Statistical models for pedestrian behaviour in front of bottlenecks

Nikolai Bode

Department of Engineering Mathematics, University of Bristol

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Movement of pedestrian crowds
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1. How do individuals interact?
2. Do interactions differ across contexts?
Focus on bottleneck scenario

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Model microscopic interactions in front of bottleneck.
Time between consecutive pedestrians

Statistical models: $\Delta t \sim \Gamma(\mu, \sigma)$

e.g. $\mu = [p_1(d_C - d_B) - p_2]^2$
Example

\[ \Delta t \sim \Gamma(\mu, \sigma) \]

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Candidate models

Models for $\mu$:

$m_0$: assume $\mu$ is constant

$m_1$: assume $\mu$ depends on density

$m_2$: assume $\mu$ depends on difference in distance between $B$ and $C$

$m_3$: assume $\mu$ depends on angle between $B$ and $C$

$m_4$: assume $\mu$ depends on distance of closest pedestrian

... consider combinations of models...
Model fitting

Statistical models: \( \Delta t \sim \Gamma(\mu, \sigma) \)

p.d.f. of gamma distribution: \( f_\Gamma \)

Likelihood of a model: 

\[
L = \prod_k f_\Gamma(\Delta t_k; \mu_k, \sigma)
\]

(assume models describe dependencies between consecutive \( \Delta t_k \))

Find model parameters that maximise \( L \).
Model selection

![Graph showing model selection with AIC values on the y-axis and models on the x-axis. The graph indicates the comparison of different models based on their AIC scores.]
Comparing different contexts
Comparing different contexts

- Simulations are not fitted to experiments
Comparing different contexts
Residual plots
Residual plots
Summary

- Can isolate most likely mechanism from candidates.

- Can use this to compare microscopic behaviour across contexts (*check simulation models*).

- Residual plots highlight aspects not explained by statistical models.

NOTE: if interactions inside bottleneck are important, the approach may not be appropriate.
Further work

- Framework is general and can be extended (e.g. social groups, age differences).
- Apply to a range of experiments/models.
- Consider wider exits.
- Investigate changes in behaviour over time.
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