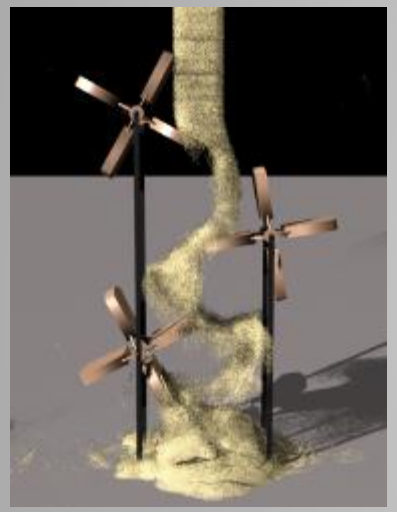
Part 2 – Crowd Simulation

What for?

PLURIDISCIPLINARY TOPIC

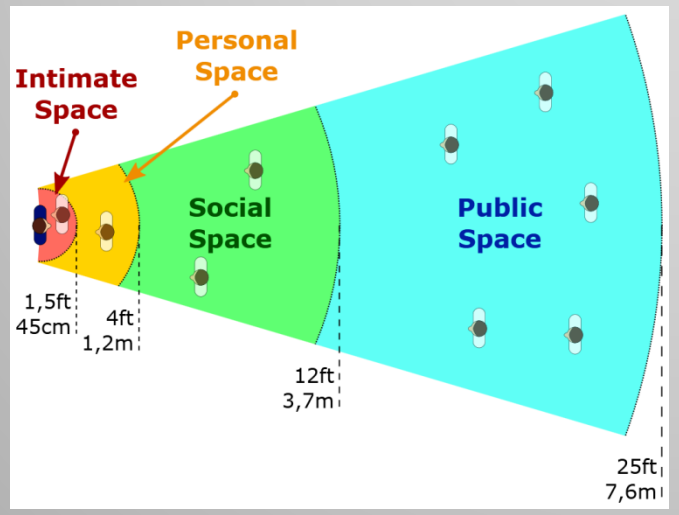


© ACM

© ACM

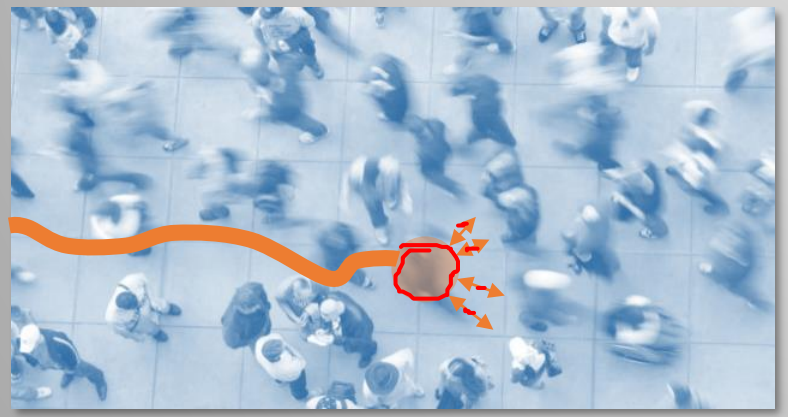
DISCIPLINES :

- Computer Sciences,
- Physics,
- Mathematics,
- Psychosociology,
- Transportation Sciences.

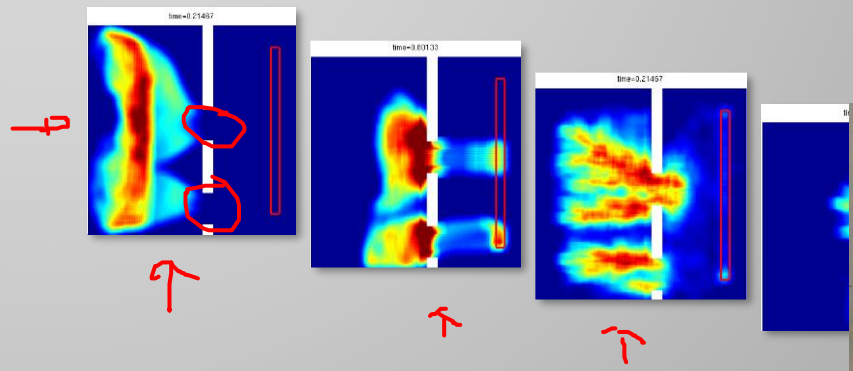


2 Main Approaches

Microscopic



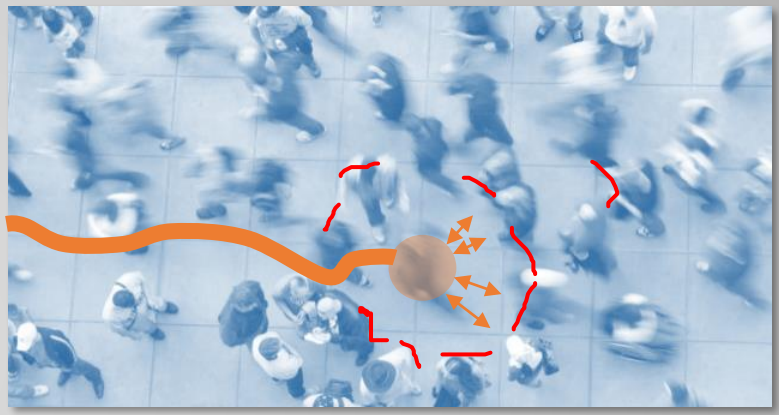
Macroscopic



Microscopic Simulator Ingredients

- Agent
- Neighborhood
- Model of local interactions

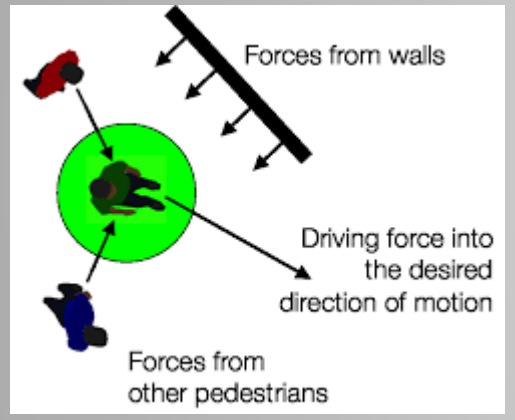
→ Generate global trajectories



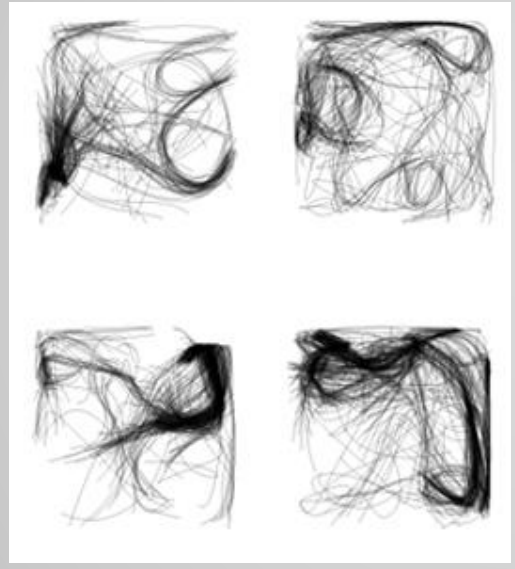
Animation engine

→ Computes articular trajectories

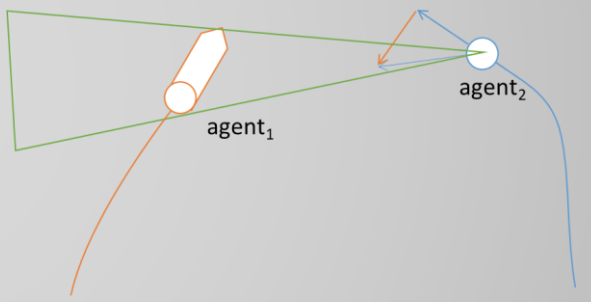
4 APPROACHES (NON EXHAUSTIVE)



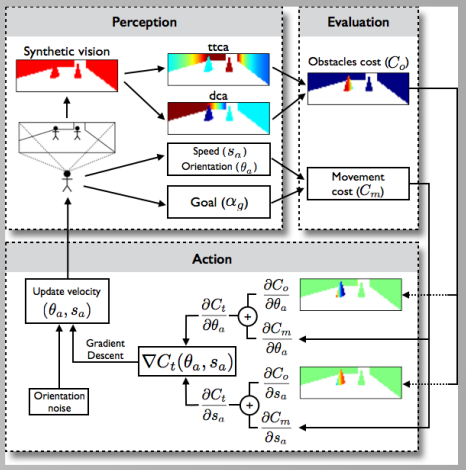
Force based



Flocks



Velocity-based



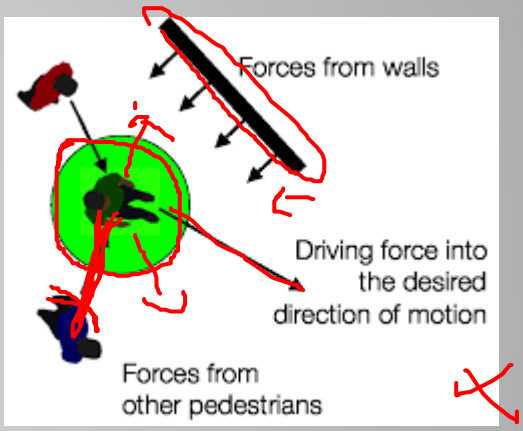
Helbing's Social Force Model

- Treats all agents as physical obstacles
- Solves a = F/m where F is "social force":

Desired Velocity — Current Velocity

$$m_i \frac{d\mathbf{v}_i}{dt} = m_i \frac{v_i^0(t)\mathbf{e}_i^0(t) - \mathbf{v}_i(t)}{\tau_i} + \sum_{j(\neq i)} \mathbf{f}_{ij} + \sum_W \mathbf{f}_{iW}$$

Avoiding Other Pedestrians — Avoiding Walls



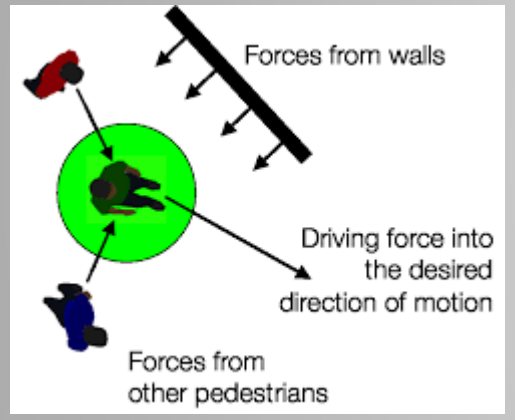
- f_{ij} – Pedestrian Avoidance

$$\mathbf{f}_{ij} = \{A_i \exp[(r_{ij} - d_{ij})/B_i] + kg(r_{ij} - d_{ij})\}\mathbf{n}_{ij} + \kappa g(r_{ij} - d_{ij})\Delta v_{ji}^t \mathbf{t}_{ij}$$

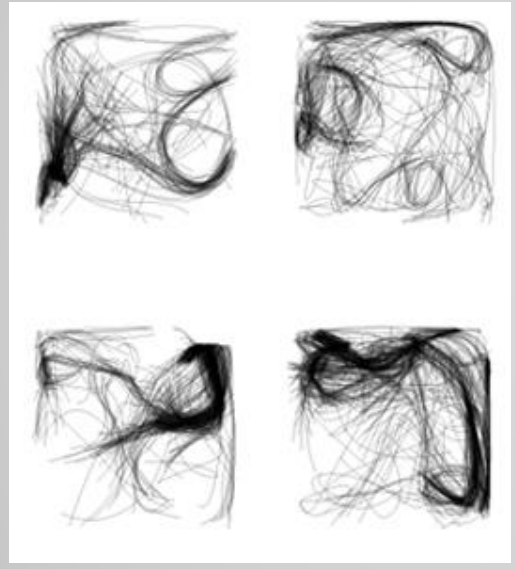
- f_{iW} – Obstacle (Wall) Avoidance

$$\mathbf{f}_{iW} = \{A_i \exp[(r_i - d_{iW})/B_i] + kg(r_i - d_{iW})\}\mathbf{n}_{iW} - \kappa g(r_i - d_{iW})(\mathbf{v}_i \cdot \mathbf{t}_{iW})\mathbf{t}_{iW}$$

4 APPROACHES (NON EXHAUSTIVE)

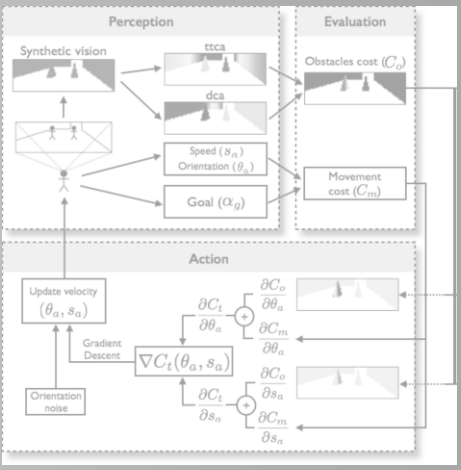


Force based



Flocks

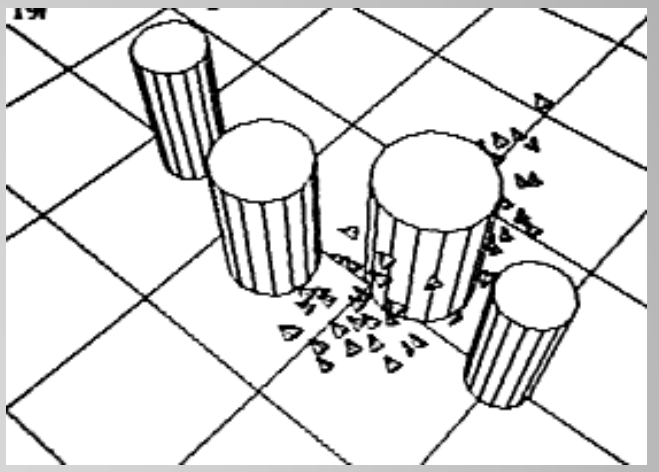
Velocity-based

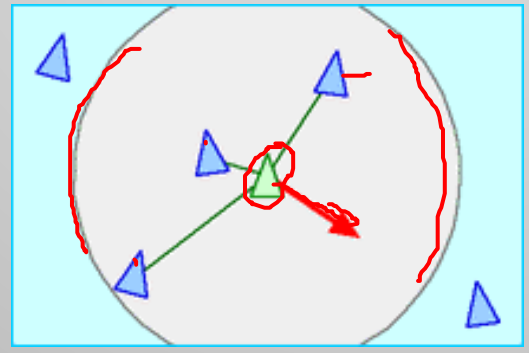


Flocking

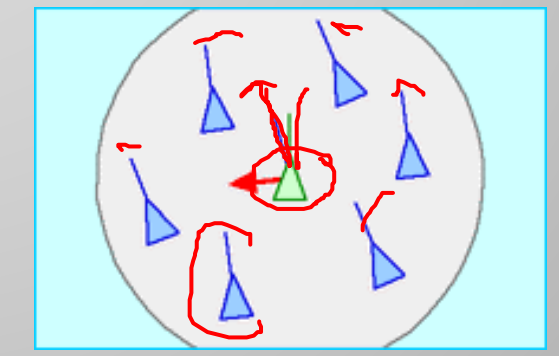
Seminal work in multi-agent movement

Assign simple force to each agent

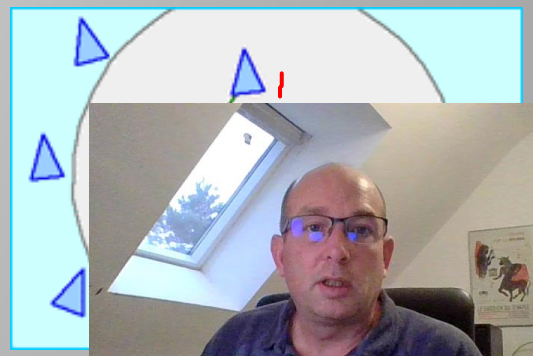




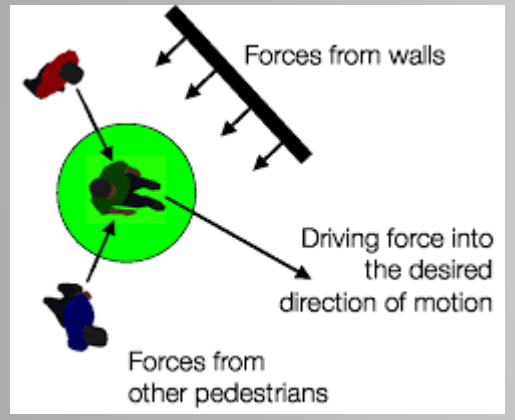
Separation



Alignment

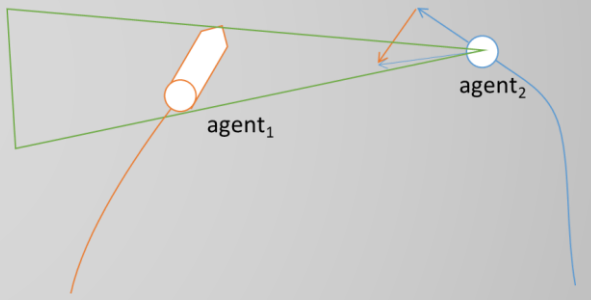


4 APPROACHES (NON EXHAUSTIVE)

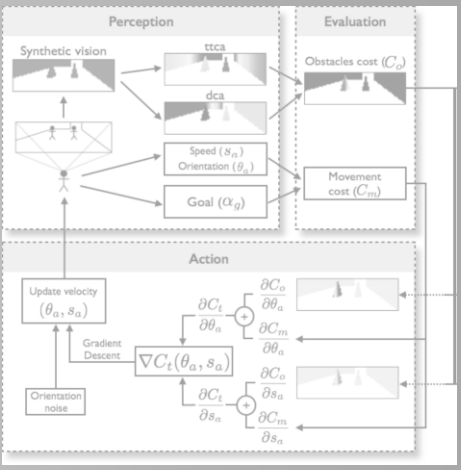


Force based

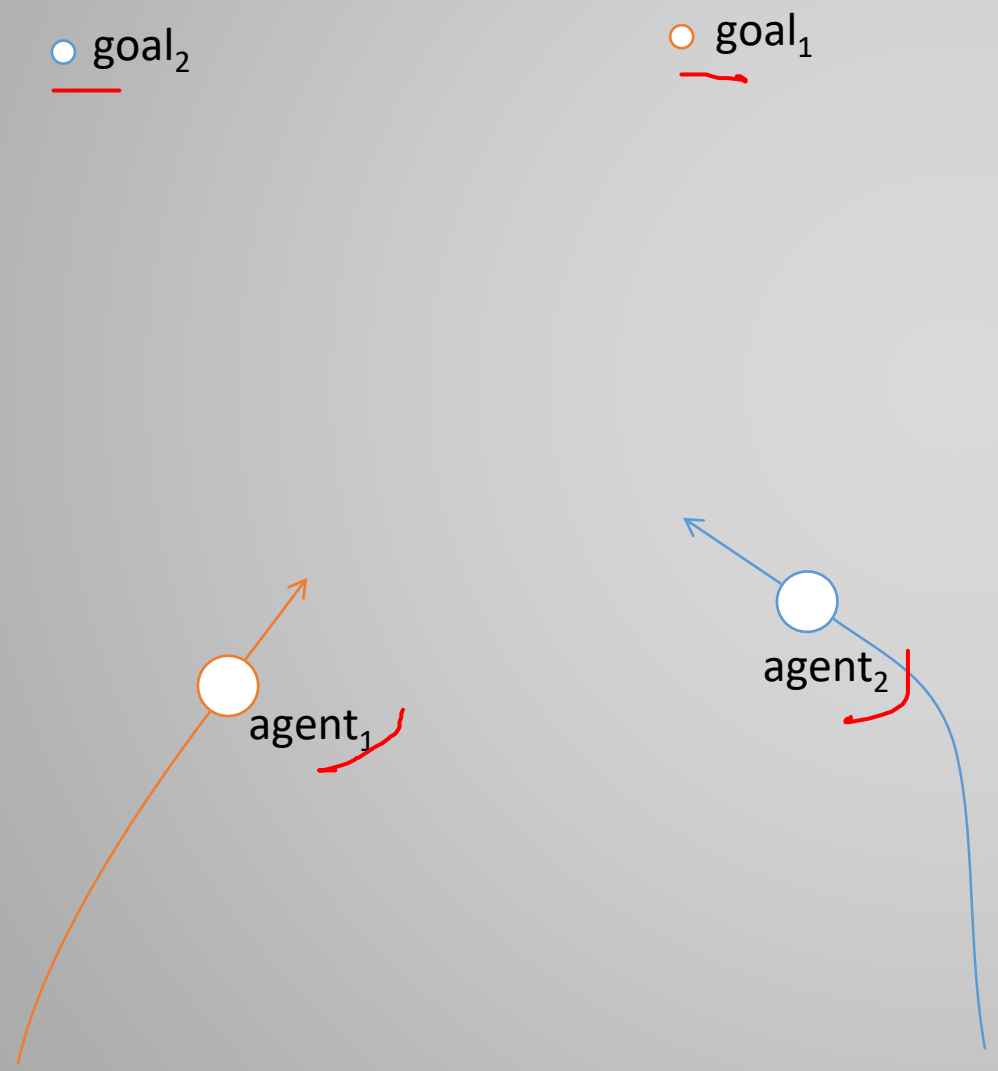
Flocks



Velocity-based



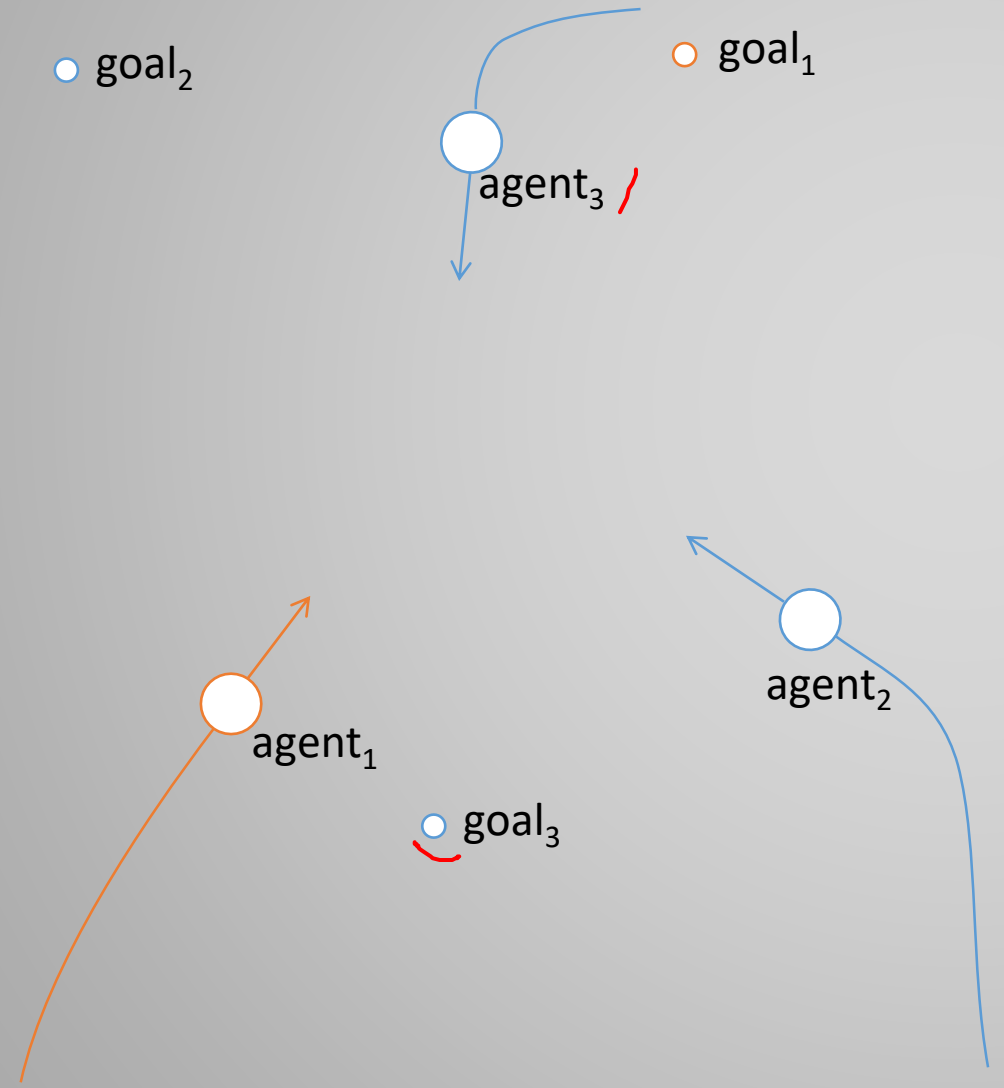
VELOCITY-BASED APPROACHES



INTERACTIONS BETWEEN AGENTS:

- How agent 1 adapts its motion to avoid collision with agent 2?

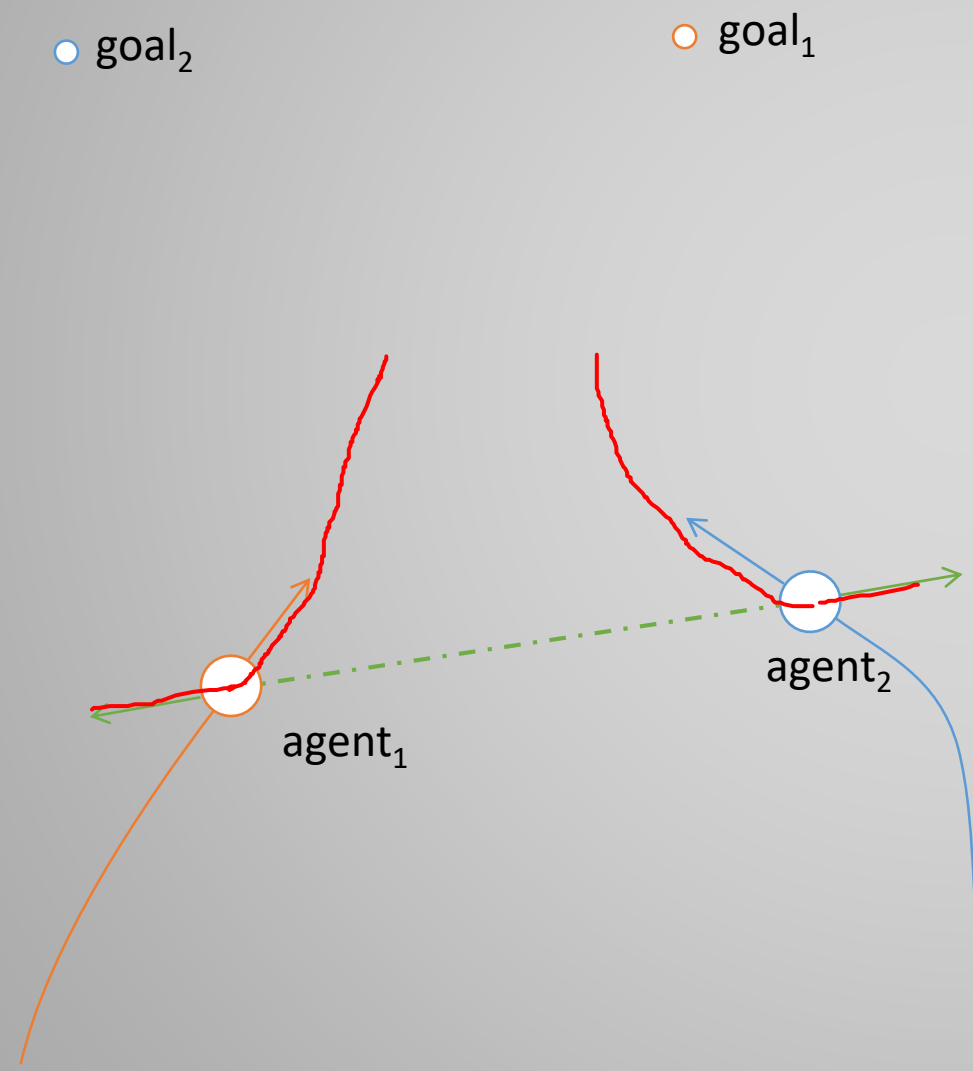
VELOCITY-BASED APPROACHES



MODELS INTERACTIONS BETWEEN AGENTS:

- How do agent 1 adapts his motion to avoid collision with agent 2?
- In combination with agent 3?

VELOCITY-BASED APPROACHES

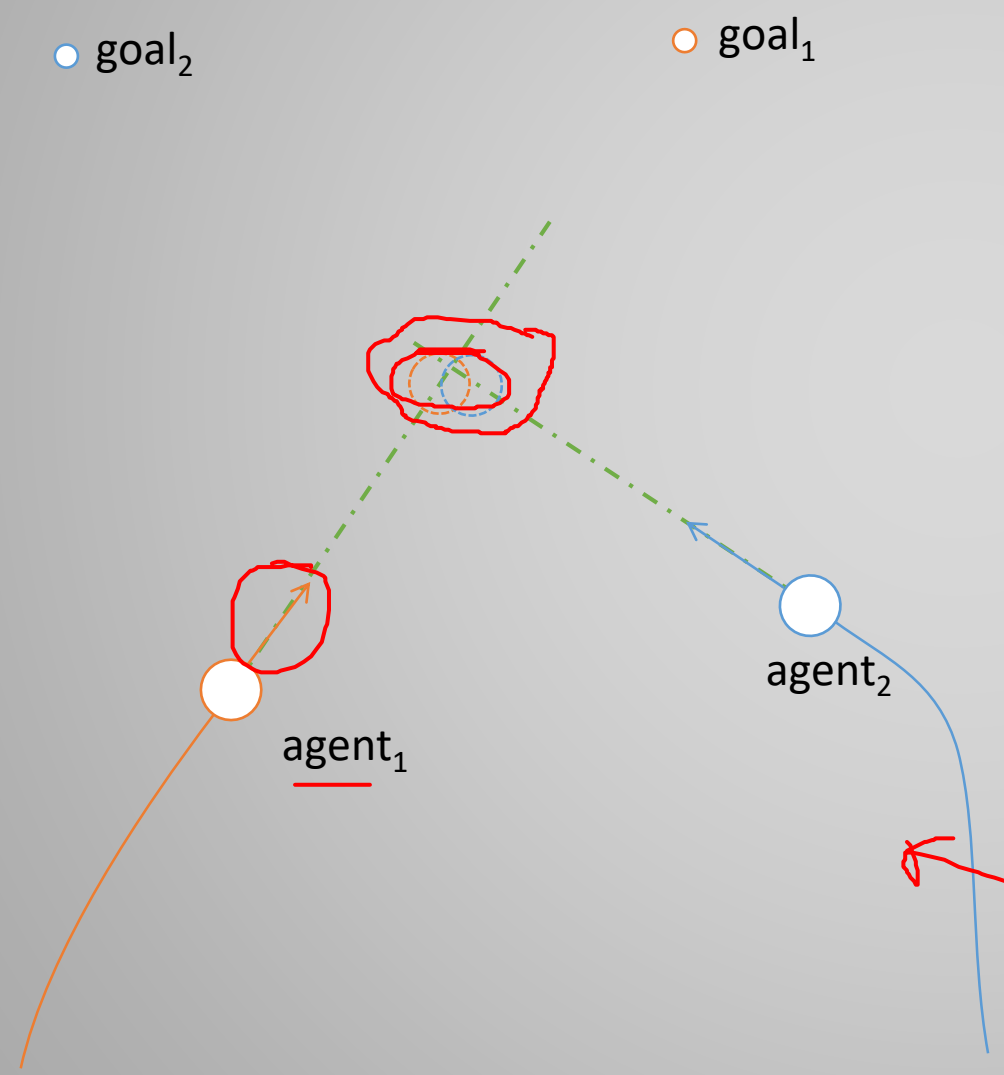


MICROSCOPIC & CONTINUOUS

MODELS INTERACTIONS BETWEEN AGENTS

POSITION-BASED MODELS (E.G., SF) PROPOSED:

VELOCITY-BASED APPROACHES



MICROSCOPIC & CONTINUOUS

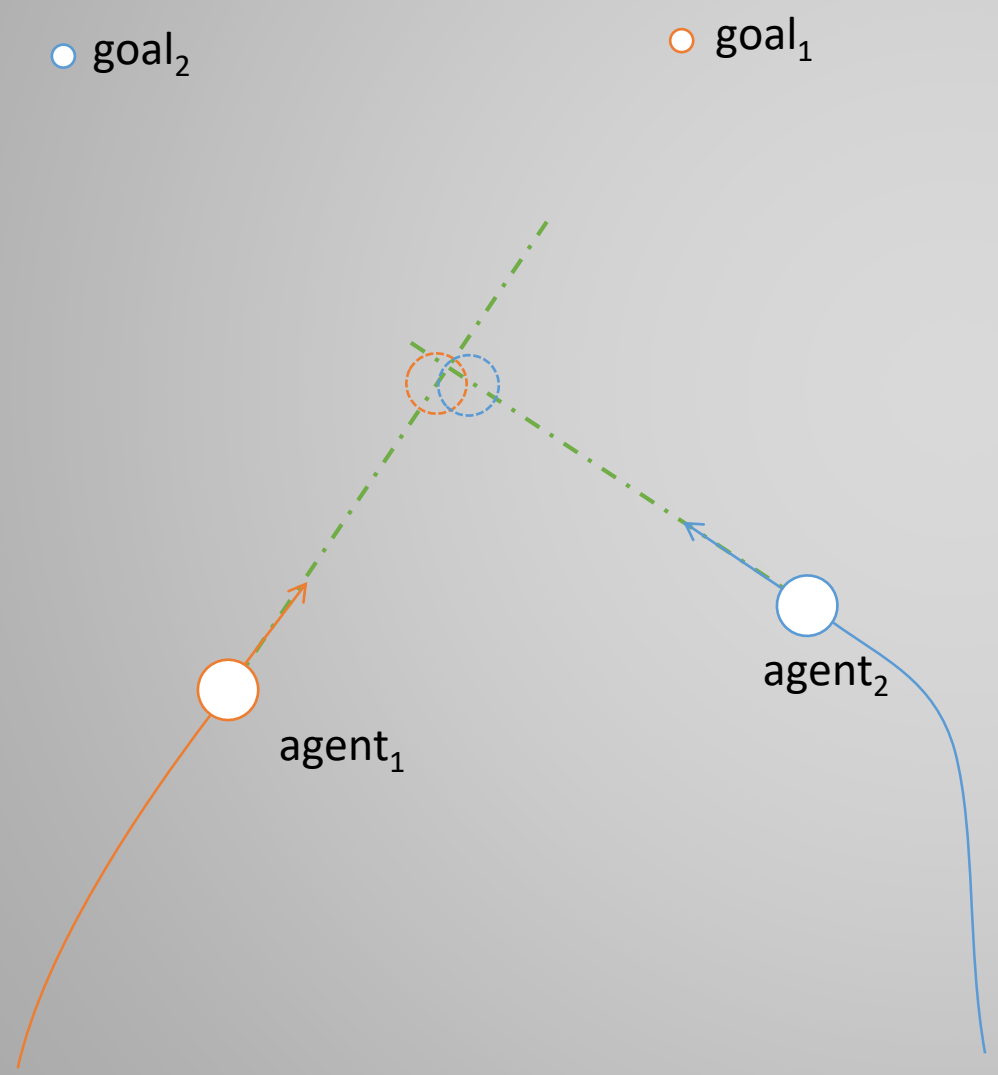
MODELS INTERACTIONS BETWEEN AGENTS

VELOCITY-BASED MODELS SUGGEST ANTICIPATION:

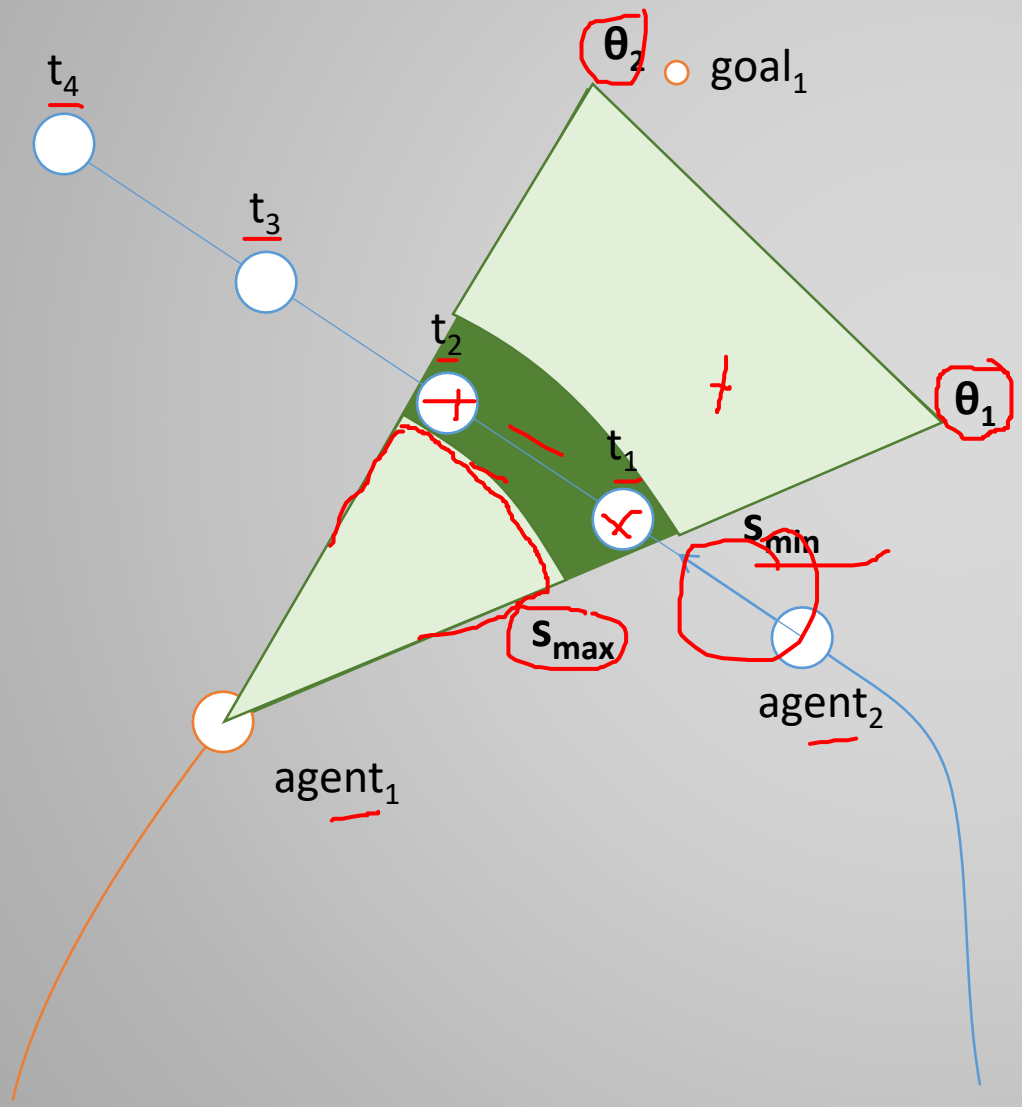
COMPUTE 2 DOMAINS:

- Admissible
- Inadmissible

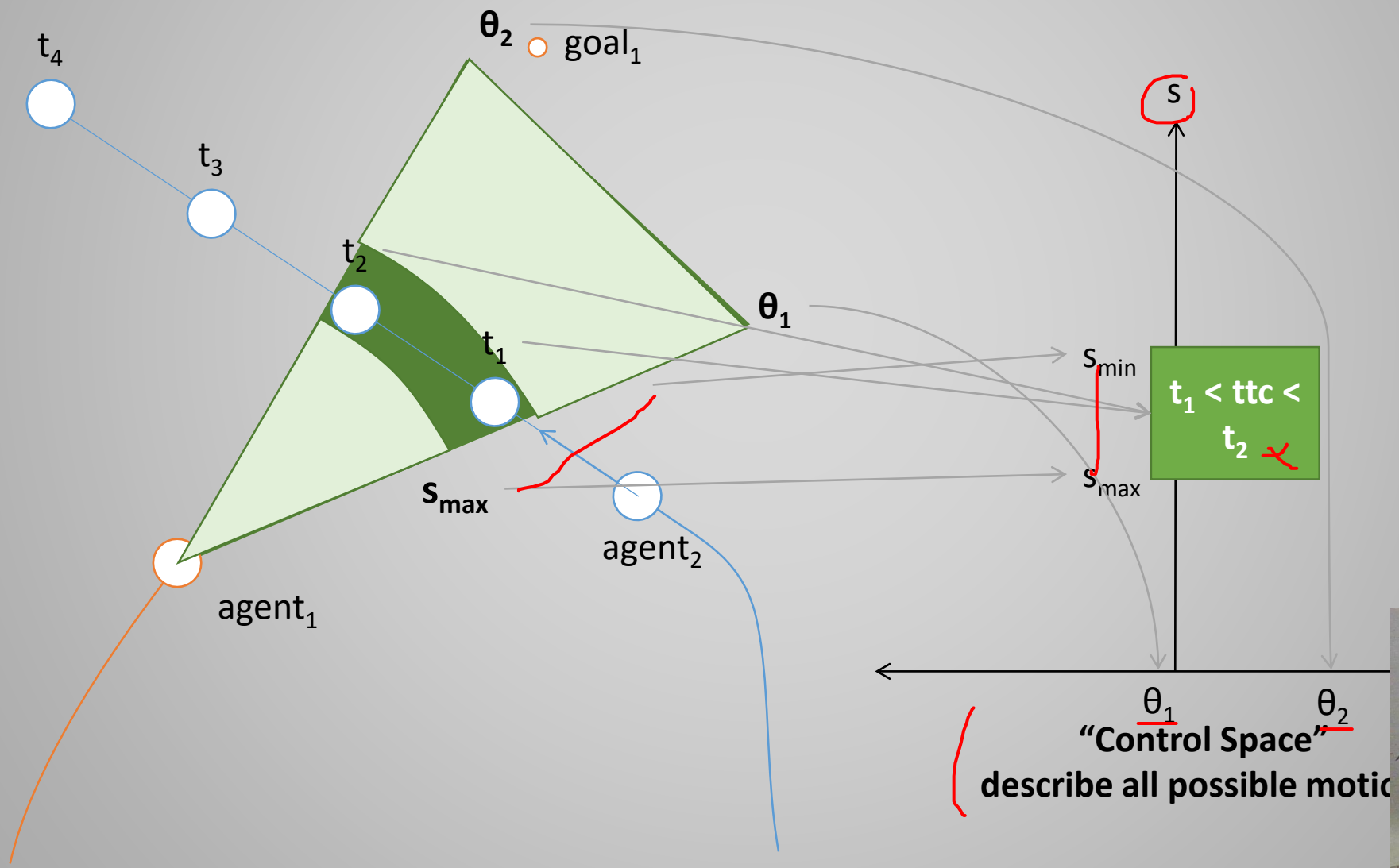
Approximate admissible velocities



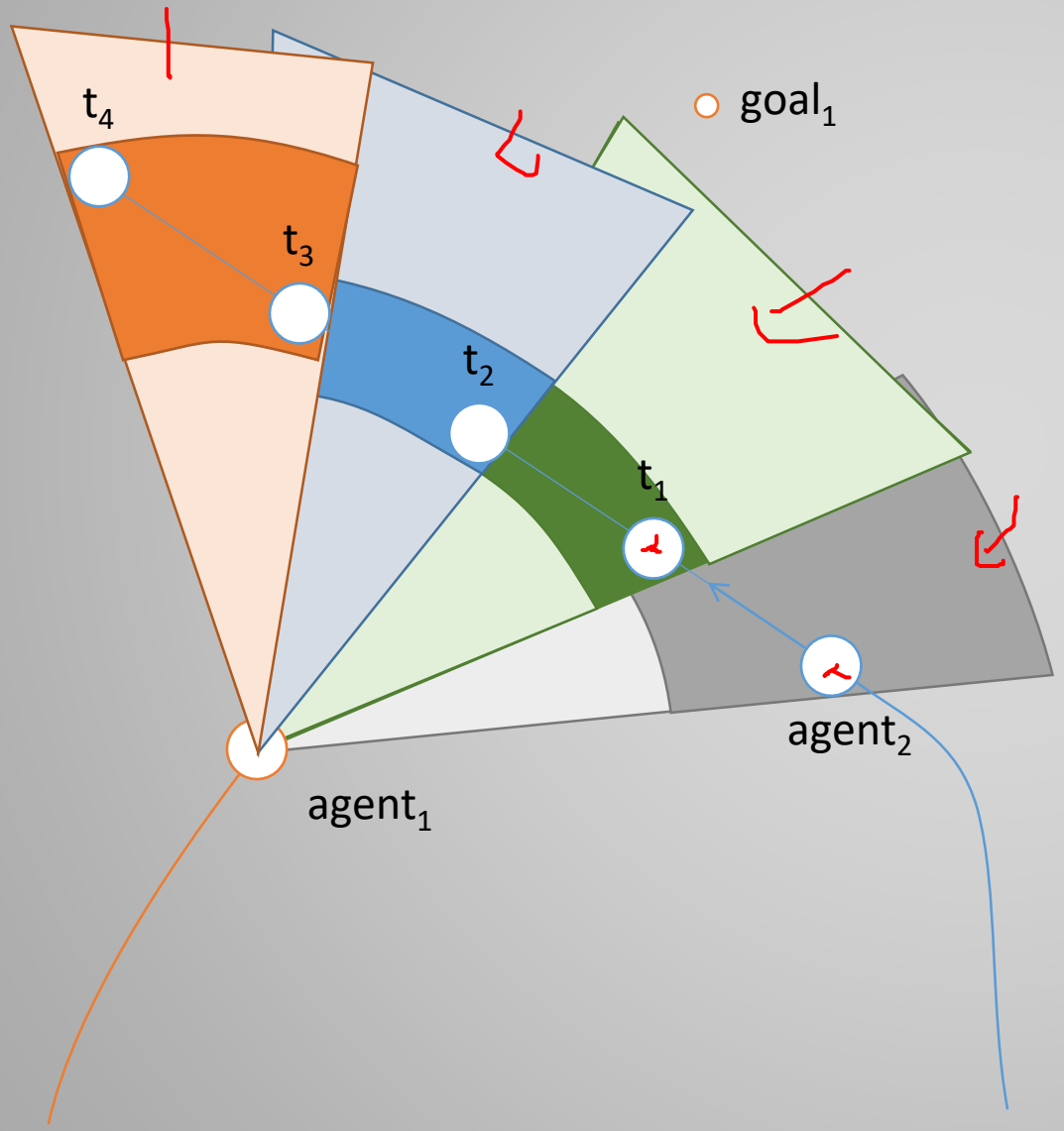
APPROXIMATE ADMISSIBLE VELOCITIES

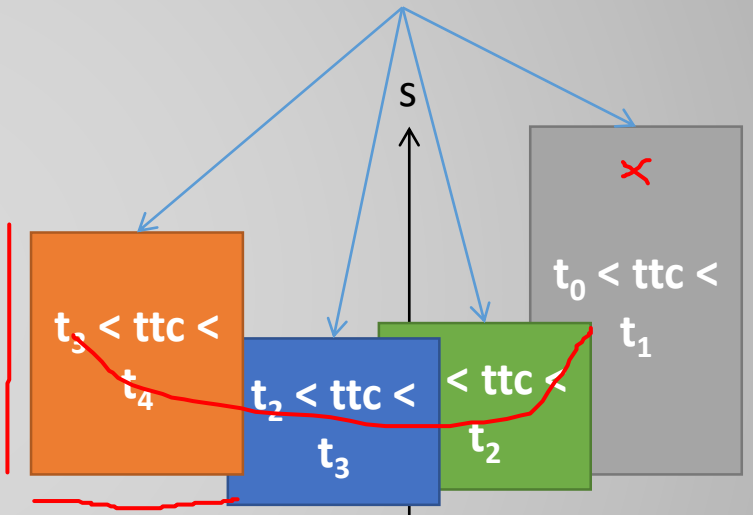


APPROXIMATE ADMISSIBLE VELOCITIES

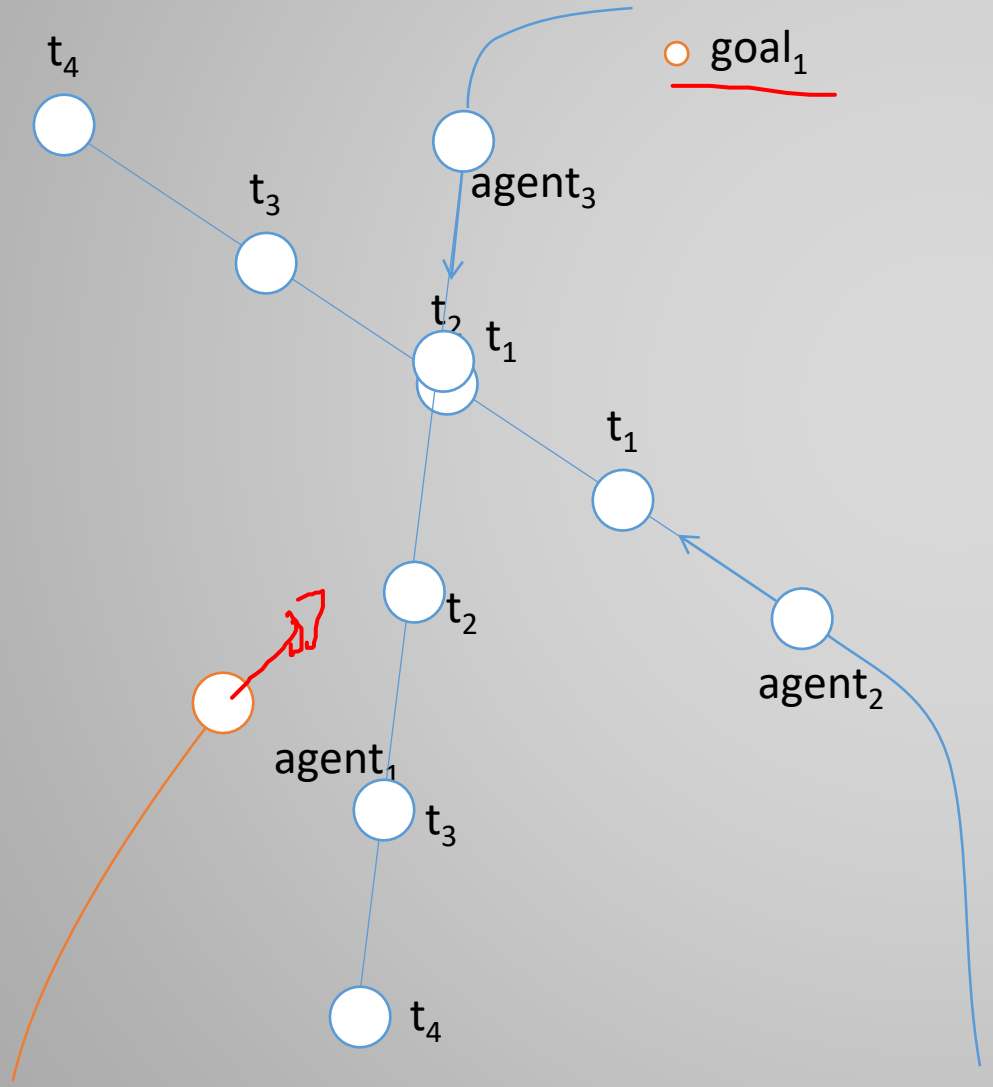


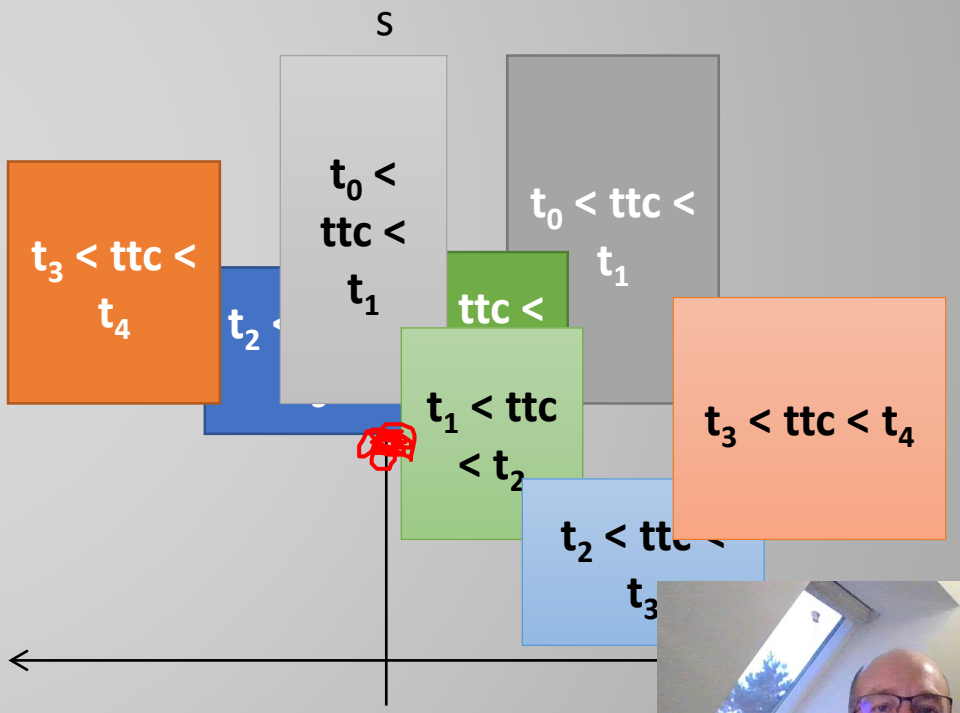
APPROXIMATE ADMISSIBLE VELOCITIES





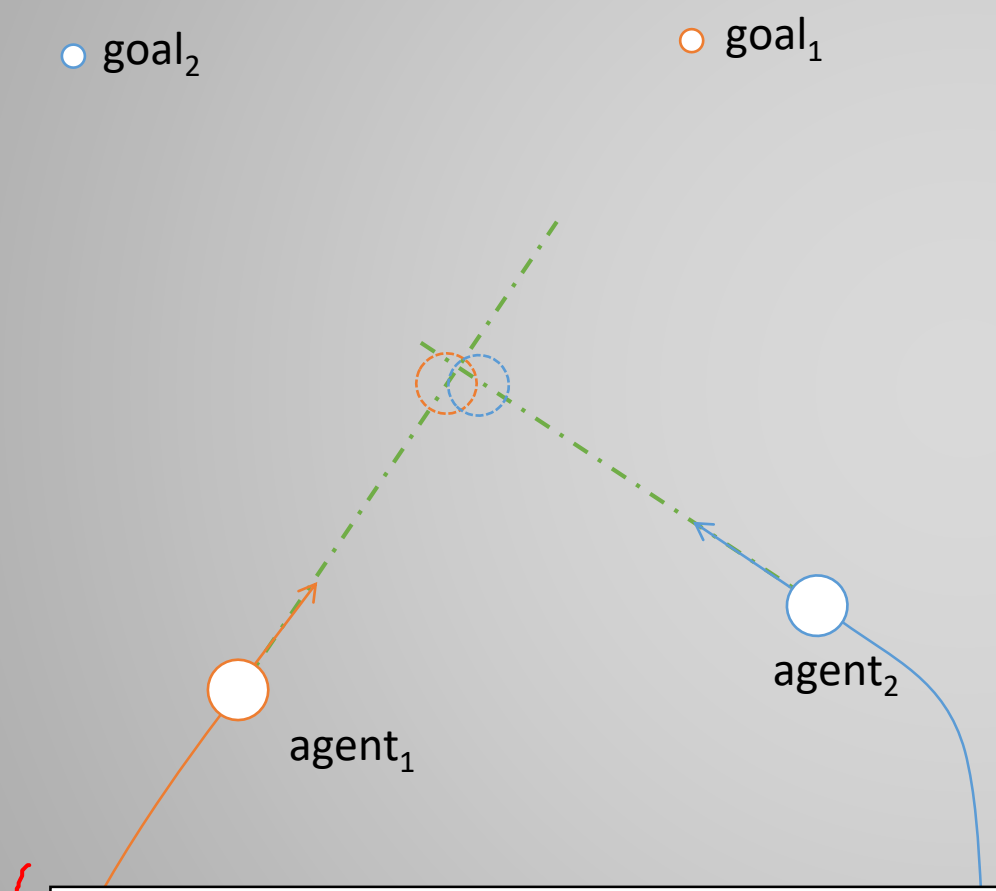
APPROXIMATE ADMISSIBLE VELOCITIES





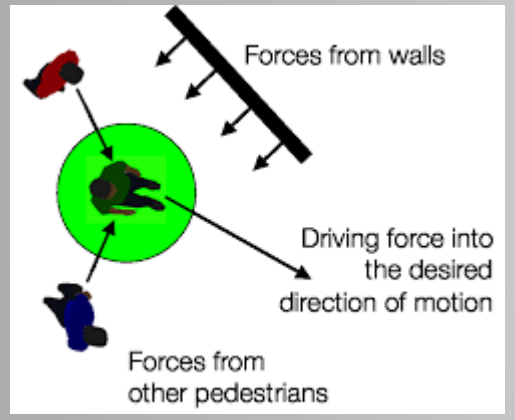
"Control Space"
describe all possible motio

EXACT ADMISSIBLE VELOCITIES

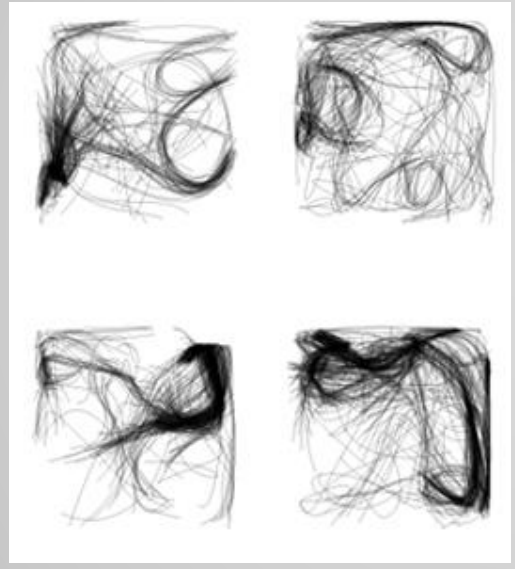


Experiment-based modeling, simulation and validation of interactions between virtual walkers
J. Pettré, J. Ondrej, A.-H. Olivier, A Crétual and S. Donikian
SCA'09

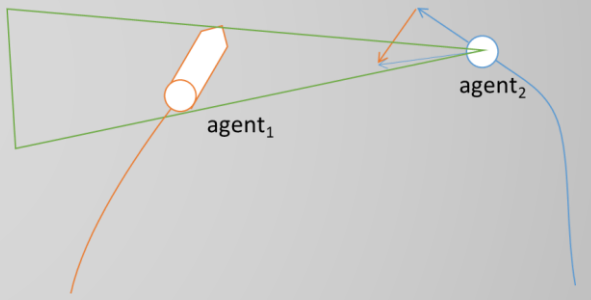
4 APPROACHES (NON EXHAUSTIVE)

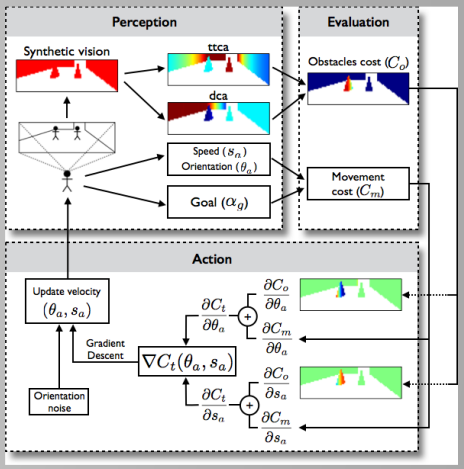


Force based



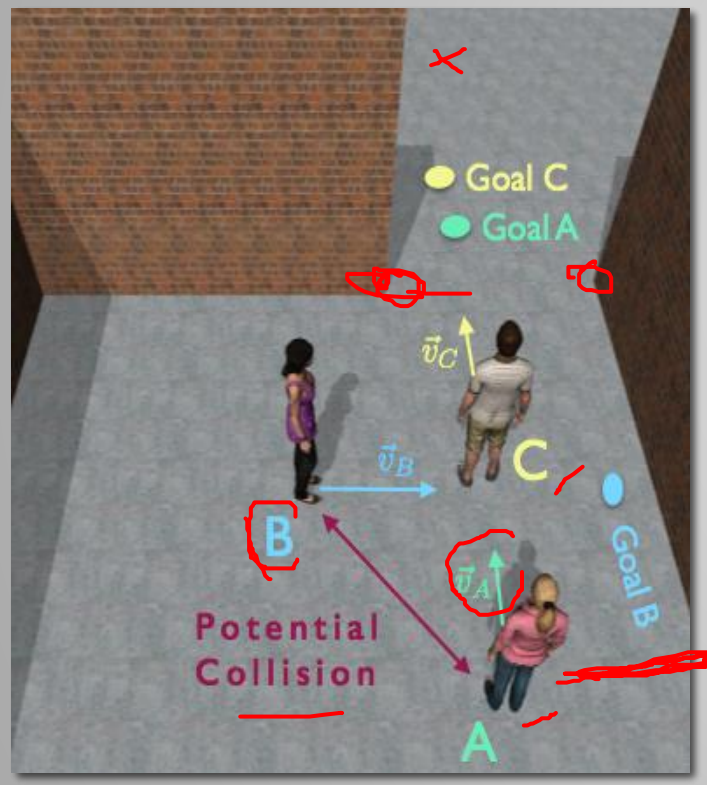
Flocks

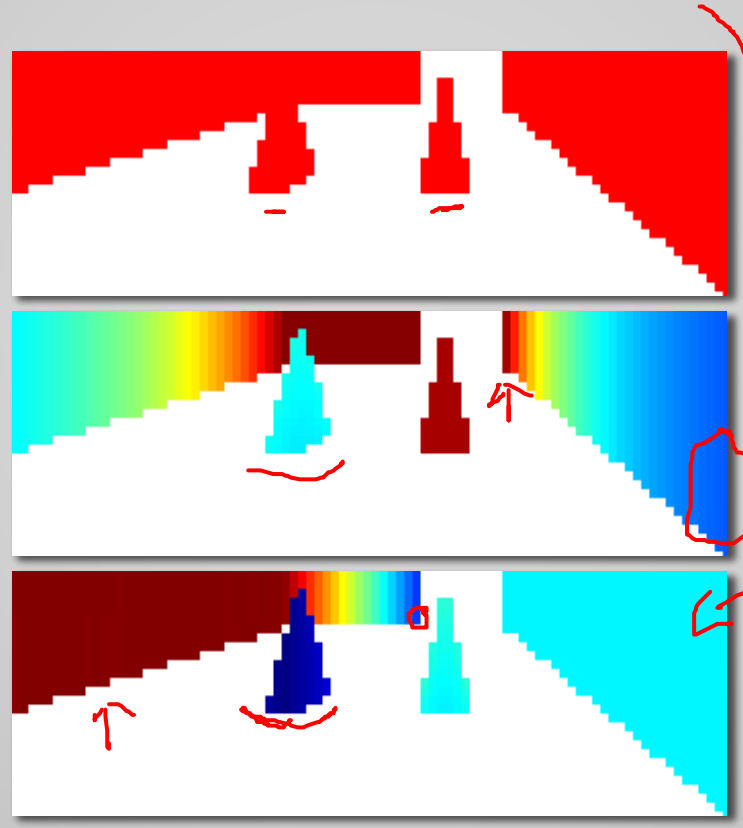




Velocity-based

VISION-BASED APPROACH



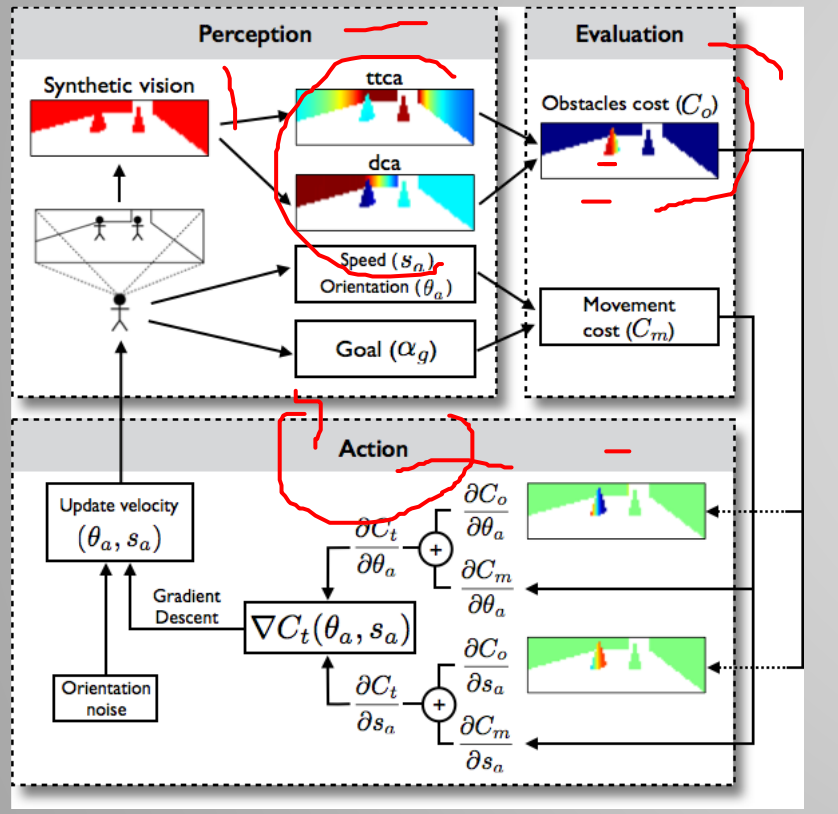


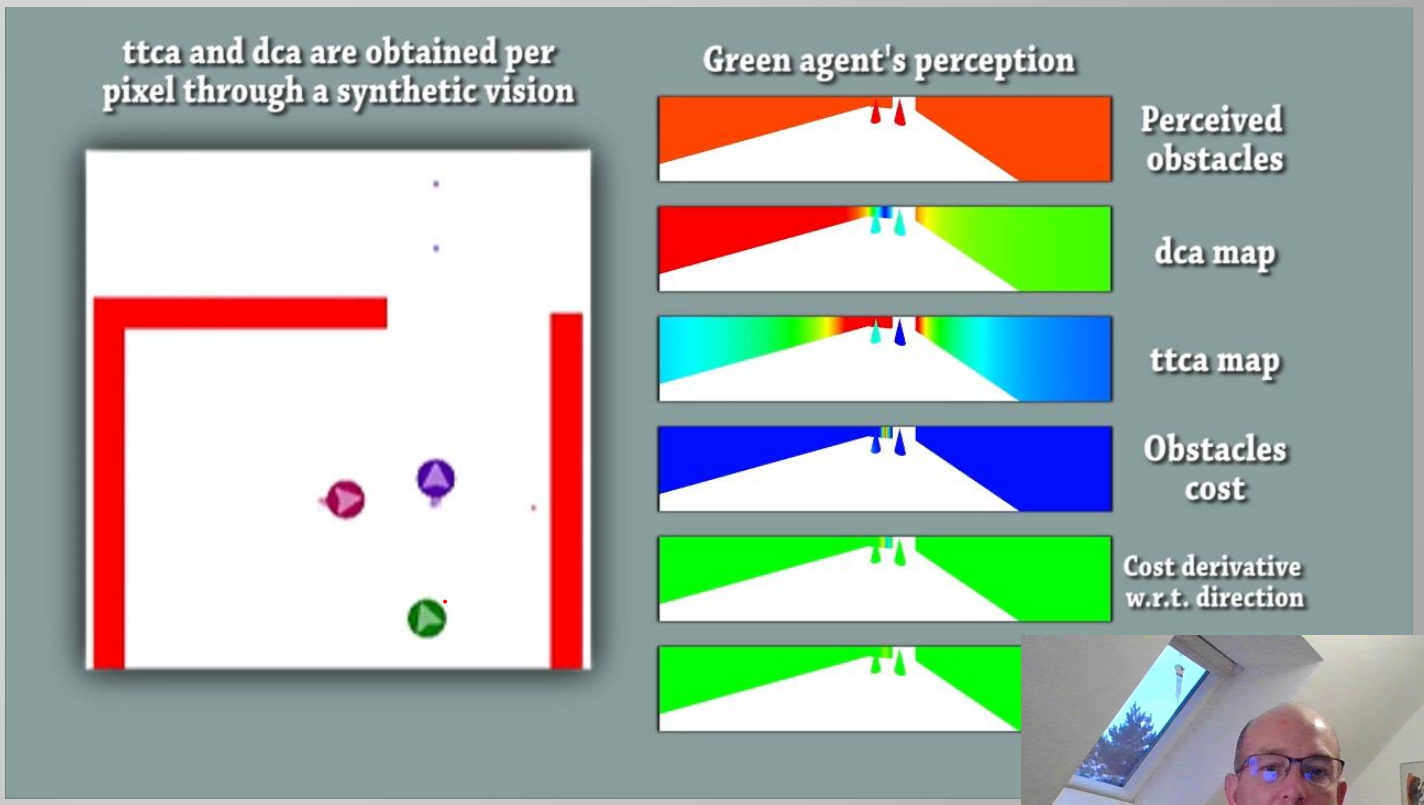
high

ttca map
(time-to-closest approach)

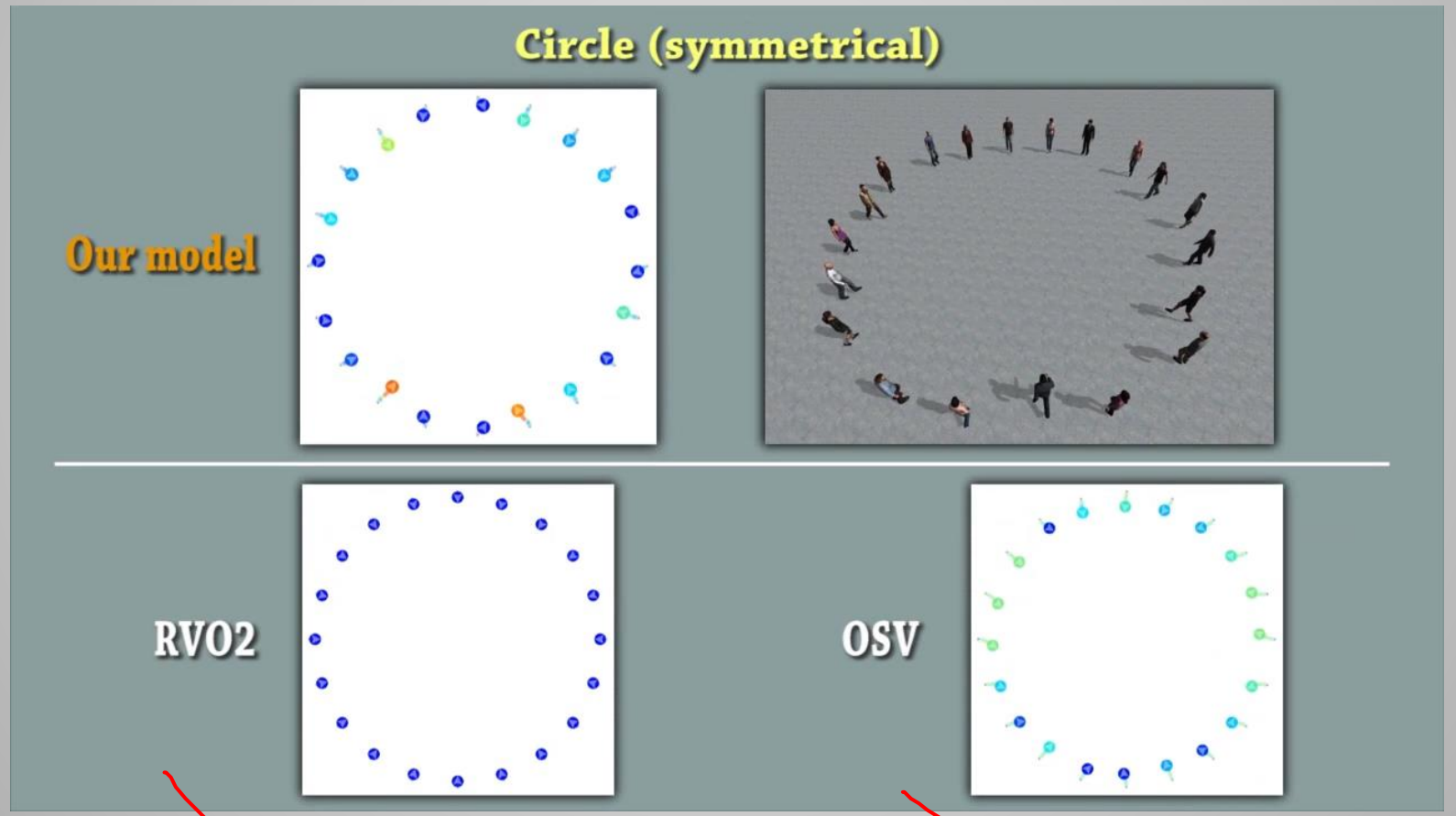
dca map
(distance of closest ap

VISION-BASED APPROACH

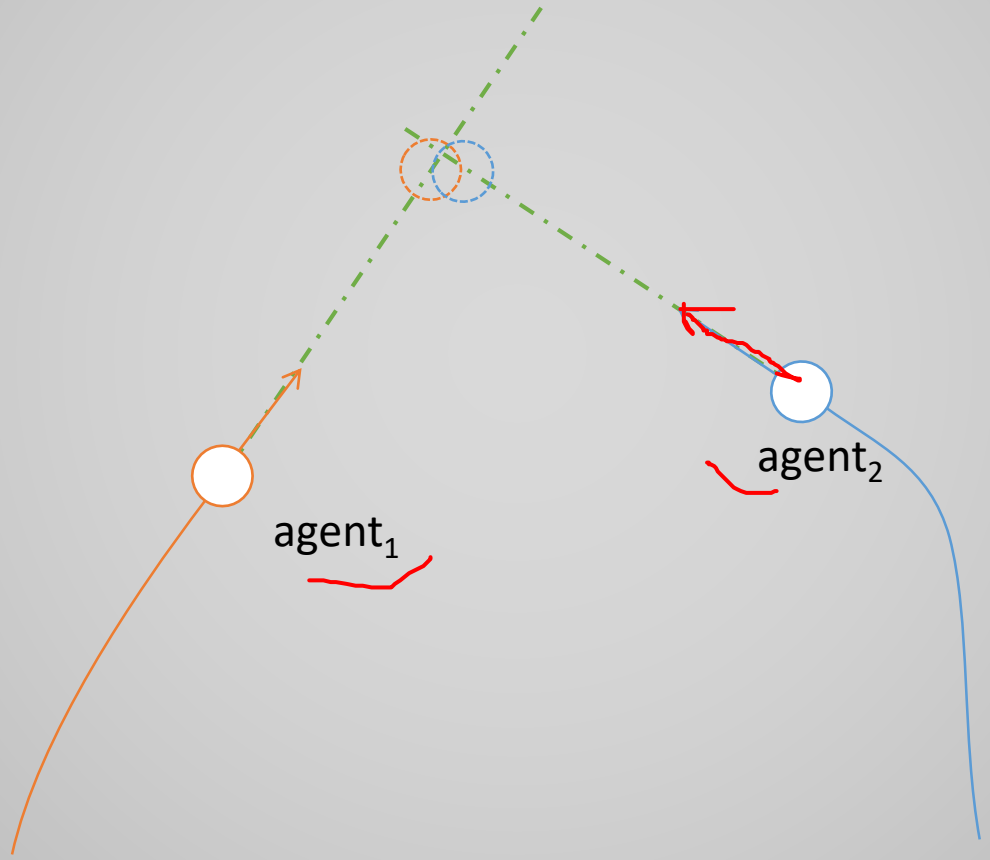




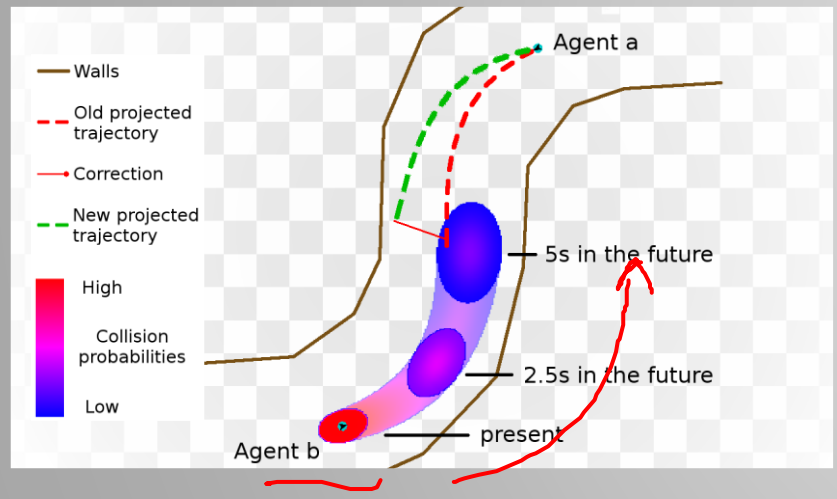
VISION-BASED APPROACH



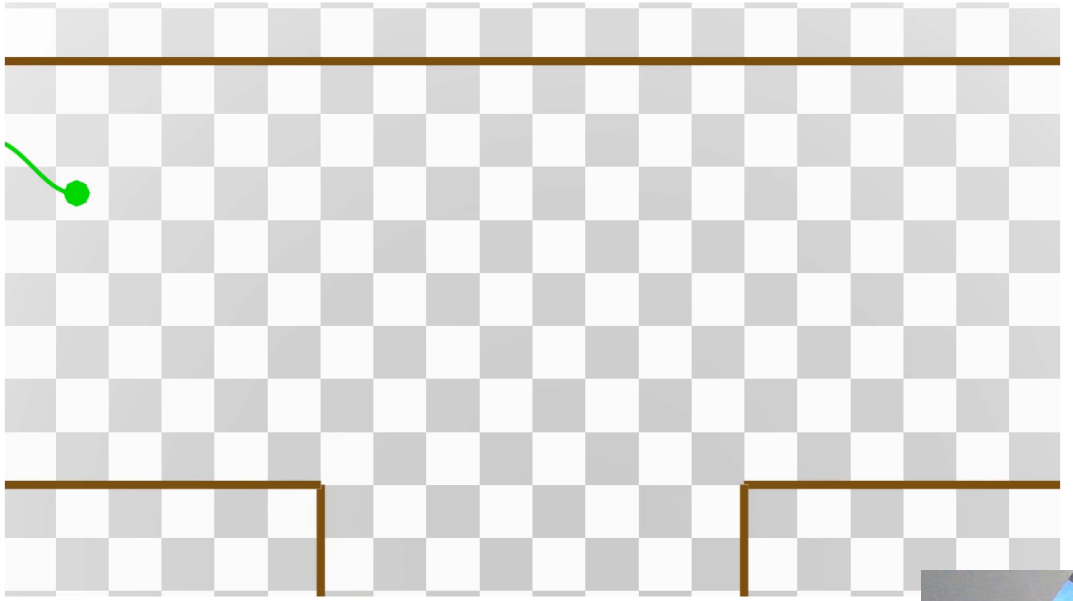
WARPDRIVER [WOLINSKI 2016]



WARPDRIVER [WOLINSKI 2016]



Overview



QUESTIONS

... AND DISCUSSION