A quick note

1. Summary of Hughes' Paper on Continuum Pedestrian Flow Modelling

I have completed reading the paper of Hughes' (A continuum theory for the flow of pedestrians). And here are some important take aways.

Assuming the pedestrians to be of single kind, the governing equation proposed is:

$$-\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x}\left(\rho g(\rho) f^2(\rho) \frac{\partial \phi}{\partial x}\right) + \frac{\partial}{\partial y}\left(\rho g(\rho) f^2(\rho) \frac{\partial \phi}{\partial y}\right) = 0$$

and

$$g(\rho) f(\rho) = \frac{1}{\sqrt{\left(\frac{\partial \phi}{\partial x}\right)^2 + \left(\frac{\partial \phi}{\partial y}\right)^2}}.$$

1. I am using "q" to specify density.
2. In the above, Author explain that pedestrian try minimizing the time taken to reach the destination but also try choosing the path with least crowd. And density is the variable, used while defining many other important variables like f(q) and g(q).
3. The paper also assume the problem to be similar to that of potential felids in physics. The phi is defined as potential which has similar significance.
4. f(q) is the speed of pedestrian at any location x, y at time t. q itself is function of x, y, t. And this could be modelled as Greenshields's definition relating speed with density (same as traffic flow problems).
5. g(q) is modelled in slightly complex ways in the paper. And this captures the nature of people to prefer paths with less crowd (or less density, q).

6. So essentially the paper provides system, that have two unknows (that is potential and density), and two equations.
7. In future I would like to explore more papers on selecting the appropriate functions for f(q) and g(q).

2. Potential Objectives of the Project

As discussed in our last meeting, I was advised to aims at understanding causes of crowd chaos and choking related to flow rates of pedestrians. Simulations based on Hughes' PDE framework can be used to address the following:

- **Threshold Regions**:

  When simulating the crowd flow over the complex geometry (like paths of temples with irregular shapes and obstacle), it will be beneficial to know at which locations did the density crossed it's threshold value.

- **Choking Conditions**:

  Identifying, at what **total flow rates of pedestrians at the entrance,** the crowd starts experiencing blockages, and problems related to congestions in it.

- **Temporal Evolution**:

  The governing equations are unsteady. And thus they could be used to see how the density develops with time.