Imperial College London
dyson Robotics Lab

Distributing Collaborative Multi-Robot Planning with Gaussian Belief Propagation

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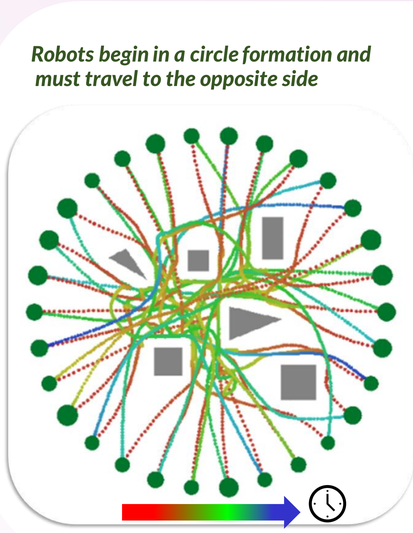
Robots can **collaborate** to **plan safe** and **efficient paths** with **iterative message passing**

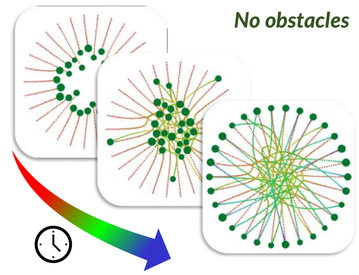
No centralized solver needed!

Video & Paper



Circle Crossing

Robots of various sizes can **smoothly navigate** around **obstacles** and **each other**



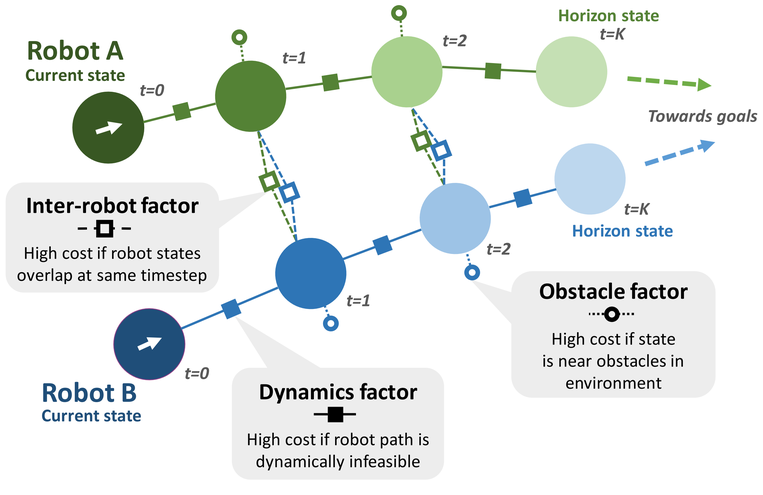
Formulating Path Planning as Inference on a Factor Graph

solved using

Gaussian Belief Propagation (GBP)

Variables
Robot future states
(*position*, *velocity*)

Factors
Cost functions
$f(\boldsymbol{X}) \propto e^{h(\boldsymbol{X})^{\top} \boldsymbol{\Sigma}\, h(\boldsymbol{X})}$



A **distributed, iterative** and **asynchronous** alternative to nonlinear least squares

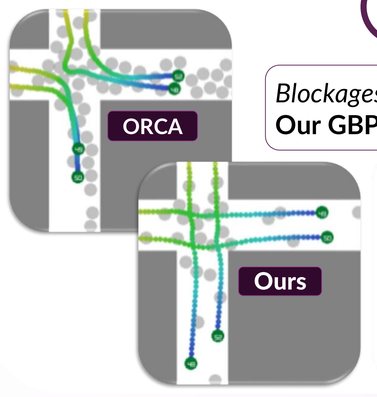
Message passing to update beliefs of variables

Robot paths **react** to **new changes** in the environment

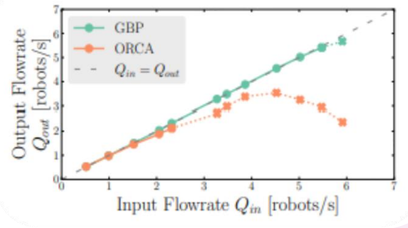
Algorithm (per robot)

Update current and horizon states
Create or destroy inter-robot factors
Optimise path with iterations of GBP

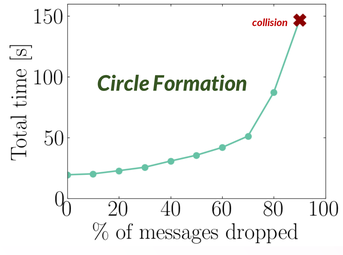
Warehouse Junction



Blockages caused by reactive planner
Our GBP planner maintains smooth flow



Robustness to Communication Failure



Collision-free paths even with **many dropped messages**

Time taken increases as **robots behave cautiously**