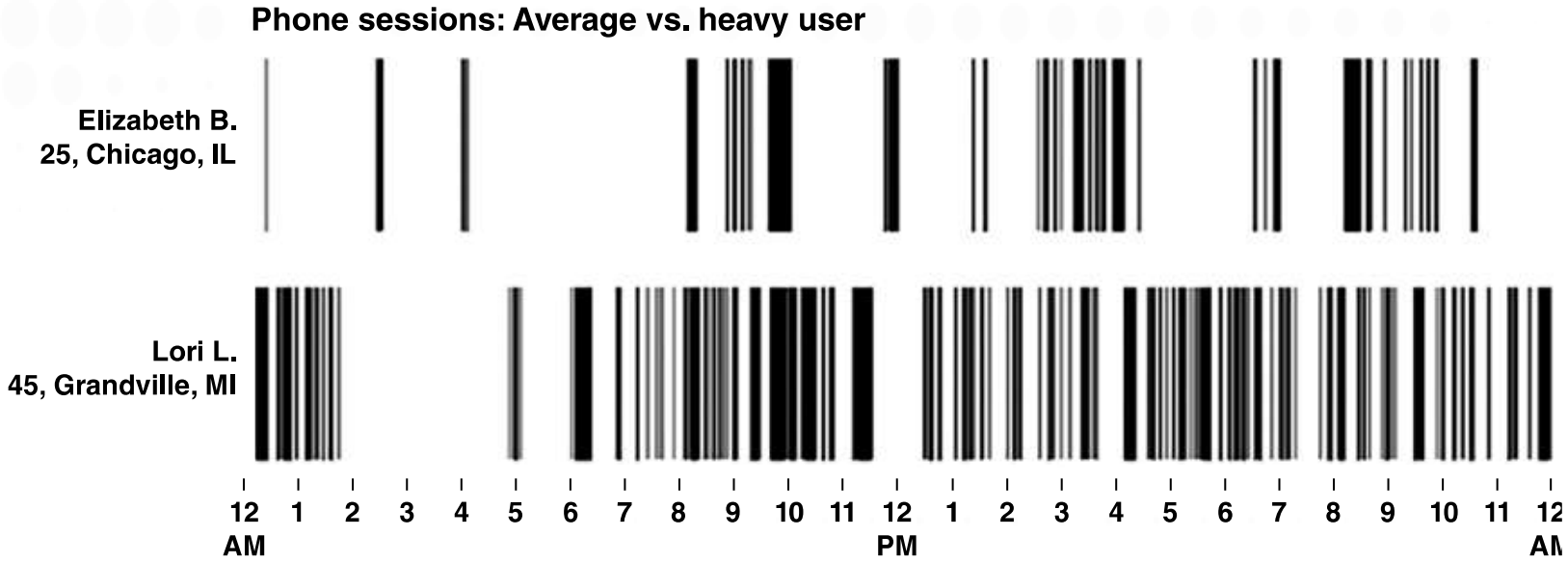


Bubble Chart of Media Networking Tools

Source: https://www.zoho.com/analytics/data-visualization-software/bubble-chart-maker.html



Q. What time of day do people use their phones most?
A. The snooze button might be what's behind all the predawn activity we saw. But at 7AM, touches explode, ramping up almost continuously until dinner time.

Source: https://medium.com/peoplenerds/putting-a-finger-on-our-phone-obsession-d65734181dc7

Presenting Findings

- Structured notations have clear syntax and semantics to present particular viewpoint
- Using stories is an easy and intuitive approach to communicate ideas
- Summarise findings using a range of notations

Key Points

- The data analysis that can be done depends on the data gathering technique(s) used
- Qualitative and quantitative data may be gathered from any of the three main data gathering approaches
- Percentages and averages are commonly used in Interaction Design
- Graphical representations help to identify patterns and outliers
- Mean, median, and mode are different kinds of ‘average’ and can have very different answers for the same set of data
- Analysis of qualitative data analysis may be inductive (extracted from the data), or deductive (pre-existing concepts)
- Several analytical frameworks exist that focus on different levels of granularity with different purposes