Lancaster University

SCC.400 Research Methods
SCC.460/SCC.460-HDS Data Science Fundamentals

The Language of Research

Agenda for this morning

- The Language of Research
- Types of Studies and Questions
- Framing research projects
- The Literature

Language of Research: Motivation

- Clarity in research
  - Ensure there is no ambiguity in how we discuss research
  - Enables others to carefully check findings and conclusions
  - Enables repetition of studies
    - E.g. demonstrating that something is an advance over the state of the art, established *under the same conditions* as prior art
- Precision
  - Specific statements: present research in “no uncertain terms”
  - Helps structure and focus your own thinking about a research problem

Qualitative and quantitative data

- Qualitative research= Understanding the quality of phenomena **why** and **how decisions are made**, as well as what, when where etc.

- Quantitative research=research based on data that can be quantified (counted)

Qualitative approach

1. Do you want to generate new theories or hypotheses?
2. Do you need to achieve a deep understanding of the issues?
3. Are you willing to trade detail for generalizability?

Qualitative approach

- To determine what might be important to measure, **why measured results are as they are**, or if the subject of study cannot be measured easily

- To **understand** not only what happened, or what people are responding to, but **why**

- To understand how people **think or feel** about something and **why they think that way**, what their perspectives and situations are and how those influence what is happening

Quantitative approach

- Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data

- Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon

Babbie, Earl R. *The Practice of Social Research*. 12th ed. Belmont, CA: Wadsworth Cengage, 2010

Qualitative VS Quantitative approach

- Quantitative research is confirmatory and deductive in nature
- Qualitative research is exploratory and inductive in nature

Qualitative and quantitative data

- How do the two types of data compare?
  - Advantages/disadvantages?
- Coding: transforming data for the purposes of analysis
  - Examples?
  - Problems?

Variables

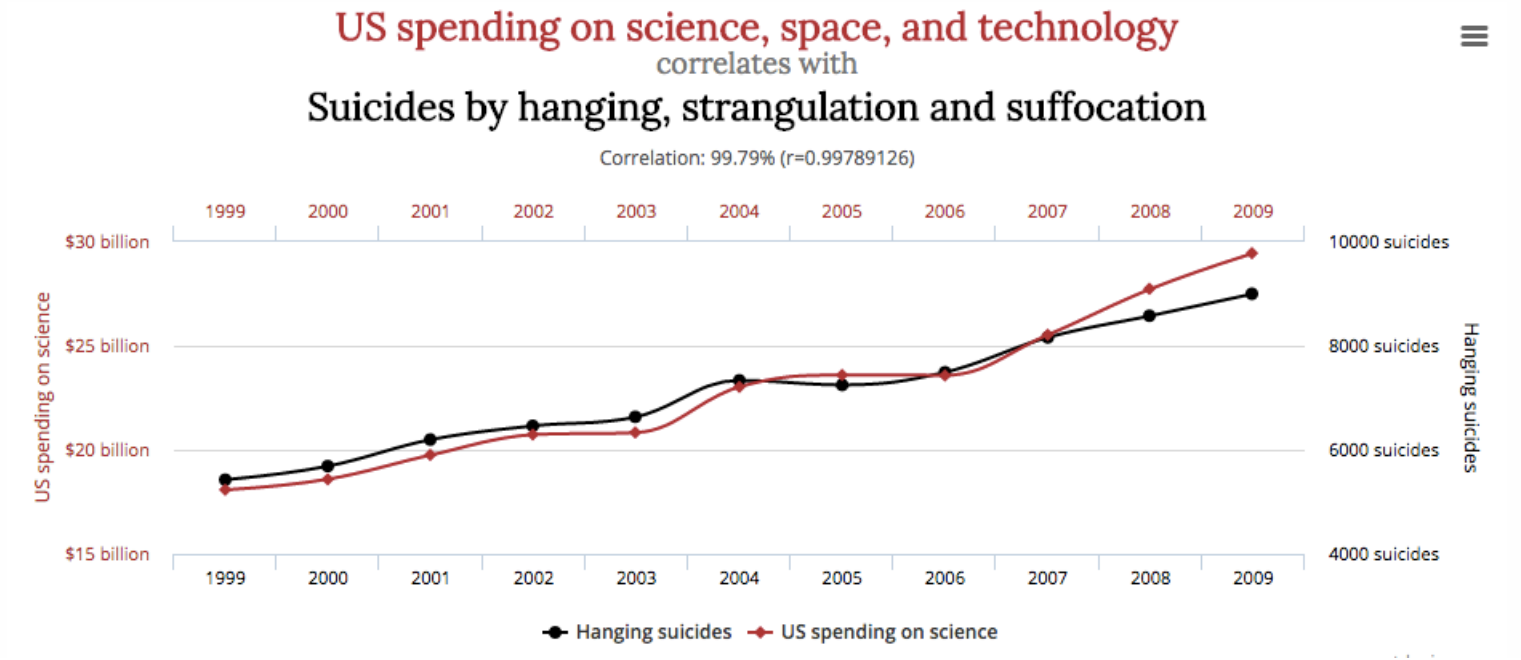
- Variables?
  - Independent? Dependent?
  - Examples?
- Attributes?
  - Exhaustive? Mutually exclusive?
- Levels of measurement?
- Nominal, ordinal, interval, ratio data
  - Examples?
  - How does the type affect analysis and interpretation?

Relationships between variables

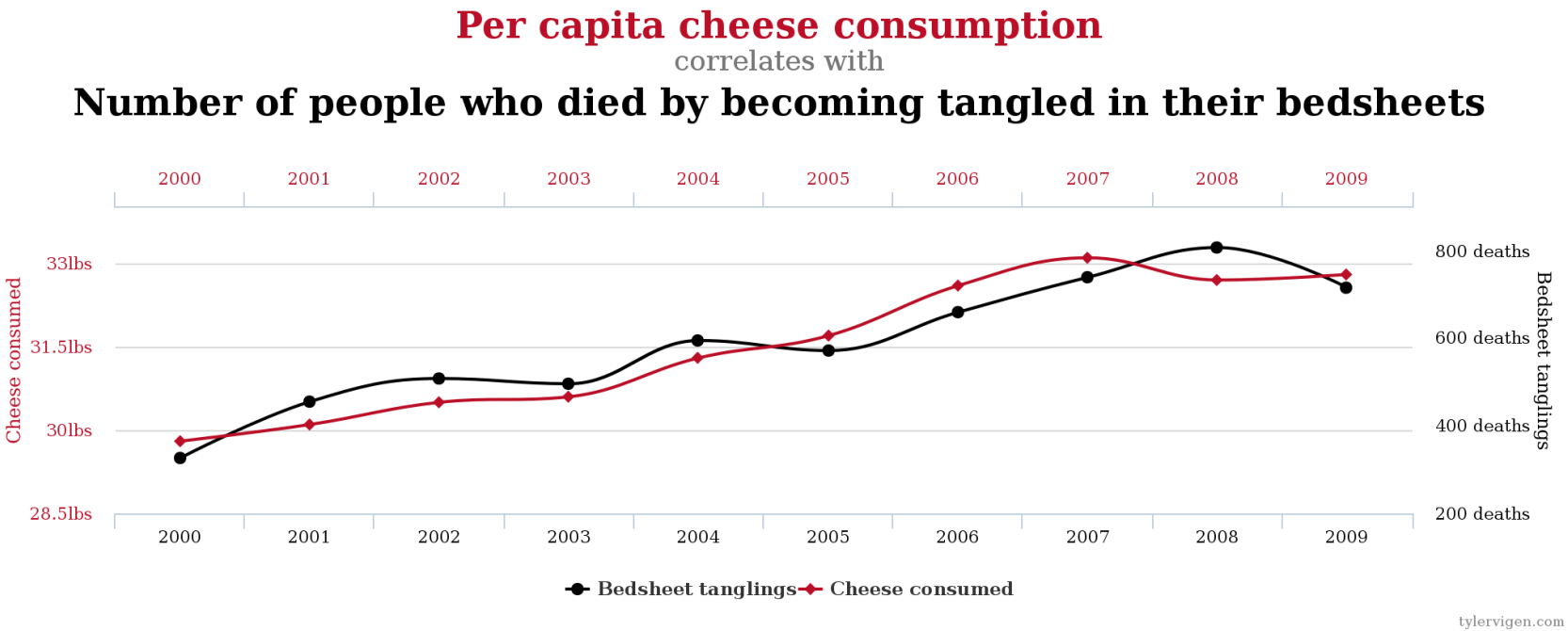
- Correspondence between variables
  - Positive versus negative relationship?
  - Third variable problem?
- Correlational or causal relationship?
  - Criteria?

  - Temporal precedence
  - Covariation: if x then y, if not x then not y
  - No plausible alternative causes

Science spending and Hanging suicides



Beware of cheese



For more of these check out tylervigen.com

Time in Research

- Studies can be
  - Cross-sectional
  - Repeated measures
  - Longitudinal
- How do they compare?
  - In terms of data collection?
  - Advantages, disadvantages?
  - Examples?

Unit of Analysis

- What is the unit of analysis?
- Example 1:
  - A study compares three travel booking systems to find out which is most efficient. Data on number of clicks and task completion time is collected with 12 users performing a set of representative tasks.
- Example 2:
  - A smart home system has been deployed to a number of households in a pilot study. Energy consumption data is collected to evaluate whether the system leads to savings. What is the unit of analysis?

Unit of Analysis

- The major entity in your study
- The analysis determines the unit
- Example pilot study of smart home system
  - Analysis of energy saving
  - Unit is household
  - Not the system, even though the research is about the system and its effect
- Same study might have different units of analysis
  - e.g. survey individuals in the home on their experience of the system

Hypothesis

- What is a hypothesis?
- Specific statement of prediction
  - Relationship between variables
  - Often formed from limited evidence (e.g. following a descriptive study)
  - Must be ‘testable’, so we can accept or reject it
  - Null hypothesis: the default outcome

Types of studies / Types of Questions

Type of Study	Type of Question	Examples
Descriptive	Exploratory	Existence: Does X exist? Description: What is X like? What are properties of X? Classification: What are categories of X?
	Base-rate	Frequency/distribution: How often does X occur? Process: How does X normally work?
Relational	Relationship	Co-occurrence: does X occur when Y occurs? Correlation: are X and Y related?
Causal	Causality	Specific: Does X cause Y? Does X prevent Y? General: What causes Y? Comparison of causes: Does X or Z cause more Y? Interaction of factors: Does X or Z cause more Y, when A but not when B?

Design Questions

- Knowledge questions
  - Focus on establishing knowledge
  - How things are and how they work
    How things are linked and how things influence each other
- Design questions
  - Focus on problem solving
  - e.g., What is an effective and reliable way of achieving X?
- Design questions imply knowledge questions that need to be answered first
  - e.g. What alternatives exist for achieving X? What do we mean by ‘reliable’ when we talk about achieving X?

Descriptive studies

- What currently exists, what is going on
- In design and engineering that includes: what has been developed, and how
- Computer science, design and engineering research is often descriptive
  - Description of a system/artefact where knowledge is conveyed by describing how it has been constructed, how it works, or what it enables
  - Description of a prototype that demonstrates the feasibility of something ("Existence proof")
  - Design exploration of a new idea, to understand what it might enable

Example: Describing a prototype solution for a problem

Fiabot! Design and Evaluation of a Mobile Storytelling Application for Schools

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ABSTRACT

This paper contributes to the ongoing debate about how digital technology can be integrated into the formal education system. Within a longitudinal research study, which lasted four years, we conducted an investigation on how mobile technology can support educational activities as defined by a school curriculum. Among the topics included in the school curriculum, we focused on the literary field and developed a Digital StoryTelling (DST) application, Fiabot!, to support this activity. Here, we describe the design of the application and how we evaluated its impact on educational activities. The application was designed and evaluated in two primary schools. The study had the objectives of exploring whether Fiabot! supports children in achieving educational objectives defined by the curriculum, how this effectively supports teachers, and to what extent children like using it for the creation and sharing of their stories. Our findings show that the application has a positive impact on curriculum enactment and effectively supports the related educational activities. Overall, Fiabot! was demonstrated to be very effective in stimulating children's discussion of a story's plot and characters. Thus, Fiabot! supported children not only in being creative but also in organizing their work and exploring a digital media opportunity. This resulted in the development of new skills and the better grounding of previously acquired knowledge, while teachers also had the opportunity to expand their teaching skills and get a taste of ICT's potential in education.

Categories and Subject Descriptors

H.5.2 [Information interfaces and presentation]: User interfaces –

now, it can be studied from different perspectives, including learning science and interaction design. Therefore, being a relatively recent field of study, many issues still need to be explored. We are contributing to this debate by carrying out a research project where we explored the extent to which digital technology can support primary school curriculum enactment and have investigated how to introduce it into existing practices. In order to address these issues, we organized a series of case studies in two primary schools. We focused on a specific area of the curriculum, such as the Local/First Language, and the subarea of literature and narrative genre. Among other linguistic competences, children have to learn how to write a narrative in different literary genres. Teachers train children by asking them to read and write stories that correspond to a specific genre in order to teach them its specific elements and structure. Often the creation of stories is done in groups since the development of social skills is an aspect included in the curriculum. In addition, this activity comprises the training of additional abilities included in the official program such as social skills, creativity, and media literacy. The study as a whole has produced several outcomes, including: a set of guidelines for the design of Digital StoryTelling (DST) intervention in schools [17], a model for illustrating the teacher's role—as the main curriculum implementer—in using digital media/devices in school [18], and a prototype of the DST application Fiabot!.

In this paper, we describe Fiabot! and the results of its evaluation in real educational contexts. In the next section, we present the background of our research project.

2. BACKGROUND

Figure 3. The "list of ingredients" for creating a fairy tale.

Example: Describing the design space of a new technique

A Cross-Device Interaction Style for Mobiles and Surfaces

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ABSTRACT
Natural forms of interaction have evolved for personal devices that we carry with us (*mobiles*) as well as for shared interactive displays around us (*surfaces*) but interaction across the two remains cumbersome in practice. We propose a novel cross-device interaction style for mobiles and surfaces that uses the mobile for tangible input on the surface in a stylus-like fashion. Building on the direct manipulation that we can perform on either device, it facilitates fluid and seamless interaction spanning across device boundaries. We provide a characterization of the combined interaction style in terms of input, output, and contextual attributes, and demonstrate its versatility by implementation of a range of novel interaction techniques for mobile devices on interactive surfaces.

Author Keywords
Interactive tabletops, surface computing, mobile phones, personal devices, interaction techniques.

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces: Input devices and strategies, Interaction Styles

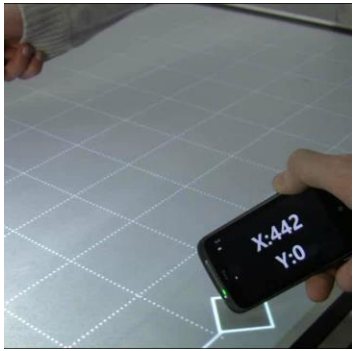
General Terms
Design, Human Factors

INTRODUCTION
Mobiles and surfaces and their associated forms of interaction become ever more powerful and pervasive in our lives, but in their separate ways. By mobiles we mean small devices of a personal nature that we have with us for interaction; devices that are highly personalized, that store private data, and that are a proxy of ourselves in the digital world. By surfaces

Figure 1. A natural style for cross-device interaction with mobiles and surfaces. The mobile is used like a stylus for direct selection on the surface. For example, users can pick up content from the surface by touching it with their phone.

There are compelling reasons for combined use of mobiles and surfaces, and for seamless interaction across the two. Mobiles are great for carrying data and media while surfaces offer better scale for interaction with content. Mobiles provide user control over personal data while surfaces make it easy to share. Surfaces can be used by multiple users in the same way while mobiles can be used in highly personalized ways.

These are not new insights. Ever since the advent of mobiles, researchers have investigated topics such as coupling with surfaces for larger display [30], sharing of personal data on surfaces for collaboration [11], direct manipulation techniques for data transfer [29], remote interaction with larger surfaces [22], and private input, output and authentication around public devices [21, 6]. For any of these concerns, numerous techniques have been demonstrated. Data transfer, for instance, has been shown in terms of hyperdragging in augmented environments [29], "squirting" onto target devices in wireless networks [18], touching of target areas using NFC [14], tangible placement of mobiles on horizontal surfaces [37], as well as other ways. However, no single interaction style has emerged that would underpin mobile-surface-interaction more



Relational Studies

- Assessing the correspondence between two phenomena: is there a link?

Study shows link between poor school results and environmental contamination in mining towns

AM By David Lewis and Zara Margolis

Updated 6 Oct 2015, 3:54am

A new study has found there is a link between the academic performance of primary school students in mining towns and their exposure to environmental contamination.

The study focused on Broken Hill in remote New South Wales where students who performed poorly in the National Assessment Program — Literacy and Numeracy (NAPLAN) were found to either live or attend school in areas with high amounts of lead, arsenic, and cadmium in the soil and air.

In contrast, students from districts with comparatively low levels of heavy metals in the

PHOTO: Exposure to dangerous levels of lead and other chemicals is known to cause harm to brain development in children. (AAP)

- Correlation simply means two things perform in a synchronised manner
- What is the danger in drawing conclusions?

Example: Relationship between mobile phone use, academic performance and anxiety

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

The relationship between cell phone use, academic performance, anxiety, and Satisfaction with Life in college students

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Anxiety
Satisfaction with Life
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Post-secondary education

ABSTRACT

While functional differences between today's cell phones and traditional computers are becoming less clear, one difference remains plain – cell phones are almost always on-hand and allow users to connect with an array of services and networks at almost any time and any place. The Pew Center's Internet and American Life Project suggests that college students are the most rapid adopters of cell phone technology and research is emerging which suggests high frequency cell phone use may be influencing their health and behavior. Thus, we investigated the relationships between total cell phone use ($N = 496$) and texting ($N = 490$) on Satisfaction with Life (SWL) in a large sample of college students. It was hypothesized that the relationship would be mediated by Academic Performance (GPA) and anxiety. Two separate path models indicated that the cell phone use and texting models had good overall fit. Cell phone use/texting was negatively related to GPA and positively related to anxiety; in turn, GPA was positively related to SWL while anxiety was negatively related to SWL. These findings add to the debate about student cell

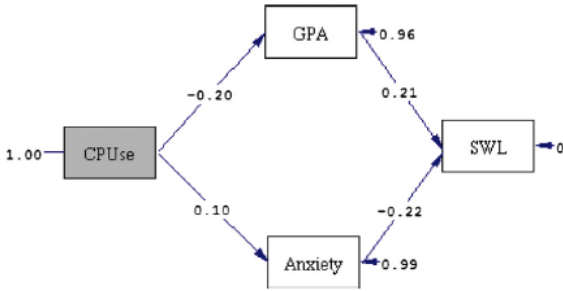

Fig. 2. Cell phone model with standardized coefficients.

Example: relationship of mouse and eye movement relate in web browsing

Exploring How Mouse Movements Relate to Eye Movements on Web Search Results Pages

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ABSTRACT

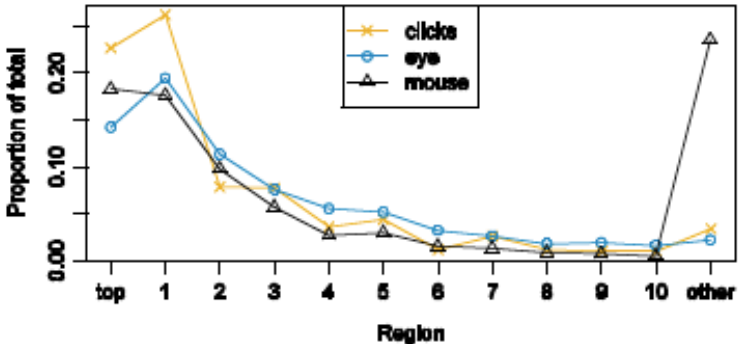
A mouse click is a proven indicator of a user's interest in a web search result. In this paper we explore the potential of a more subtle signal: mouse movements. We conducted a study where participants completed a range of tasks using Google, and we tracked both their eye movements and mouse movements. We discuss the relationship between these movements, and three different types of eye-mouse coordination patterns. We believe that mouse movements have most potential as a way to detect which results page elements the user has considered before deciding where to click.

client-side implementations – variety of data available.

Our goal in conducting this potential usefulness of tracki search results page – for e movements reflect eye mover pointer as a marker to help ther them make a decision about wh

Unlike this study, which focuse studies on the relationship be movements have been concer

Using the full set of regions, we were interested to know how likely it was, within a single visit, that when the user moved their mouse over a region, they also looked at it. Of regions that they covered with the mouse, a mean of 76.2% (s.d. 23.4) were also fixated on during the visit. Conversely, of the regions that the users fixated on during a single visit, a mean of 64.0% of those regions (s.d. 25.7) were also covered by the mouse.



Causal studies

- Assessing whether one thing is the cause of another
- Scientific advance
  - Seeking explanations for phenomena (beyond the patterns we observe)
  - Laws versus theories
- Design and engineering
  - Changing the world
  - Seeking evidence that our interventions (systems) have a desired effect
  - Understand cause-effect relationships in systems (parameter variation)
  - Understand effects of different conditions on a system

Causal studies: Evidence of desired effect

Observational and Experimental Investigation of Typing Behaviour using Virtual Keyboards on Mobile Devices

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ABSTRACT

With the rise of current smartphones, virtual keyboards for touchscreens became the dominant mobile text entry technique. We developed a typing game that records how users touch on the standard Android keyboard to investigate users' typing behaviour. 47,770,625 keystrokes from 72,945 installations have been collected by publishing the game. By visualizing the touch distribution we identified a systematic skew and derived a function that compensates this skew by shifting touch events. By updating the game we conduct an experiment that investigates the effect of shifting touch events, changing the keys' labels, and visualizing the touched position. Results based on 6,603,659 keystrokes and 13,013 installations show that visualizing the touched positions using a simple dot decreases the error rate of the Android keyboard by 18.3% but also decreases the speed by 5.2% with no positive effect on learnability. The Android keyboard outperforms the control condition but the constructed shift function further improves the performance by 2.2% and decreases the error rate by 9.1%. We argue that the shift function can improve existing keyboards at no costs.

While touchscreens and virtual keyboards have been studied for years, understanding users' touch behaviour remains challenging. Previous work usually studies the effect of single aspects, such as key size or keyboard layout, on the users' performance. Due to limited resources corresponding user studies are often conducted with a homogenous sample and a single device. Such studies usually try to seek a balance between internal validity (the extent to which variance is due to the test conditions) and external validity (the extent to which results are generalizable). Experimenters control most variables and conduct studies with a small number of participants in a lab (high internal and low external validity). Many results from related work are therefore based on the performance of male right-handed students from a technical discipline that live in the same region i.e. no equal gender split and mainly participants from the authors' institution.

In contrast to previous work, our aim is to observe and manipulate the touch behaviour of a diverse sample, a large number of devices, and various contexts. To collect the required large amount of keystrokes on a virtual keyboard we developed a mobile typing game. To attract a large number of participants

Figure 8. Keyboard that shows a red dot at the position where the user touches the screen after typing an 'f'.

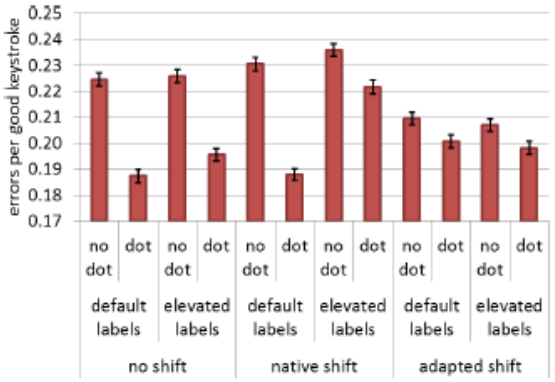
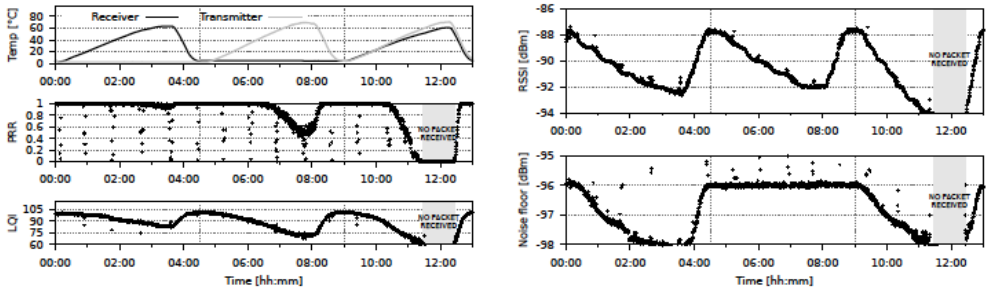


Figure 11. Average error rate assessed by dividing the number of keystrokes that are errors or compensate an error by the total number of keystrokes (error bars show standard error).

Causal studies:
Understanding the effect of different conditions

Hot Packets: A Systematic Evaluation of the Effect of Temperature on Low Power Wireless Transceivers

Carlo Alberto Boano[†*], Hjalmar Wennerström[§], Marco Antonio Zúñiga[¶], James Brown[‡], Chamath Keppitiyagama[♮], Felix Jonathan Oppermann[†], Utz Roedig[‡], Lars-Åke Nordén[§], Thiemo Voigt[♮§], and Kay Römer[†]



(a) PRR and LQI

(b) RSSI and Noise floor

Figure 4: Impact of temperature on the quality of links in our controlled testbed. We heat transmitter and receiver nodes separately first, and then both of them at the same time. When temperature increases, PRR, LQI, and RSSI decrease significantly, with the highest impact occurring when both nodes are heated at the same time. The periodic noise is due to a Wi-Fi access point beaconing in proximity of the testbed.

Summary

- Importance of language in research
- Types and properties of data and variables
- Types of studies and questions
- Design questions have associated knowledge questions

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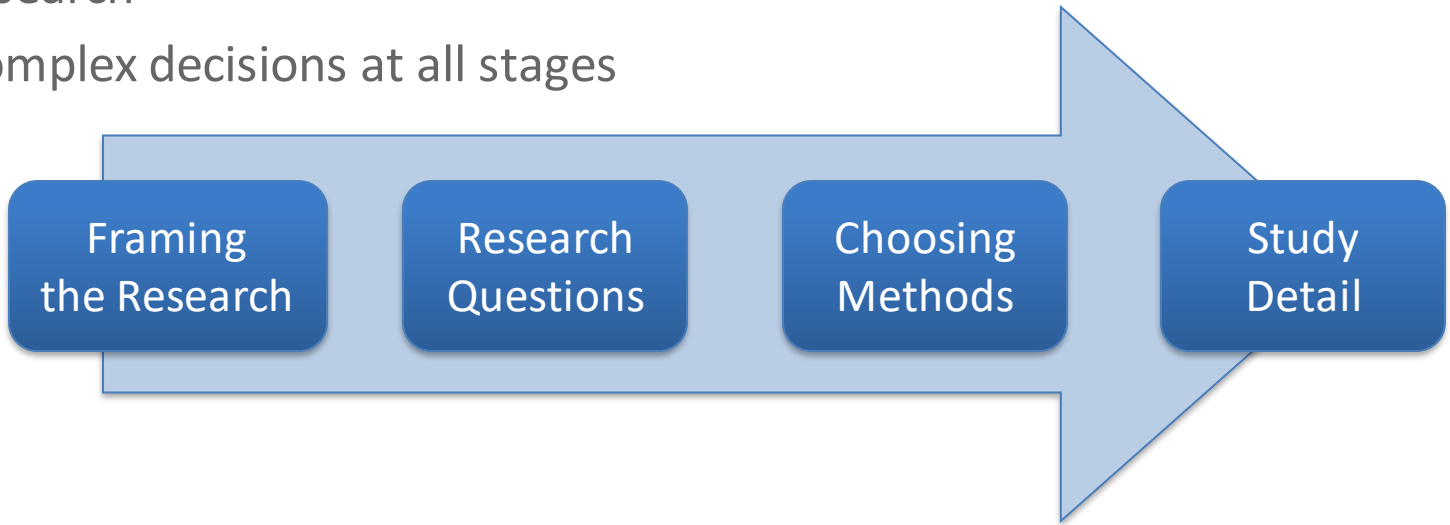
Framing Research Projects

What is research design?

- A structured approach to define a research project or study
- From figuring out what the problem is to a concrete plan for carrying out the research
- Complex decisions at all stages



Framing ???

https://bakerstreetpublishing.com/decisioncoaching/2015/06/01/what-are-the-3-most-important-project-framing-questions/

Framing a research project

- What is the research about?
- What is the research problem? Or what is the research opportunity?
- What do you want to do about it?
- What are your motivations?
- What assumptions are you making?
  - About the problem
  - About ways of addressing it
  - About the extent to which you aim to solve the problem

Understanding context and background

- The motivation and purpose of the research
- Relevant background
  - What has previous experience and/or research established?
  - What is the state of the art?
  - What are the key concepts, issues and ways of addressing them
- Assumptions
  - Any assumptions you are making
  - Viewpoints and beliefs from which you approach the problem

Understanding context and background

- Literature review
  - Not just “has anybody done this before”
  - Understanding the concepts and terminology of the problem domain
  - Identify apparently distant but actually relevant and even enabling concepts
  - Understanding different points of view
  - Capture state of the art
  - Identify gaps in knowledge

Defining the problem

- A clear problem statement is fundamental for research design
- A problem definition states the reason for the research
- Research can be motivated by very different kinds of problems
  - Social problems
  - Technical problems
  - Scientific problems
- Any of these become research problems when they require new knowledge
  - A problem statement should make clear what the gap in knowledge is

Sendhil Mullainathan' TED Talk

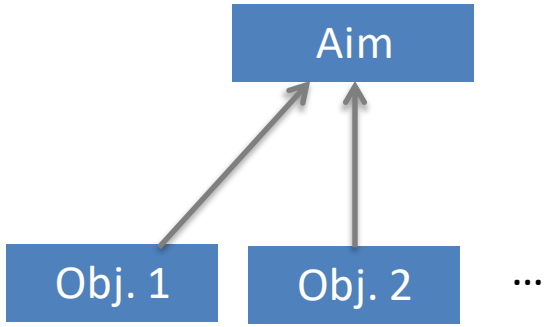
- https://www.ted.com/talks/sendhil_mullainathan#t-42807

Defining the problem

- Most problems are incremental
- Social real world problems
  - Most problems in the real world are never completely solved
  - The motivation is to improve a given situation
- Technical problems
  - Gaps in technology and how-to knowledge
  - Ideas for technical solutions that improve the state of the art
- Given a problem, there are choices about what to do

Defining aim and objectives

- Problem: the **reason** for the research
- Aim: the **purpose** of the research
  - What to do about the problem, e.g.
    - What particular issue to focus on
    - What particular idea to investigate
- Objectives: the **scope** of the research
  - Concrete objectives that are measurable
  - Each objective contributes to the aim
  - Each objective focuses on a well-defined aspect of the problem or aim
  - The set of objectives define what the project/study will cover



Focus and feasibility

- Problems and aims are typically bigger than what you can tackle
- Focus on something that is
  - Novel -> checked against state of the art
  - Worthwhile -> promising a relevant contribution
  - Feasible -> doable within given time and resources

Focus and feasibility

- Focus: making a research study more specific
  - achievable within limited time and resources
  - “understanding a little is better than not understanding a lot”
- Narrow down broad aims by using the six “W” questions
  - What you study
  - Where: location of study
  - When: duration of study, start and end
  - Who: which participants, stakeholders etc
  - Why: which purpose?
  - hoW: e.g., which technology will be used

Research Questions

- Research questions follow directly from objectives
- Formulating good questions is hard!
  - Questions are often too vague, or make assumptions
  - For any question, consider how it can operationalised
- Remember types of questions to ask:
  - Exploratory questions: existence, description, classification
  - Base-rate questions: describing frequency, distribution, processes
  - Relationship questions: examining co-occurrence, correlation
  - Causality questions: examining causes and effects
  - Design questions: examining how-to problems

Exercise 1: Aims -> Objectives -> Questions

- Consider the following scenario
  - Problem: children in the UK smoking
  - Aim: to gain sufficient insight into the problem in order to inform policy
  - Obj. 1: To understand how widespread smoking among UK children is
  - Obj. 2: To identify key issues of relevance for tackling the problem
- Think about which questions would be relevant here
- Think about how those questions could be studied
- Work in groups, 5 minutes, take notes

The Literature

- What's the literature
- What's a literature review?
- Why do one, and when?

What is “The Literature”?

- Primary sources
  - Where a new piece of knowledge was first reported
  - Written by researchers for researchers
  - Admission control: publication only after peer-review
  - Seal of approval by the “research community”

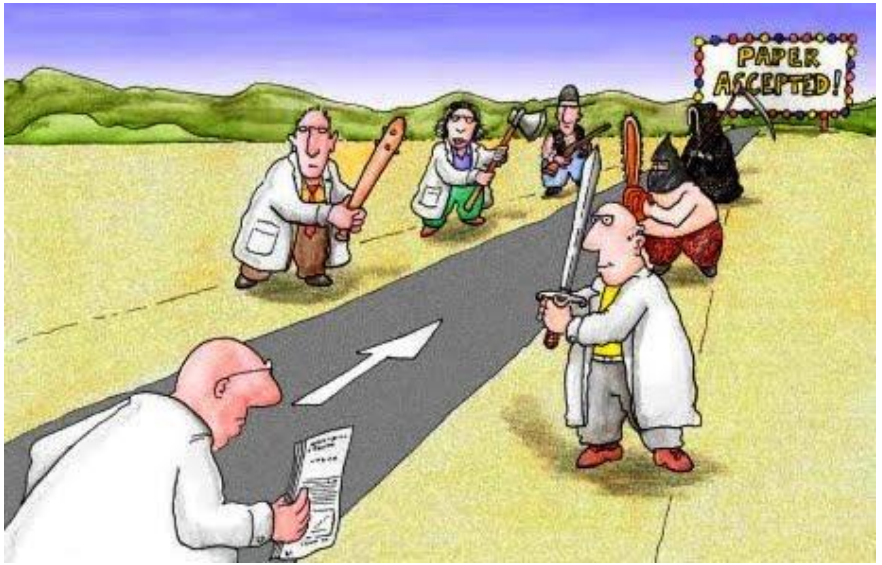


Image credit: Nick of http://www.lab-initio.com/

Scholarly Peer-review

- Peer-review
  - Subjecting an author's research and ideas to the scrutiny of others who are experts in the same field
  - Gate-keeping and revision before *archival publication*
  - Aims to maintain standards, and provide credibility
- Limitations
  - Peer review standards vary hugely
  - There is never enough real expertise available to review all the research
  - There are always more journals and conferences than good research

What is not “the Literature”?

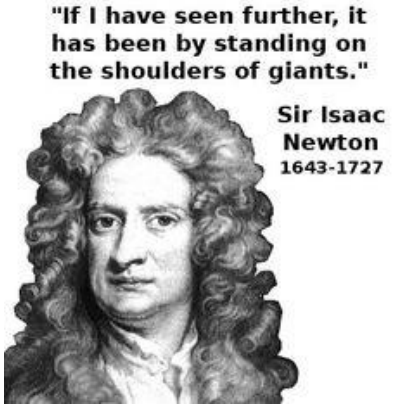
- Secondary sources
  - Reference sources that might help in finding literature
  - Indirect reports of new research
  - Textbooks
- Controversial sources
  - Wikipedia, blogposts, web sites
  - Popular science magazines
  - …

What's a literature review

- Uses primary literature as its data (= reports of original research)
  - Original research and data can be of any type (empirical, theoretical, etc)
  - Literature review itself does not report new primary research
- Summarises, evaluates and/or integrates the content of primary research
  - More than a list of separate reviews of individual articles
  - Should compare and relate different contributions/findings
  - Has to have a focus and should be comprehensive
- Discussing all of the more significant literature for a given focus

Why do a literature review

- “Standing on the shoulder of giants”
- Poor motivation (but common)
  - Looking for faults in other work, to justify one’s own research
  - Focusing only on what others have not done
- Better motivation
  - Looking for insights from other work to build on in one’s own research
  - Focusing on what others actually have done and critically assessing it



For what purpose and when?

- Find out what to do – before your research starts
  - Seek inspiration
  - Identify gaps in the literature
- Find out where to start – first step in your research
  - Identify what exactly has already been achieved, or established
  - Identify information, methods, ideas that may be relevant for your work
  - Avoid reinventing the wheel
- Put your work into perspective – final step in your research
  - Relate what you have achieved (or found out) to existing knowledge

Where to present a literature review

- Standalone, as a contribution to understanding in the field
  - Survey / comprehensive overview
  - Systematic literature review concerning a specific question
- Part of a report
  - Background discussion in proposals
    - Describing the state of the art as baseline for the proposed research
  - Background chapter in project reports, theses and dissertations
    - Explaining prior work
    - Essential for demonstrating progress beyond the state of the art
  - Related work discussion in research articles

What is a *Systematic* Literature Review

- Literature review ("survey")
  - Generic aim: provide a comprehensive overview on a topic of interest
  - Establish what's been done / what is known
  - Approach: include all of the "more significant" literature
- Systematic literature review
  - Meta-analysis
  - Specific aim: focus on a research question
  - Aspiring to provide evidence (of something), not just an overview
  - Approach: systematic identification, selection and analysis of literature

Literature survey: Example

Peer-to-Peer Architectures for Massively Multiplayer Online Games: A Survey

AMIR YAHYAVI and BETTINA KEMME, McGill University

Scalability, fast response time, and low cost are of utmost importance in designing a successful massively multiplayer online game. The underlying architecture plays an important role in meeting these conditions. Peer-to-peer architectures, due to their distributed and collaborative nature, have low infrastructure costs and can achieve high scalability. They can also achieve fast response times by creating direct connections between players. However, these architectures face many challenges. Distributing a game among peers makes maintaining control over the game more complex. Peer-to-peer architectures also tend to be vulnerable to churn and cheating. Moreover, different genres of games have different requirements that should be met by the unde
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Table II. Comparison of Representatives of Different P2P Architectures (N/A: not applicable)

Architecture	Type	Network Overlay	Interest Management	Replication & Consistency Control
SimMud [Knutsson et al. 2004]	Structured	DHT: Pastry + AL Multicast: Scribe	Static Regions: Rectangular Cells	Primary Copy: Region Controller
N-Trees [GauthierDickey et al. 2005]	Structured	DHT: Pastry + AL Multicast: N-trees	Nested Regions (scopes) + Scoped events: Grid Cells	Primary Copy: Region Controller
Colyseus [Bharambe et al. 2006]	Structured	DHT: Mercury + Direct	Dynamic Rectangular Cells + Prefetching objects	Primary Copy: Each Peer + Proactive Replication + Soft-State Storage
P2P Second Life	Structured	DHT (Kad)	Dynamic:	Primary Copy:

- Many P2P architectures published
  - But hard to compare as terminology isn't consistent
- Survey structure
  - Defines terminology
  - Explains common ground
  - Identifies categories of architectures
  - Compares representatives
  - Bibliography: ~200 references

Literature Surveys in Computing

Lancaster University

- What survey's are good for
  - Capturing all significant work/results achieved until then
    - Save others the search, filtering and collation
  - Providing structure: common terms, categories, classifications, taxonomies
    - Help others understand a topic more systematically
- Use in computer science
  - Some journals are dedicated to publishing surveys
    - e.g. ACM Computing Surveys (CSUR)
  - "Chapter 2" in many MSc and PhD dissertations
  - Great resource for getting started in a new topic area

Systematic Review: Example

The global prevalence of dementia: A systematic review and metaanalysis

Martin Prince, Renata Bryce, Emiliano Albanese, Anders Wimo, Wagner Ribeiro, Cleusa P. Ferri

[4] are summarized in Table E1. We conducted a systematic review of the world literature on the prevalence of dementia with PubMed/Medline up to March 2009 using the search terms ("Dementia"[Mesh] AND (("Prevalence"[Mesh]) OR "Epidemiology"[Mesh])). We sought and included population-based studies of the prevalence of dementia among people aged ≥60 years of age (according to the Diagnostic and *Statistical Manual of Mental Disorders, fourth edition* [DSM-IV] or the *International Classification of Diseases, tenth edition* [ICD-10] criteria, or similar clinical criteria), for which the fieldwork started on or after January 1, 1980. The exclusion crite

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Table 1

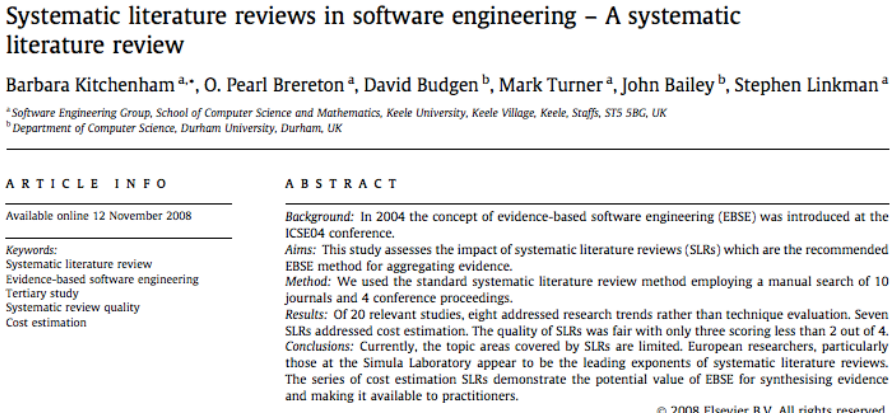
Study characteristics, by region (for those regions within which meta-analyses were conducte

	Europe	North America	Latin America and Caribbean	Asia Pacific High Income	Australasia	East Asia	South Asia
Number of studies*	51	13	15	20	4	34	7
Year of research							
1980–1989	13 (26%)	3 (23%)	0	7 (35%)	2 (50%)	5 (15%)	0
1990–1999	34 (67%)	9 (69%)	3 (20%)	10 (50%)	1 (25%)	25 (74%)	4 (57%)

- Research question: global prevalence of dementia
  - Meta-analysis of published studies
- Method
  - Specific search terms in PubMed
  - Specific criteria for exclusion
    - Excluding studies with inadequate sampling, etc
- Search yielded 2017 articles
  - 135 eligible for analysis

Systematic Review in Computing

- What systematic reviews are good for
  - Answering questions for which the evidence can be compiled by reviewing previous studies
  - They provide new evidence, not "just" an overview and structure
- Use in computer science
  - Gaining traction as research method in software engineering
- **Main threat to validity in SR?**
- **Why are SRs not as common in computing as in medicine?**



Systematic literature reviews in software engineering – A systematic literature review

Barbara Kitchenham [a,*], O. Pearl Brereton [a], David Budgen [b], Mark Turner [a], John Bailey [b], Stephen Linkman [a]

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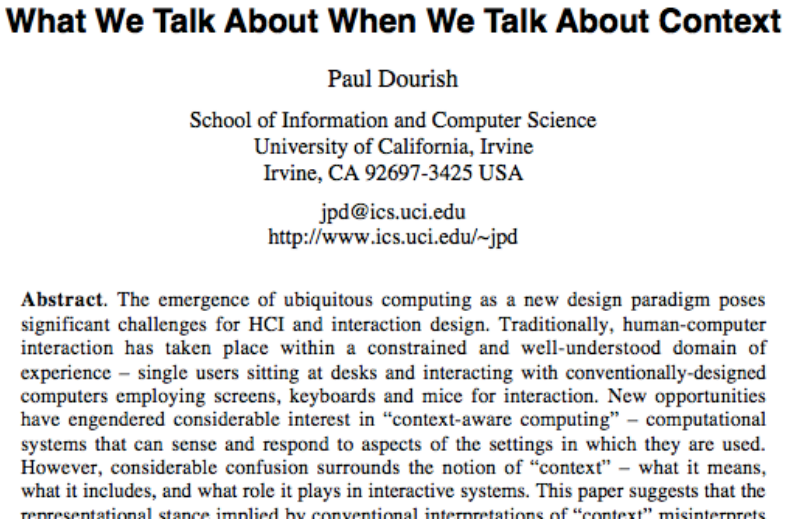
ABSTRACT

Background: In 2004 the concept of evidence-based software engineering (EBSE) was introduced at the ICSE04 conference.
Aims: This study assesses the impact of systematic literature reviews (SLRs) which are the recommended EBSE method for aggregating evidence.
Method: We used the standard systematic literature review method employing a manual search of 10 journals and 4 conference proceedings.
Results: Of 20 relevant studies, eight addressed research trends rather than technique evaluation. Seven SLRs addressed cost estimation. The quality of SLRs was fair with only three scoring less than 2 out of 4.
Conclusions: Currently, the topic areas covered by SLRs are limited. European researchers, particularly those at the Simula Laboratory appear to be the leading exponents of systematic literature reviews. The series of cost estimation SLRs demonstrate the potential value of EBSE for synthesising evidence and making it available to practitioners.

Literature review - Types

- Integrative
  - Drawing conclusions from many different studies
- Methodological
  - Examining different methods/systems that have been applied to a problem
- Theoretical
  - Reviewing theories and how certain phenomena are conceptualised



What We Talk About When We Talk About Context

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Abstract. The emergence of ubiquitous computing as a new design paradigm poses significant challenges for HCI and interaction design. Traditionally, human-computer interaction has taken place within a constrained and well-understood domain of experience – single users sitting at desks and interacting with conventionally-designed computers employing screens, keyboards and mice for interaction. New opportunities have engendered considerable interest in "context-aware computing" – computational systems that can sense and respond to aspects of the settings in which they are used. However, considerable confusion surrounds the notion of "context" – what it means, what it includes, and what role it plays in interactive systems. This paper suggests that the representational stance implied by conventional interpretations of "context" misinterprets

Framing a literature review

- Formulating the problem
  - As with any research, be clear about the purpose of the review
- Topic and scope
  - Topic doesn't need to be too specific to start with (exploratory review)
  - But make sure to develop focus (narrow the scope)
  - Be prepared to alter scope depending on what you find
- Breadth versus depth
  - Range of subjects covered
  - Level of detail at which each instance is reviewed

How to search literature

- Use resources such as Google Scholar, ACM DL, IEEE Explore, …
- A search heuristic for a comprehensive survey
  1. Start with any paper relevant to your topic
  2. Follow references, look up those papers' references
  3. Papers that are referenced most are probably the "real literature"
  4. Use "cited by" to look up work that followed
- Systematic review: define a rigorous search protocol
- Citations can help identify key literature
  - But are not necessarily a measure of quality or importance

Critical analysis of literature

- Collation: what to keep?
- Critical analysis of the available literature
  - Is it going to be useful?
    - Relevant for your purpose? Significant in the information provided?
  - Is it any good?
    - Quality of the research reported; validity and trustworthiness
- Keep track of everything
  - The literature is your research data; keep full text copies
  - Use a system to manage your bibliography, and annotate it your own paper summaries

Synthesis of literature

- Structuring by concepts and themes
  - Synthesise, instead of reviewing instances one by one.
- Develop a clear framework for your analysis
  - What are your units of analysis
  - What data to extract from individual articles
- Might only emerge in the process of the review
  - Categories for what you are reviewing -> Classifications
  - Relationships between categories -> Taxonomies
  - Properties and attributes of your units of analysis -> qualitative and quantitative comparison

Writing up a literature review

- Introduction
  - Define topic: make it crystal-clear what the purpose and focus is
  - Define terms: literature isn't consistent in use of terms and you have to make clear how you use terms for the purposes of the review
  - Introduce concepts around which the review is organised, and the parameters you use in your analysis
- The review itself
  - Find a logical structure, e.g. by themes, concepts, chronologically, …
- Discussion and conclusion
  - Overarching insights from the review, e.g. about open questions

Avoid common problems

- Don’t just produce an annotated bibliography
  - Discuss themes and concepts
  - Reference many sources simultaneously
- You are reviewing, not summarising
  - Report on data extracted from reviewed literature, not on the wider context of that data (unless it is relevant for your analysis)
    - What have others found is more relevant than what they have done
  - If the reader wants to know more, they can follow your reference

Literature review

- Questions?
- Discussion points?

Coursework Assignment

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- Watch Sendhil Mullainathan's TED Talk on youtube
  - https://www.ted.com/talks/sendhil_mullainathan#t-42807
- Read "Selecting Empirical Methods for Software Engineering Research" by Steve Easterbrook, Janice Singer, Margaret-Anne Storey, Daniela Damian
  - www.cs.toronto.edu/~sme/papers/2007/SelectingEmpiricalMethods.pdf
- Quiz
  - 3 random questions reflecting on the above material (and what we covered in class this morning)
  - 3 random questions on material covered this afternoon