Human-Computer Interaction

Lecture 8: Usability evaluation methods

Different kinds of system evaluation/research

- Analytic/Empirical
  - ‘Analytic’ means reasoning and working by ***analysis***
  - ‘Empirical’ means making ***observations*** or ***measurements***
- Formative/Summative
  - Formative research (earlier in a project) evaluates & refines ***ideas***
  - Summative research (later in a project) tests & evaluates ***systems***
- Qualitative/Quantitative
  - Qualitative data involves ***words*** (or pictures), and can provides broad / detailed information about a small number of users and their context.
  - Quantitative data involves ***numbers***, and can be used to compare data from larger numbers of users, or measure some specific aspect of their behaviour.

Cognitive Walkthrough

Formative Analytic Qualitative

Can be used earlier in project

No measurement or observation

Descriptive, not numerical

From cognitive theory of exploratory learning

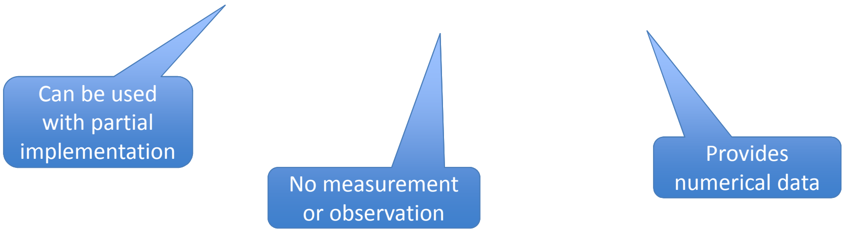
- User sets a ***goal*** to be accomplished, in terms of the expected system capabilities.
- User searches interface for currently available ***actions***.
- User ***selects*** the action that seems likely to make progress toward the goal.
- User ***performs*** the selected action and ***evaluates*** the feedback given by the system, looking for evidence that progress has been made.
  - The user learns what to do in future by observing what the system does

Evaluation procedure

- Manually simulate an (*imaginary*) user carrying out the stages of the model.
  - relies on knowing enough about this person to anticipate their prior knowledge / mental model.
- Evaluators move through task, telling a *story* about why user would choose each action.
- Evaluate the story according to:
  - user's current *goal*.
  - *accessibility* of correct control.
  - quality of *match* between label and goal.
  - *feedback* after the action.

GOMS

Formative Analytic Quantitative



Can be used with partial implementation

No measurement or observation

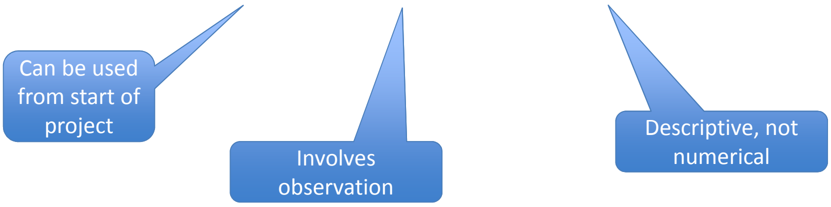
Provides numerical data

GOMS: Goals, Operators, Methods, Selection

- Goals: what is the user trying to do?
- Operators: what actions must they take?
  - **H**ome hands on keyboard or mouse
  - **K**ey press & release (tapping keyboard or mouse button)
  - **P**oint using mouse/lightpen etc
- Methods: what have they learned in the past?
- Selection: how will they choose what to do?
  - **M**ental preparation

Interviews and Ethnographic Studies

Formative Empirical Qualitative



Can be used from start of project

Involves observation

Descriptive, not numerical

Structured interviews

- Additional to requirements definition meetings.
- Encourage participation from a range of users.
- *Structured* in order to:
  - collect data into common framework
  - ensure all important aspects covered
- Newman & Lamming’s proposed structure:
  - *activities*, *methods* and *connections*
  - *measures*, *exceptions* and domain *knowledge*
- Semi-structured interviews:
  - Ask further questions to probe topics of interest

Observational task analysis

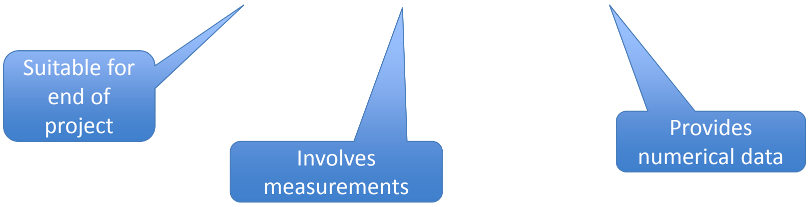
- Less intrusive than interviews
- Potentially more objective
- Inspired huge debate between cognitive and sociological views of HCI: see Lucy Suchman
- Harder work:
  - transcription from video protocol
    - relative duration of sub-tasks
    - transitions between sub-tasks
    - interruptions of tasks
  - alternatively, transcription from audio recording

Ethnographic field studies

- Field observation to understand users and context
- Division of labour and its coordination
- Plans and procedures
  - When do they succeed and fail?
- Where paperwork meets computer work
- Local knowledge and everyday skills
- Spatial and temporal organisation
- Organisational memory
  - How do people learn to do their work?
  - Do formal methods match reality?
- See Beyer & Holtzblatt, *Contextual Design*

Controlled Experiments

Summative Empirical Quantitative



Suitable for end of project

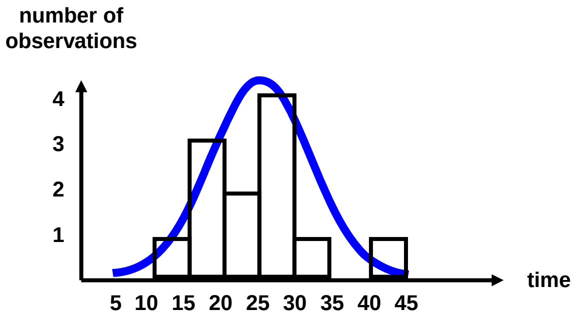
Involves measurements

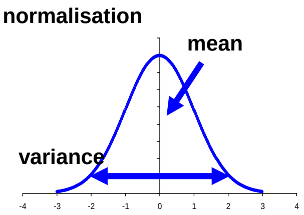
Provides numerical data

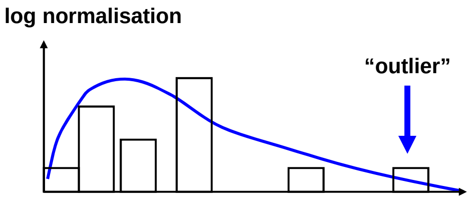
Controlled experiments

- Based on a number of observations:
  - How *long* did Fred take to order a CD from Amazon?
  - How many *errors* did he make?
- But every observation is different.
- So we compare averages:
  - over a number of trials
  - over a range of people (experimental participants)
- Results often have a normal distribution

(statistics: histograms & distributions)

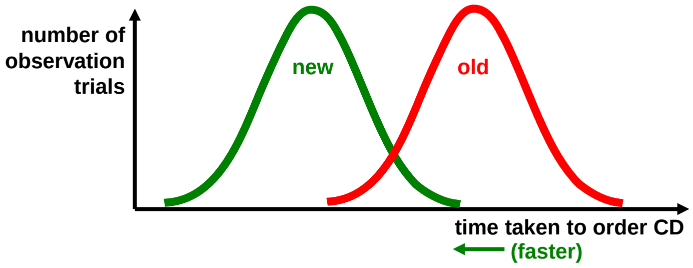






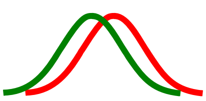
Experimental treatments

- A *treatment* is some modification that we expect to have an effect on usability:
  - How long does Fred take to order a CD using this great new interface, compared to the crummy old one?
  - Expected answer: *usually* faster, but not *always*

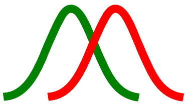


Hypothesis testing

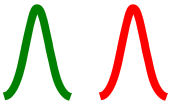
- *Null hypothesis:*
  - What is the probability that this amount of difference in means could be random variation between samples?
  - Hopefully very low ($p < 0.01$, or 1%)
  - Use a statistical *significance test*, such as the *t-test*.



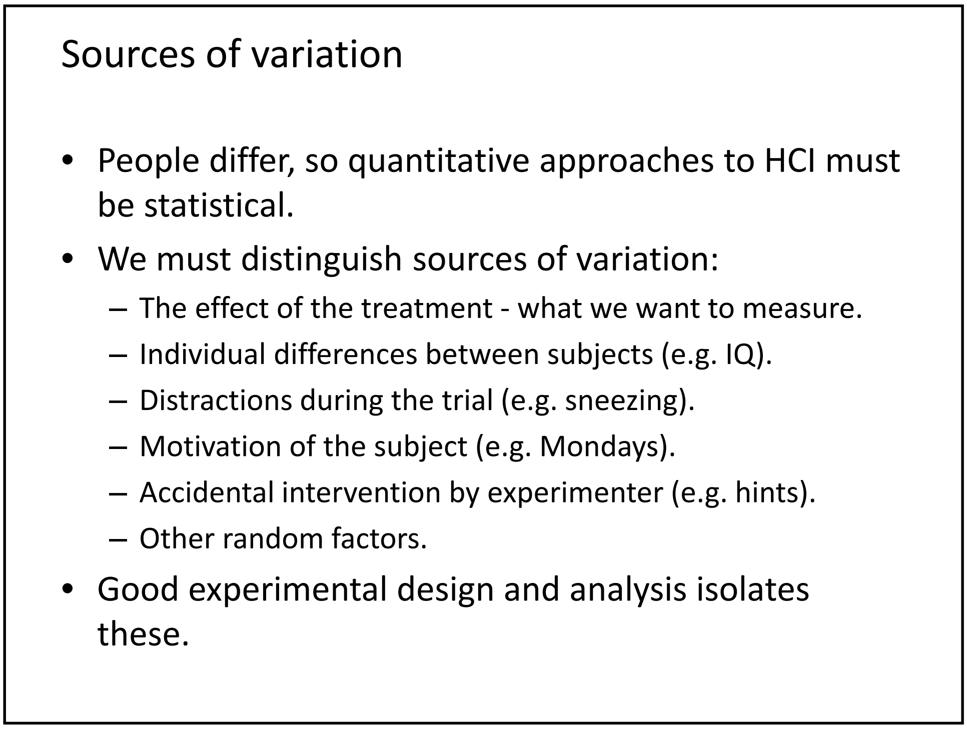
only random variation observed



observed effect probably does result from treatment

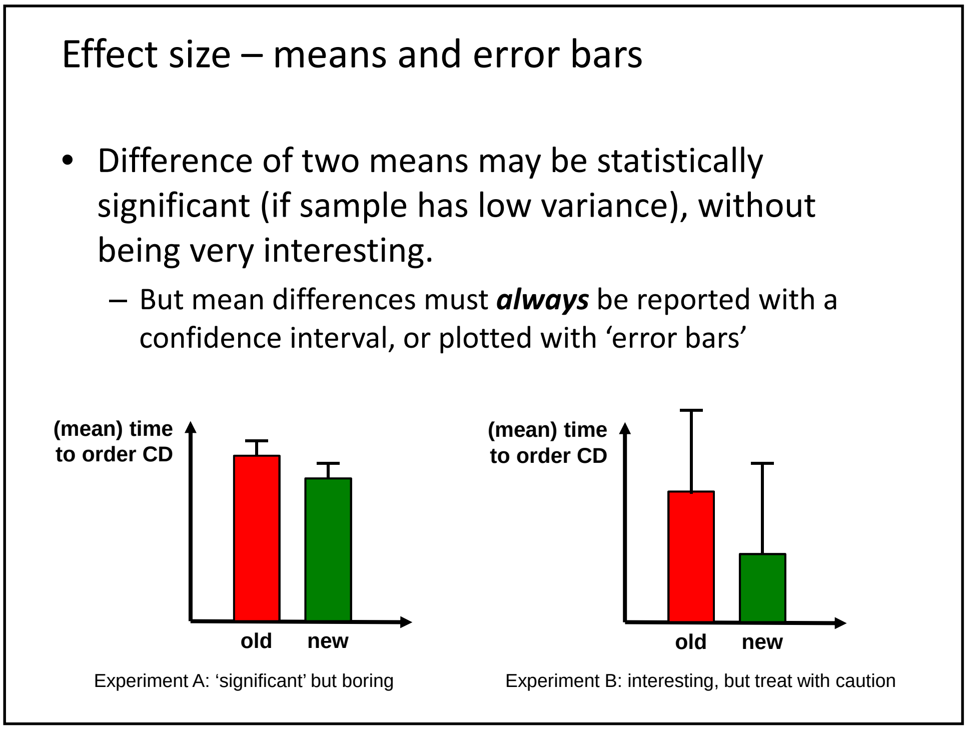


very significant effect of treatment



Sources of variation

- People differ, so quantitative approaches to HCI must be statistical.
- We must distinguish sources of variation:
  - The effect of the treatment - what we want to measure.
  - Individual differences between subjects (e.g. IQ).
  - Distractions during the trial (e.g. sneezing).
  - Motivation of the subject (e.g. Mondays).
  - Accidental intervention by experimenter (e.g. hints).
  - Other random factors.
- Good experimental design and analysis isolates these.

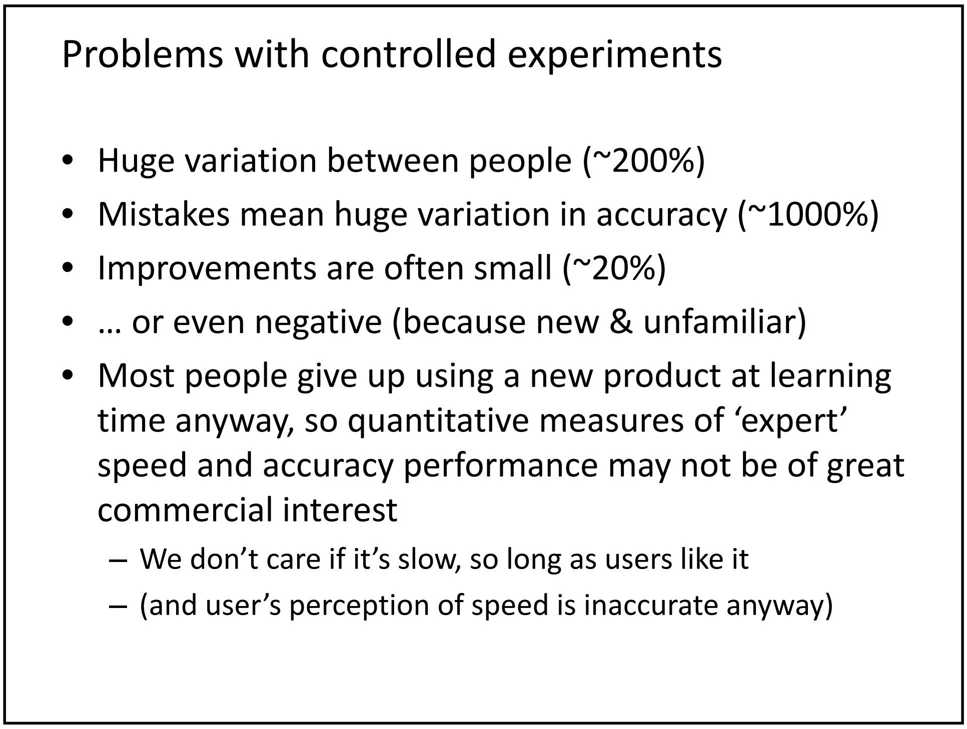


Effect size – means and error bars

- Difference of two means may be statistically significant (if sample has low variance), without being very interesting.
  - But mean differences must ***always*** be reported with a confidence interval, or plotted with ‘error bars’

Experiment A: ‘significant’ but boring

Experiment B: interesting, but treat with caution



Problems with controlled experiments

- Huge variation between people (~200%)
- Mistakes mean huge variation in accuracy (~1000%)
- Improvements are often small (~20%)
- … or even negative (because new & unfamiliar)
- Most people give up using a new product at learning time anyway, so quantitative measures of ‘expert’ speed and accuracy performance may not be of great commercial interest
  - We don’t care if it’s slow, so long as users like it
  - (and user’s perception of speed is inaccurate anyway)

Surveys and Questionnaires

Self-report measures

Surveys and questionnaires

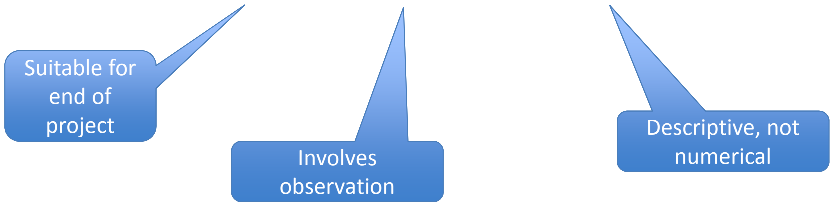
- Standardised *psychometric instruments* can be used
  - To evaluate mental states such as fatigue, stress, confusion
  - To assess individual differences (IQ, introversion …)
- Alternatively, questionnaires can be used to collect *subjective* or *self-report* evaluation from users
  - as in market research / opinion polls
  - ‘I like this system’ (and my friend who made it)
  - ‘I found it intuitive’ (and I like my friend)
- This kind of data can be of limited value
  - Can be biased, and self-report is often inaccurate anyway
  - It’s hard to design questionnaires to avoid these problems

Questionnaire design

- *Open* questions …
  - Capture richer qualitative information
  - But require a *coding frame* to structure & compare data
- *Closed* questions …
  - Yes/No or *Likert* scale (opinion from 1 to 5)
  - Quantitative data easier to compare, but limited insight
- Collecting survey data via interviews gives more insight but questionnaires are faster
  - Can collect data from a larger sample
  - Remember to test questionnaires with a pilot study, as it’s easier to get them wrong than with interviews

Product Field Testing

Summative Empirical Qualitative


Suitable for end of project

Involves observation

Descriptive, not numerical

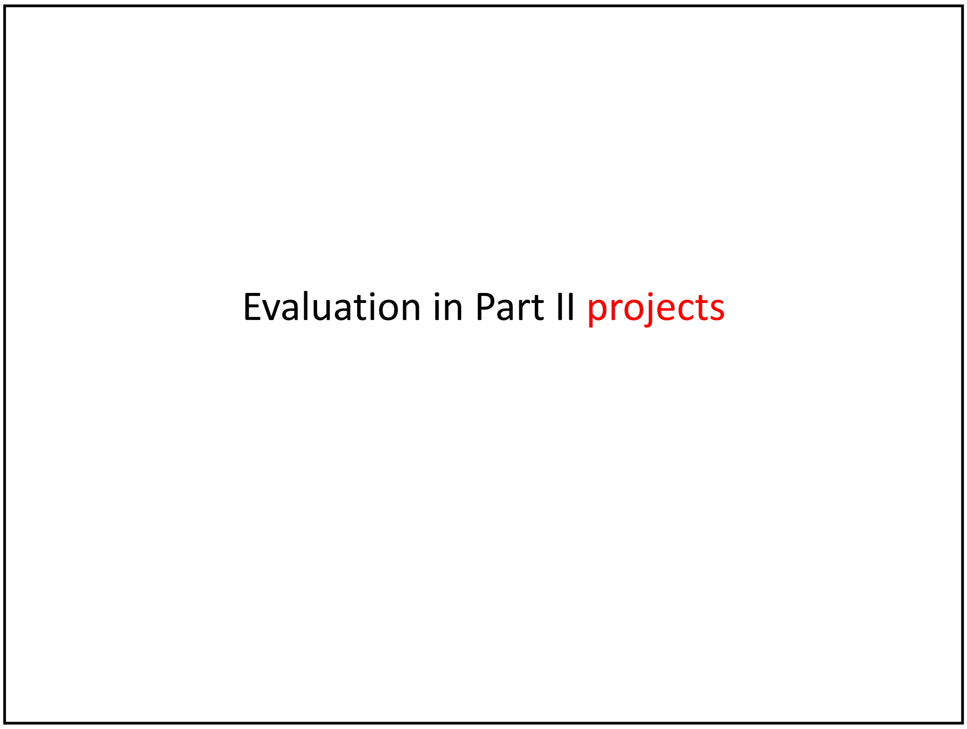
Product field testing

- Brings advantages of task analysis/ethnography to assessment and testing phases of product cycle.
- Case study: Intuit Inc.'s Quicken product
  - originally based on interviews and observation
  - follow-me-home programme after product release:
    - random selection of shrink-wrap buyers;
    - observation while reading manuals, installing, using.
  - Quicken success was attributed to the programme:
    - survived predatory competition from Microsoft Money
    - later valued at $15 billion.

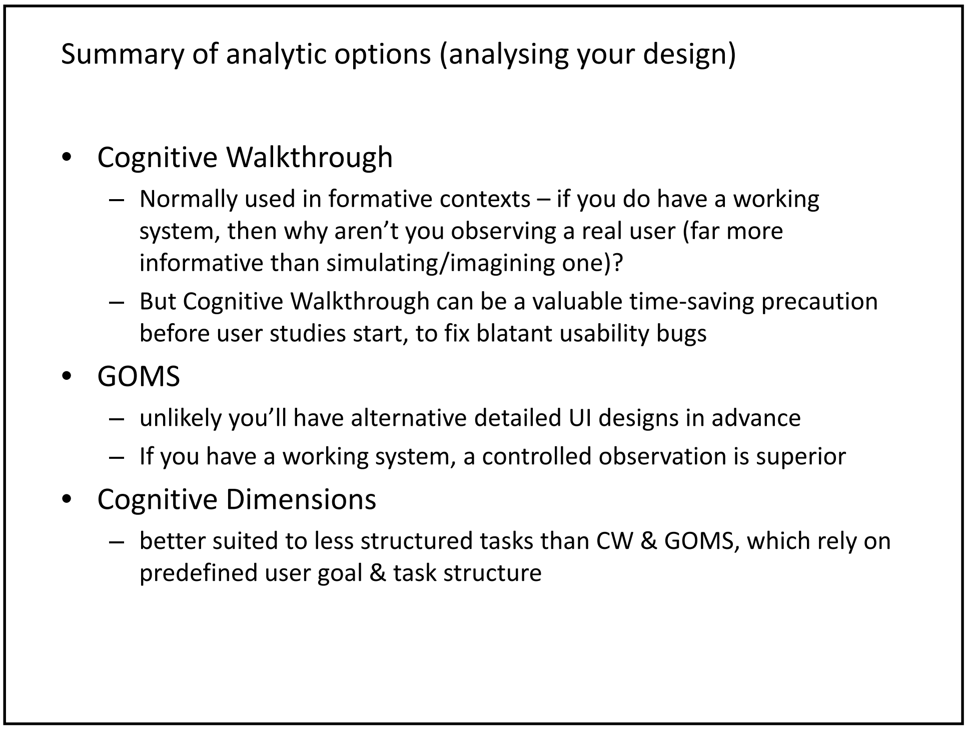
Non-Evaluation

Bad evaluation techniques

- Purely *affective* reports: 20 subjects answered the question “Do you like this nice new user interface more than that ugly old one?”
    - Apparently empirical/quantitative
    - But probably biased – if friends or trying to please
- No testing at all: “It was deemed that more colours should be used in order to increase usability.”
    - Apparently formative/analytic
    - But subjective – since the author is the subject
- Introspective reports made by a single subject (often the programmer or project manager): “I find it far more intuitive to do it this way, and the users will too.”
    - Apparently analytic/qualitative
    - Both biased and subjective

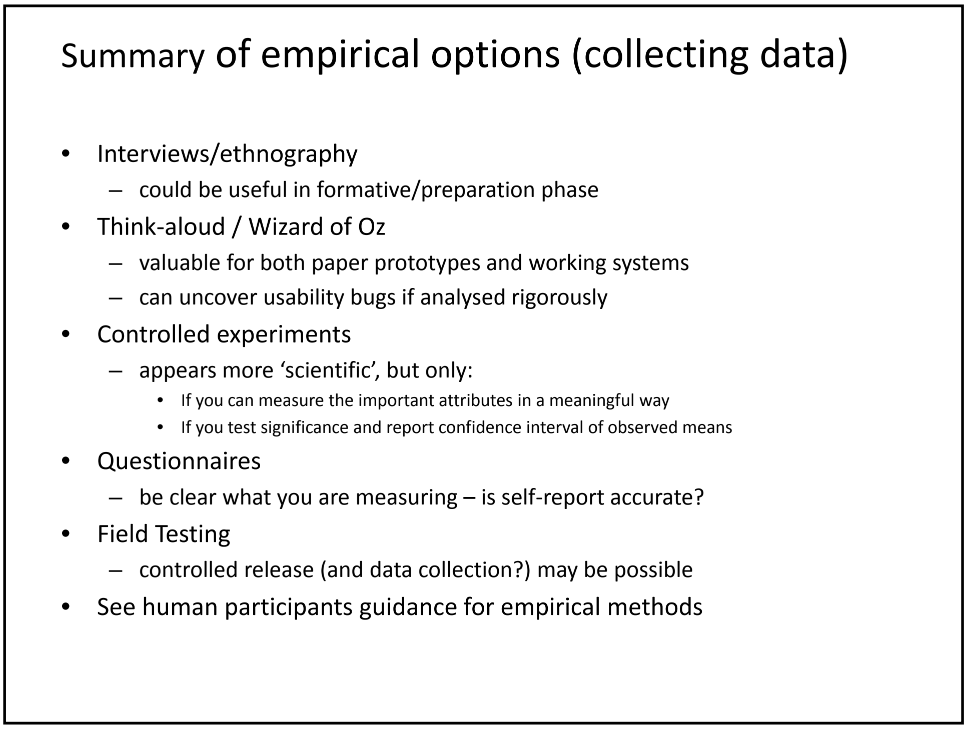


Evaluation in Part II projects



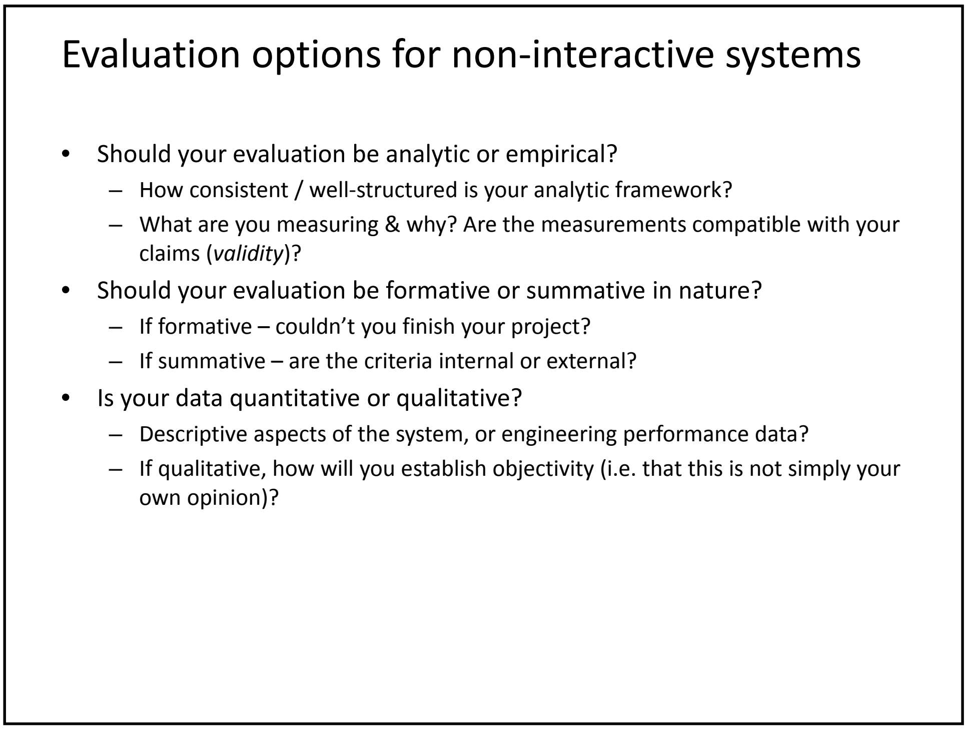
Summary of analytic options (analysing your design)

- Cognitive Walkthrough
  - Normally used in formative contexts – if you do have a working system, then why aren’t you observing a real user (far more informative than simulating/imagining one)?
  - But Cognitive Walkthrough can be a valuable time-saving precaution before user studies start, to fix blatant usability bugs
- GOMS
  - unlikely you’ll have alternative detailed UI designs in advance
  - If you have a working system, a controlled observation is superior
- Cognitive Dimensions
  - better suited to less structured tasks than CW & GOMS, which rely on predefined user goal & task structure



Summary of empirical options (collecting data)

- Interviews/ethnography
  - could be useful in formative/preparation phase
- Think-aloud / Wizard of Oz
  - valuable for both paper prototypes and working systems
  - can uncover usability bugs if analysed rigorously
- Controlled experiments
  - appears more ‘scientific’, but only:
    - If you can measure the important attributes in a meaningful way
    - If you test significance and report confidence interval of observed means
- Questionnaires
  - be clear what you are measuring – is self-report accurate?
- Field Testing
  - controlled release (and data collection?) may be possible
- See human participants guidance for empirical methods



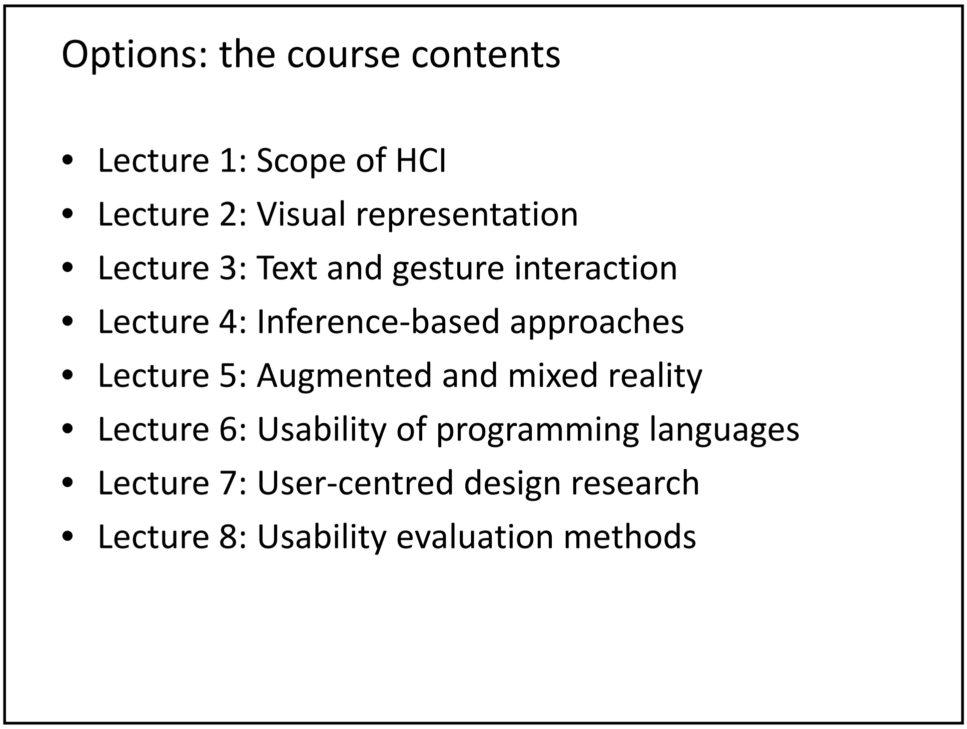
Evaluation options for non-interactive systems

- Should your evaluation be analytic or empirical?
  - How consistent / well-structured is your analytic framework?
  - What are you measuring & why? Are the measurements compatible with your claims (*validity*)?
- Should your evaluation be formative or summative in nature?
  - If formative – couldn’t you finish your project?
  - If summative – are the criteria internal or external?
- Is your data quantitative or qualitative?
  - Descriptive aspects of the system, or engineering performance data?
  - If qualitative, how will you establish objectivity (i.e. that this is not simply your own opinion)?

Evaluating students’ knowledge of HCI

2013 votes on course objectives

Learn interesting stuff about humans	20
Prepare for professional life	7
See cool toys	9
Find an alternative perspective on CS	9
Take an opportunity to be more creative	6
Get easy marks in final exam	14



Options: the course contents

- Lecture 1: Scope of HCI
- Lecture 2: Visual representation
- Lecture 3: Text and gesture interaction
- Lecture 4: Inference-based approaches
- Lecture 5: Augmented and mixed reality
- Lecture 6: Usability of programming languages
- Lecture 7: User-centred design research
- Lecture 8: Usability evaluation methods