When (ish) is my bus?

user-centered visualizations of uncertainty in everyday, mobile predictive systems


Sanne Willems, reading group Sept 12th
How to convey uncertainty of transit predictions?

• **current:**
  • point estimates
  • uncertainty ignored
How to convey uncertainty of transit predictions?

• current:
  • point estimates
  • uncertainty ignored

• displaying uncertainty may:
  • improve trust
    • Point estimates give false precision
    • Frustration when errors are made
  • Allow users to apply situation-dependent risk tolerance
Design requirements?

**User goals:**
- When to leave
- Wait time
- Time to next bus
- Schedule risk
- Schedule opportunity
- Schedule frequency
Design requirements?

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Design Requirements:
• Point estimate of time to arrival
• Probabilistic estimate of time to arrival
• Probabilistic estimate of arrival status
• Glanceability
• Small -> small screen
First design – two layouts

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But focus of article is on design of densities, not bus/route timeline.
First design – point estimates
More designs – how to show density?

Aim: discrete outcome visualizations of continuous variables

(as in natural frequencies, icon arrays, hypothetical outcome plots)

<table>
<thead>
<tr>
<th></th>
<th>Density</th>
<th>Stripeplot</th>
<th>Density+ Stripeplot</th>
<th>Dotplot(20)</th>
<th>Dotplot(50)</th>
<th>Dotplot(100)</th>
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<tbody>
<tr>
<td>shows discrete, countable events</td>
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Figure 4. Comparison of various encodings of probability we considered for use in our designs.
More designs – how to show density?

Aim: discrete outcome visualizations of continuous variables

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**Figure 4. Comparison of various encodings of probability we considered for use in our designs.**
Final choices to compare:

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*Figure 5. The four types of visualizations selected for evaluation.*
Survey questions, examples:

4 scenarios:

You are waiting for a bus, and must decide if you have enough time to get coffee before the bus arrives.

2 questions per scenario, e.g.:
What is the chance that the bus will arrive in 10 minutes or earlier?
Response: Visual Analog Scale, with bubble (20/100, 10/50, 4/20)

How confident are you?
Measures

Error: bias and variance

Authors:

\textit{as long as bias is low, variance is more important}

\textit{\rightarrow low variance allows people to adjust their behaviour to less bias}

- Estimation error = \text{logit}(\text{estimated } p) - \text{logit}(\text{true } p)
Results: bias (and variance)

We take the log odds ratio of estimated $p$ versus true $p$: the narrower this distribution is, the more precise respondents were at estimating probabilities, and the lower the dispersion will be in our model of responses.

Respondents' estimates in dotplot-20 are the most precise of all conditions: note the narrow, peaked distribution.

Dotplot-100 and density perform similarly, exhibiting slightly less precise estimates than dotplot-20.

Respondents' estimates in stripeplot are the least precise of all conditions: note the wide, diffuse distribution.
Results: variance

Figure 7. Differences in variance for each visualization type.
Confidence

• Dotplot-20:
  • Most confident
  • Negative correlation: confidence and absolute estimation error

• Next: dotplot-100 (significant difference with dotplot-20)
Conclusions and discussion

- Discrete-outcome visualization of uncertainty can improve probability estimation.
- Fewer dots seems better -> discrete plots with too many outcomes converge to continuous encodings?

Recommendation: use discrete outcome plots with few enough outcomes to take advantage of subitizing (=quickly recognizing counts).
User opinions:

Communicating uncertainty:
- Positive:
  - helps making better decisions
  - alleviates anxiety when app’s information does not match their knowledge
- Negative:
  - More responsibility - I cannot blame the app

Precision vs glanceability
- Some like the design, others think it overwhelming
- Too much to comprehend while walking to bus station?
- Maybe practice helps?
Points for discussion

• Is dotplot-20 easier to answer correctly due to “bubble” with slider?

• What if you need to make an estimate for < 12 minutes?
Points for discussion

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Questions?

Figure 5. The four types of visualization