The Need for an Interaction Cost Model

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Research Goals

- Adaptive *customization* for users
- Solution requirements:
  - Reduce user effort
  - Increase ease of use
  - Account for existing HCI factors
  - Explain/adapt to individual preferences
  - Optimize sequential tradeoffs

Decision-Theoretic Customization

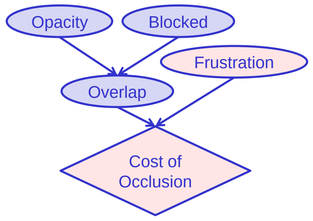
- Models noise and uncertainty
- Evaluates action's costs and benefits
- $\text{Utility}_{action} = w_1\text{utility}_{factor_1} + w_2\text{utility}_{factor_2} + \ldots$
- Each interaction factor has:
  - **Objective value**
  - Subjective utility

Relevant Interaction Factors

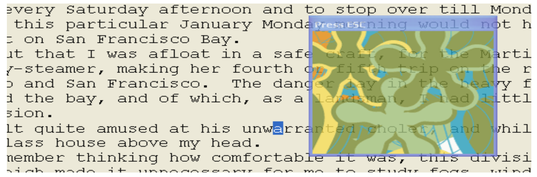
- Many potential costs

Adaptive Actions	Savings	Processing	Occlusion	Bloat	Disruption	Interruption
AUTO	X					X
TOOLBAR	X	X	X			X
ADD	X			X	X	X
HIDE	X			X	X	X
MOVE	X				X	X
HINT	X	X	X			X
ASK	X	X	X			X

Model of Occlusion



Experiment

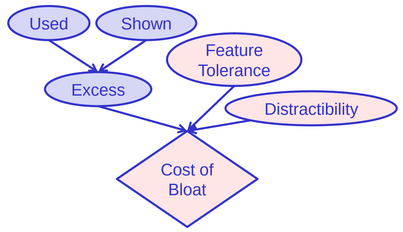


- Learn objective value ***Overlap***
- Variables (of the occluding dialog box):
  - Direction
  - Size
  - *Opacity*
  - Proximity
  - Intersection (area *blocked*)
- Measured task completion time
- Total 12 participants

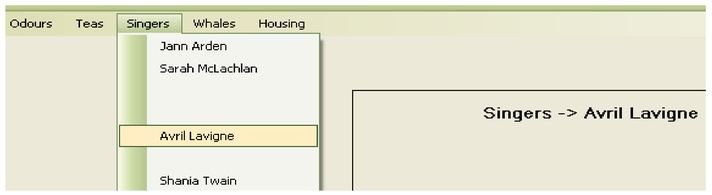
Analysis & Results

- Factor analysis, ANOVA, F-test
- Overlap = f(Blocked,Opacity)
  - Blocked=0:
    - Overlap = constant
  - Blocked=1:
    - Cubic in Opacity, for half of the users
    - Linear in Opacity, for remaining users

Model of Bloat



Experiment



- Learn objective value ***Excess***
- Variables:
  - Number menu items *Shown*
  - Number menu items *Used*
- *Unused* = Shown – Used
- Measured task completion time
- Total 12 participants

Analysis & Results

- ANOVA, F-test
- Excess = f(Unused)
  - Linear, for most users
  - Quadratic, for 1 user
  - Cubic, for 1 user

Simulations

- Markov decision process (MDP)
- Adaptive menu layout
- Actions: add or delete menu item
- Bloat = f(Excess, Tolerance, Distractibility)
- Savings = f(Quality, Frustration, Neediness, Distractibility, Independence)
- Utility = w_1Bloat + w_2Savings

Results

- Effect of bloat:

Distractibility	Tolerance	Shown	Policy
Low/medium	Feature-keen	Any	Add
High	Feature-keen	Few	Add
Low	Feature-shy	Many	Delete

- Most receptive user:

Distractibility	Tolerance	Shown	Policy
Low	Keen/shy	Any	Add
Medium/high	Feature-keen	Any	Add

- Least receptive user:

Distractibility	Tolerance	Shown	Policy
Low	Feature-keen	Any	Add
Low	Feature-shy	Many	Delete
Medium	Feature-shy	Many	Delete

Contributions

- Decision-theoretic framework for adaptive interfaces
- Formal model for interaction costs
- Models individual differences
- Simulation as proof of concept
- Usability evaluation next

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