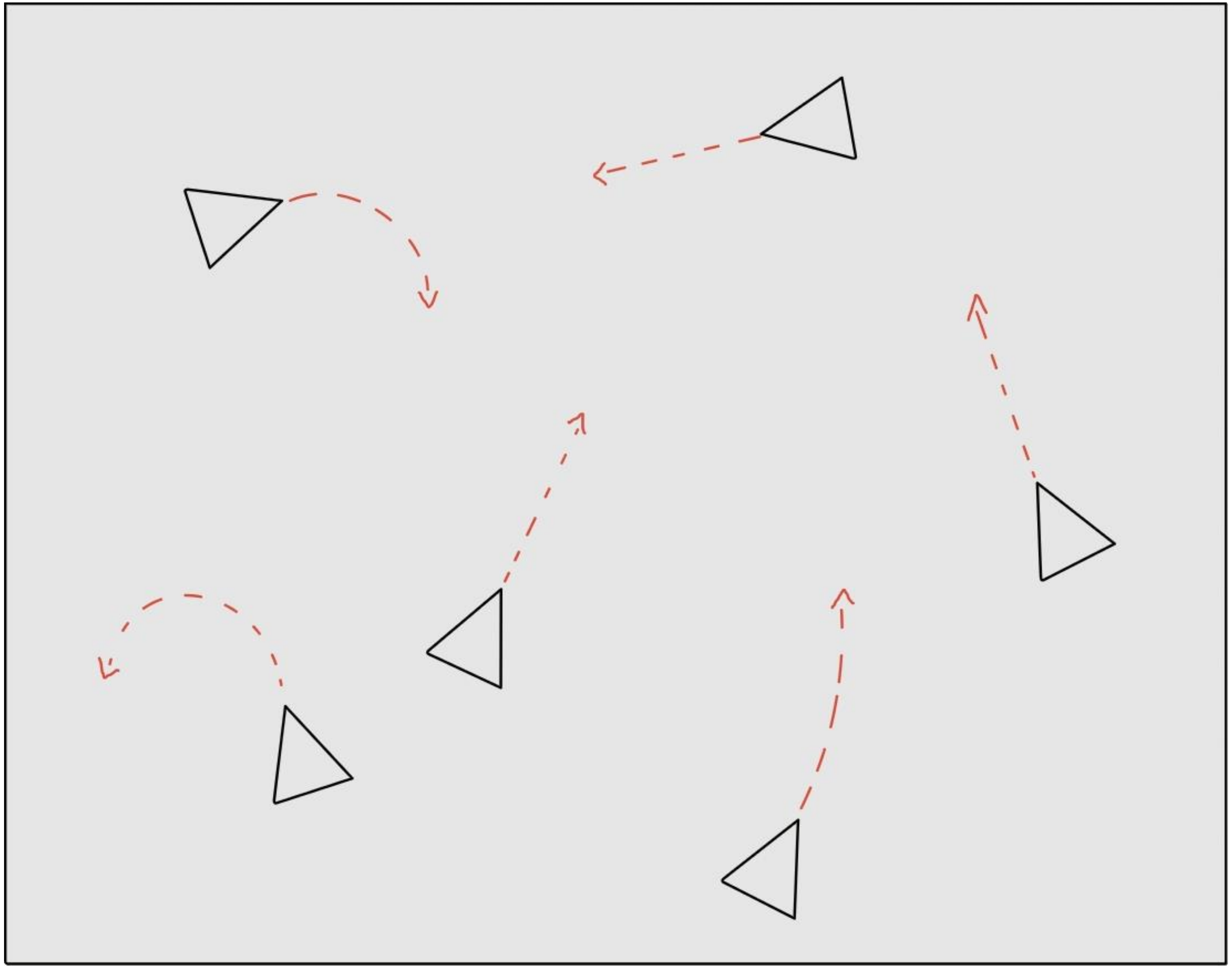
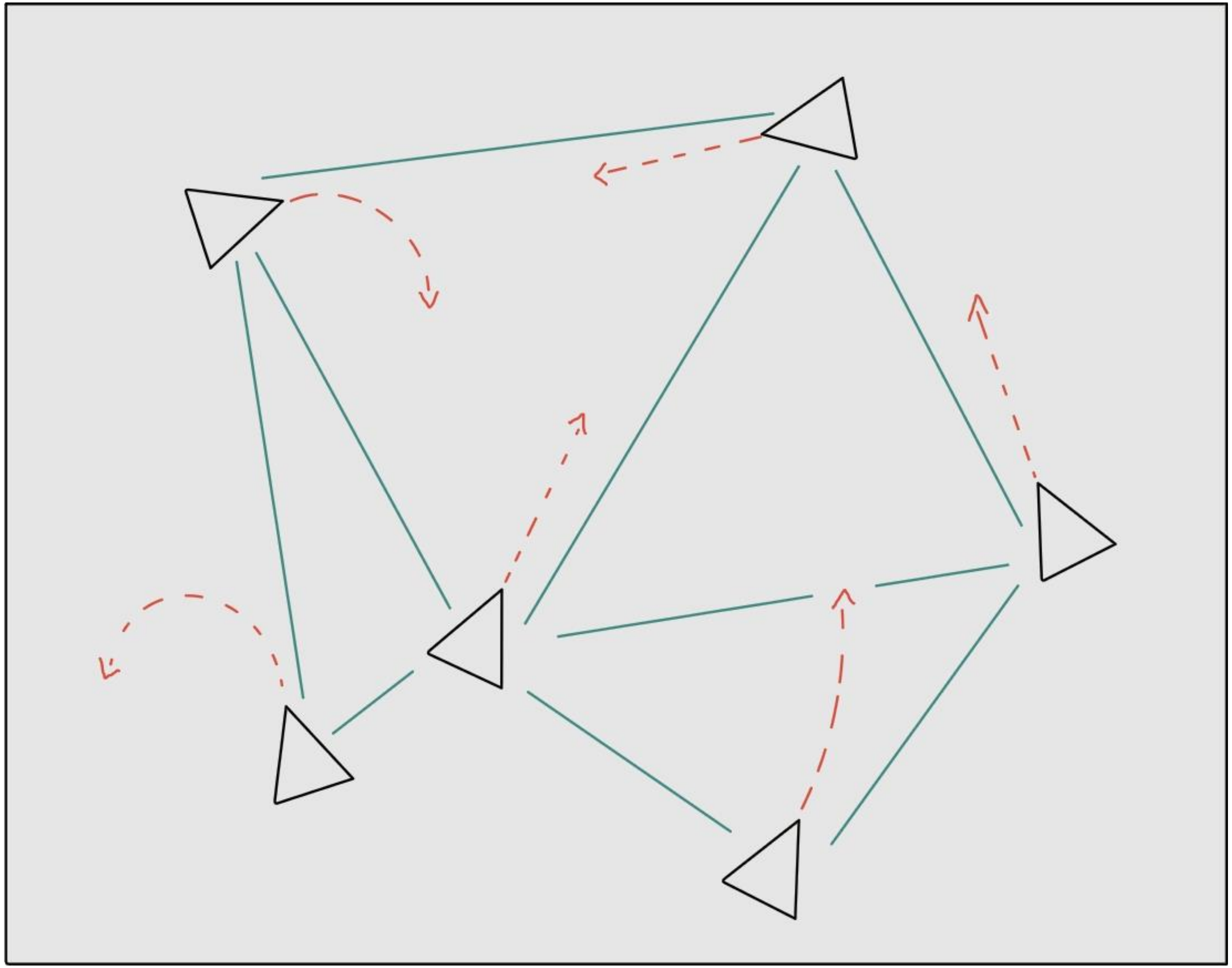
Distance-Based Localization

Robot tracking with EKF and optimization

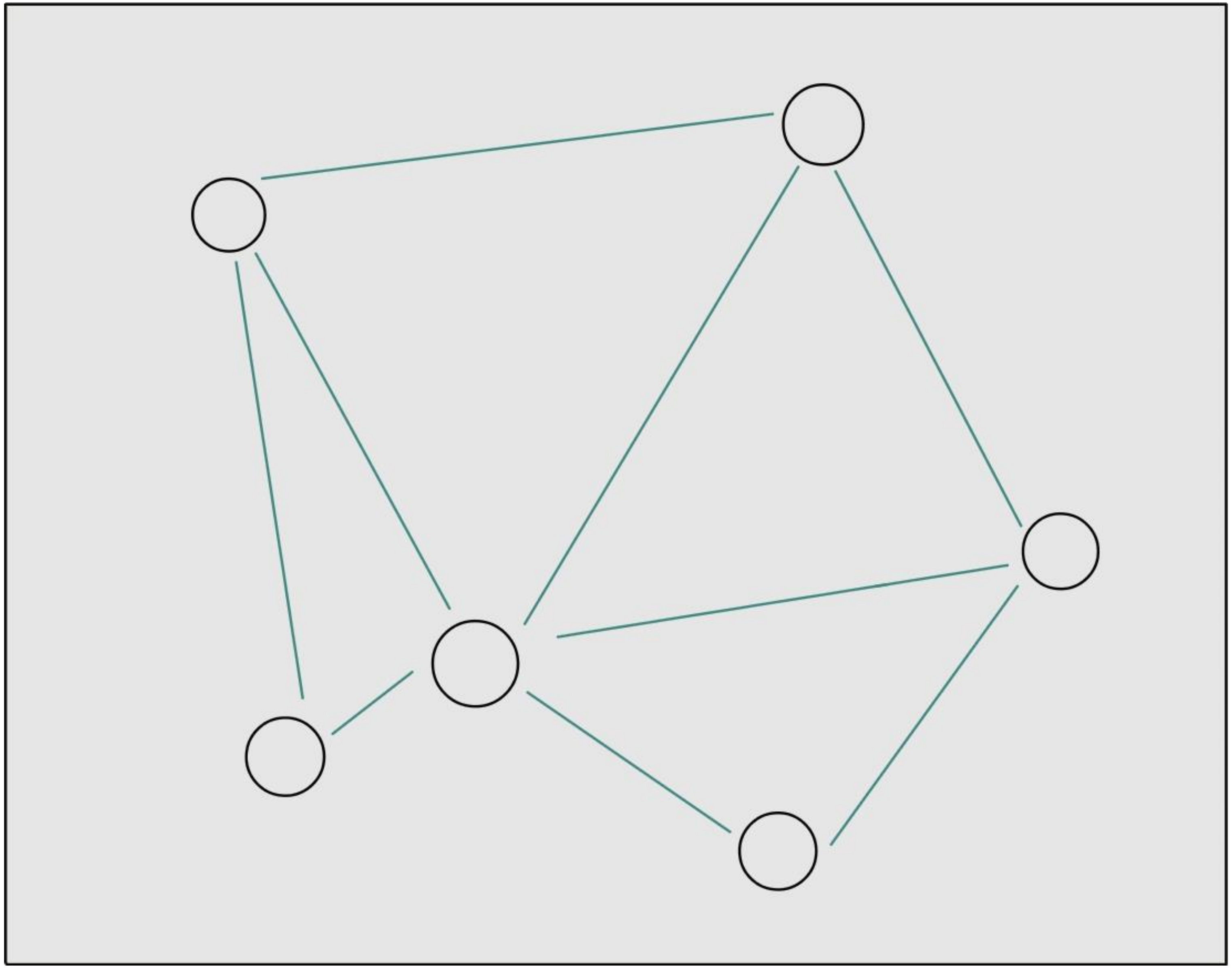
Problem



Relative measurements



Equivalent formulation



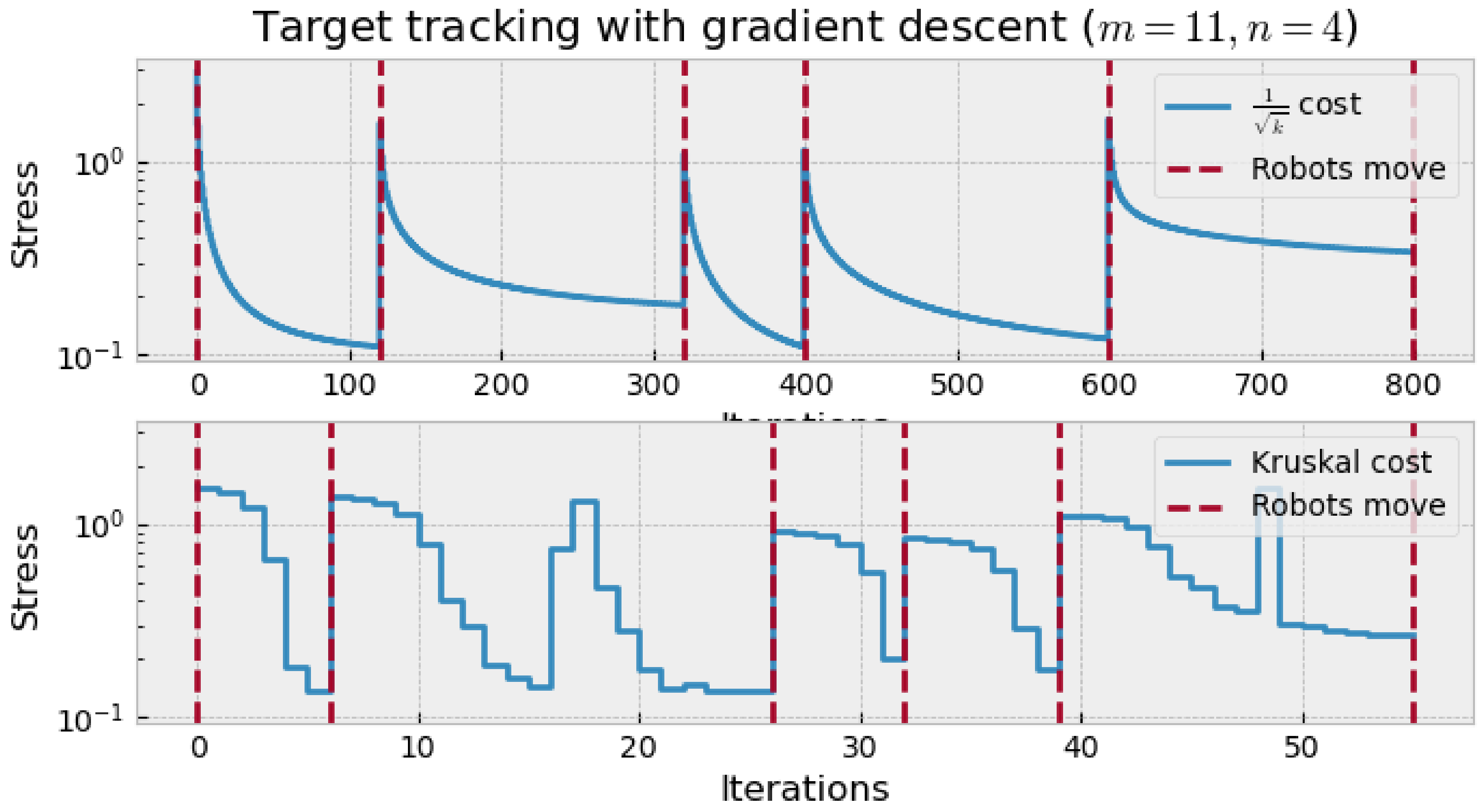
The math

$$\begin{aligned}
\text{Graph:} &\quad \mathcal{G} = (\mathcal{V}, \mathcal{E}) \\
\text{Positions:} &\quad x_i \in \mathbf{R}^2 \\
\text{Measurements:} &\quad y_i \in \mathbf{R} \\
\text{Weights:} &\quad w_{ij} \in \mathbf{R} \\
\text{Objective:} &\quad \min_{x_1, \ldots, x_n} S(x_1, ..., x_n) = \sum_{(i,j) \in \mathcal{E}} \frac{w_{ij}}{2} (||x_i - x_i||_2 - y_i)^2
\end{aligned}$$

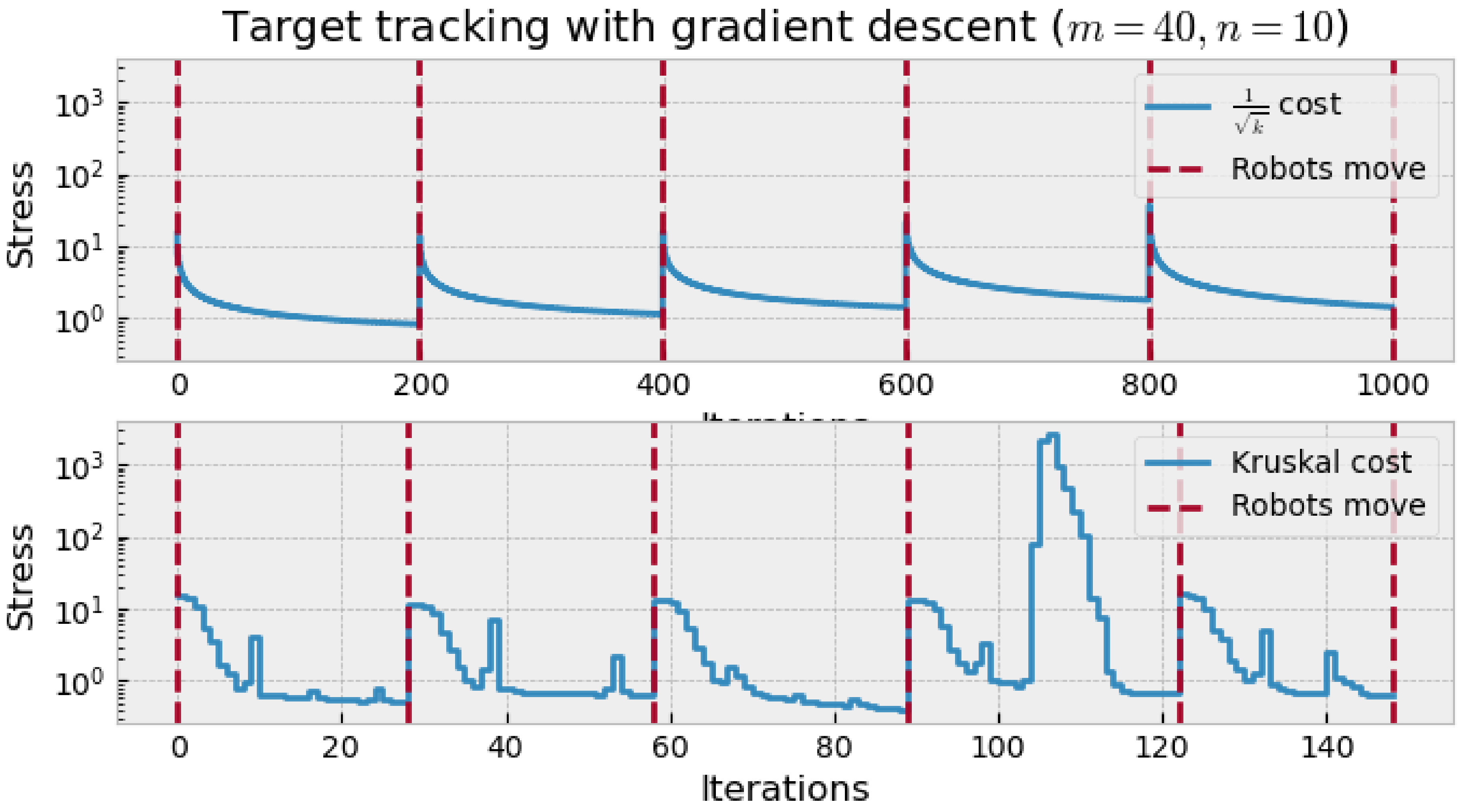
Kruskal’s algorithm

- Simple
- Essentially gradient descent
- Smart choice of step sizes

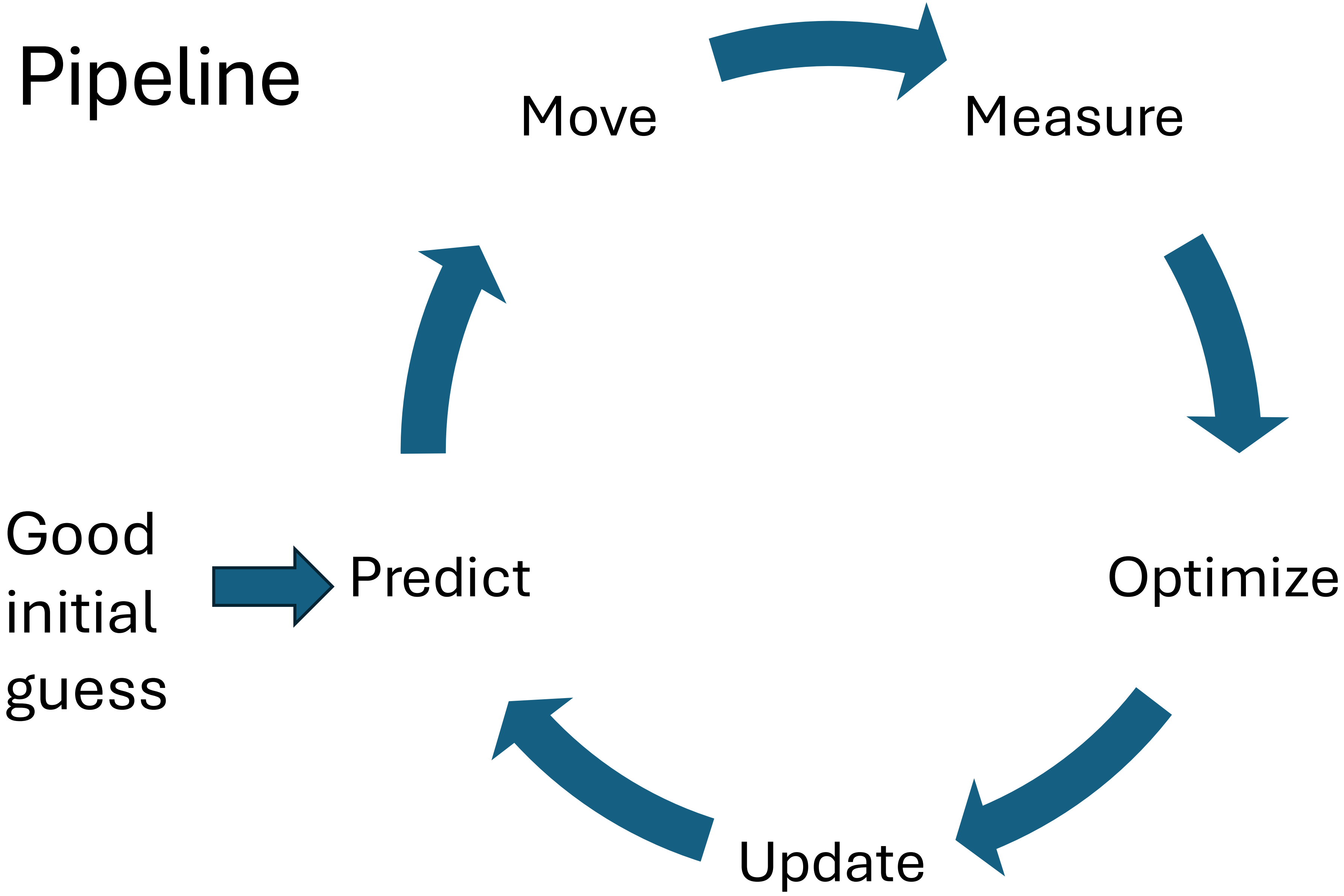
Kruskal's algorithm



Kruskal’s algorithm



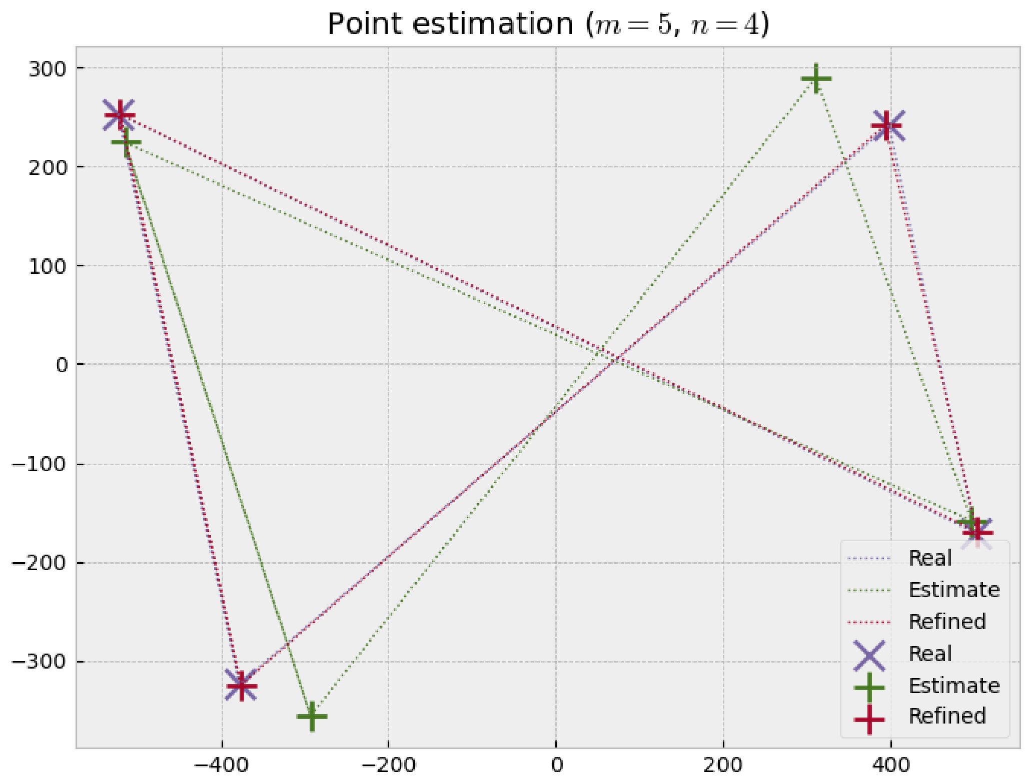
Pipeline

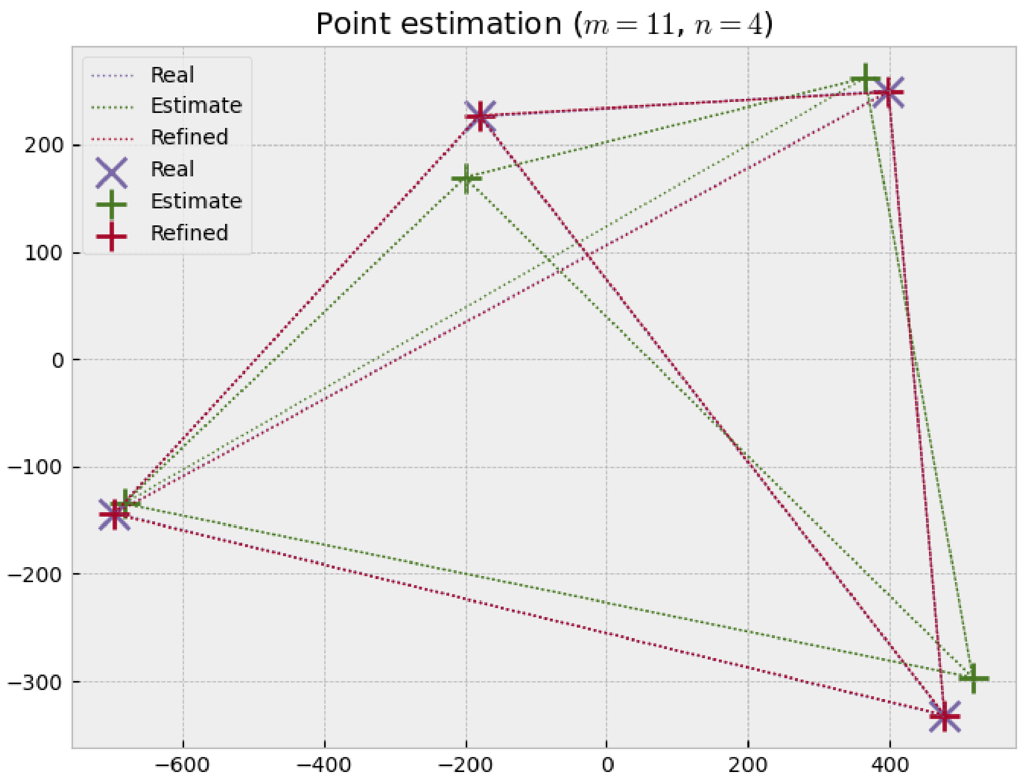


Riemannian Elevator

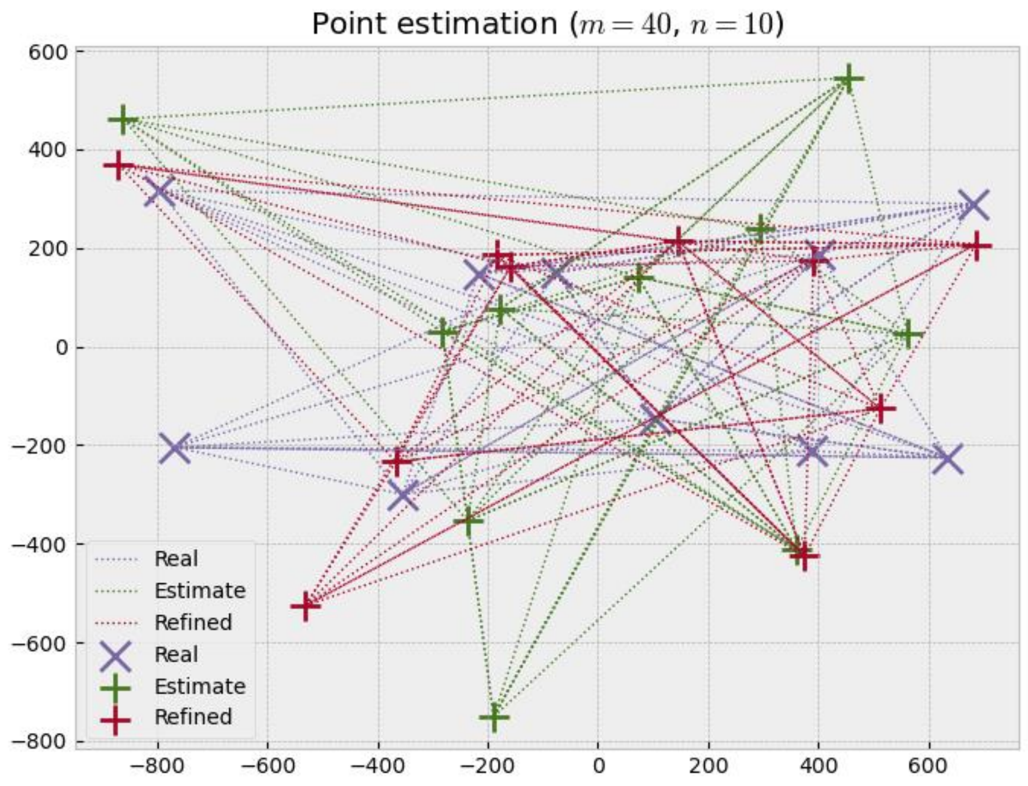
- Developed at prof. Schwager’s lab
- Doesn’t need an initial guess
- Solves a higher-dimensional relaxations
- Optimizes over edge directions and vertex positions

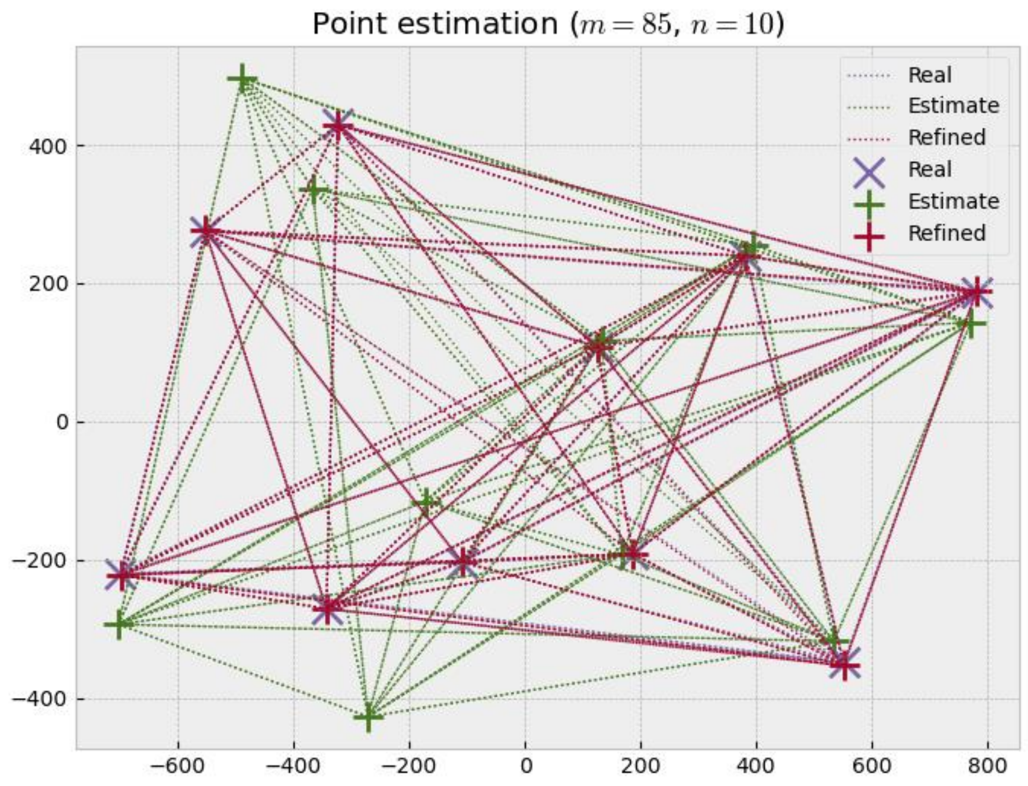
Riemannian Elevator



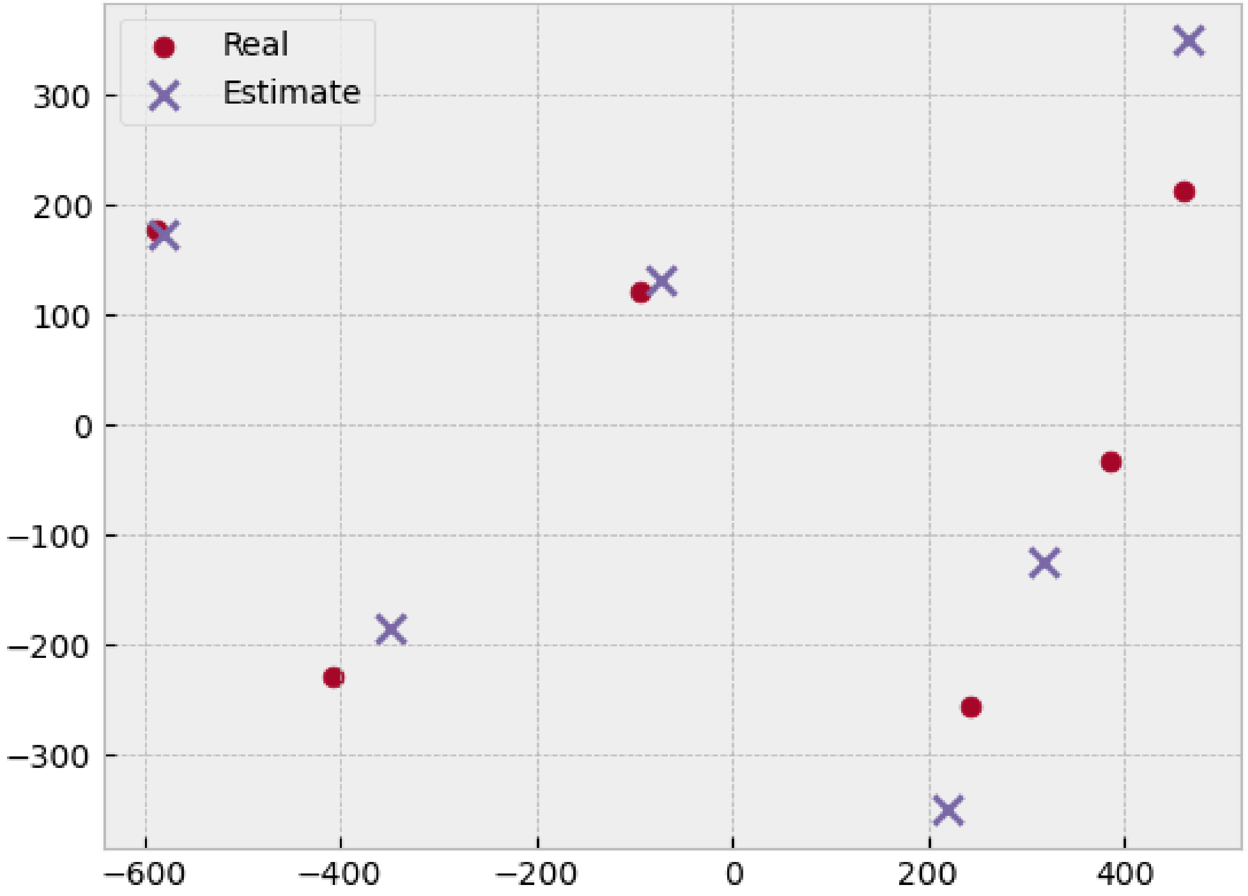


Riemannian Elevator

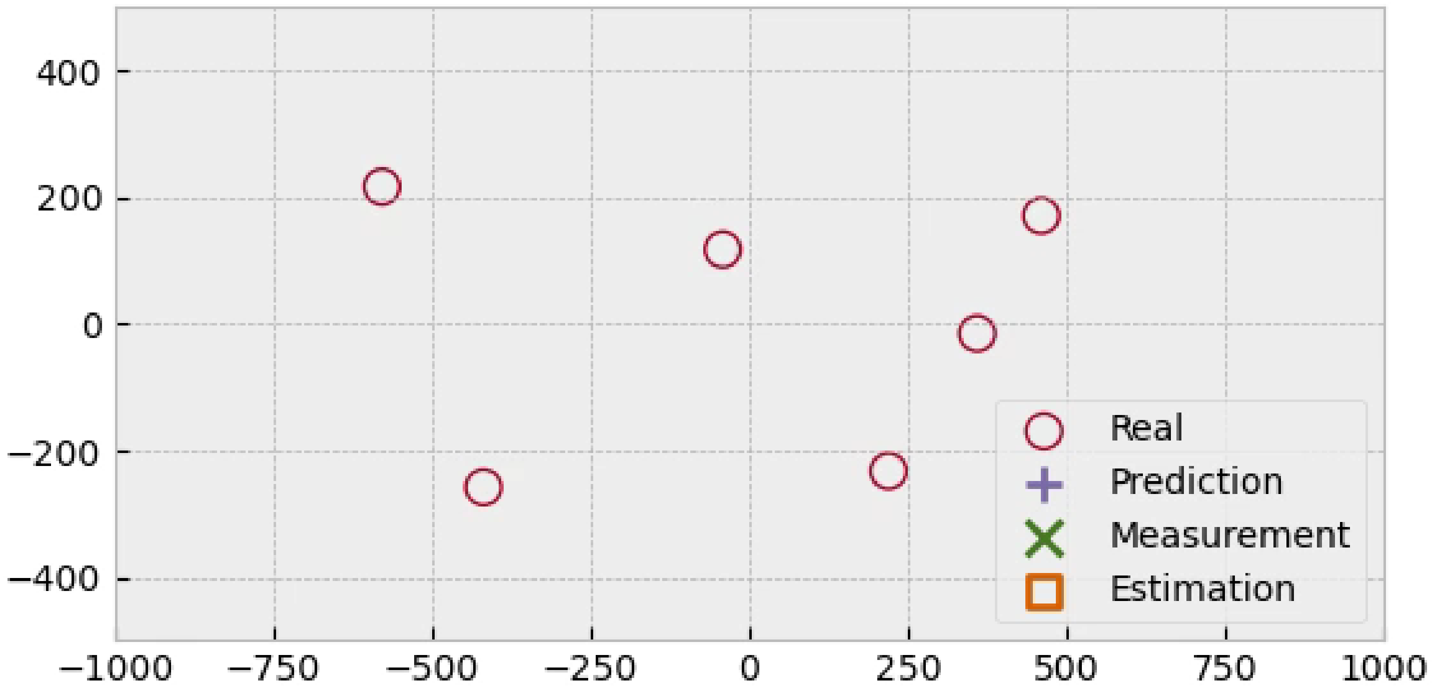




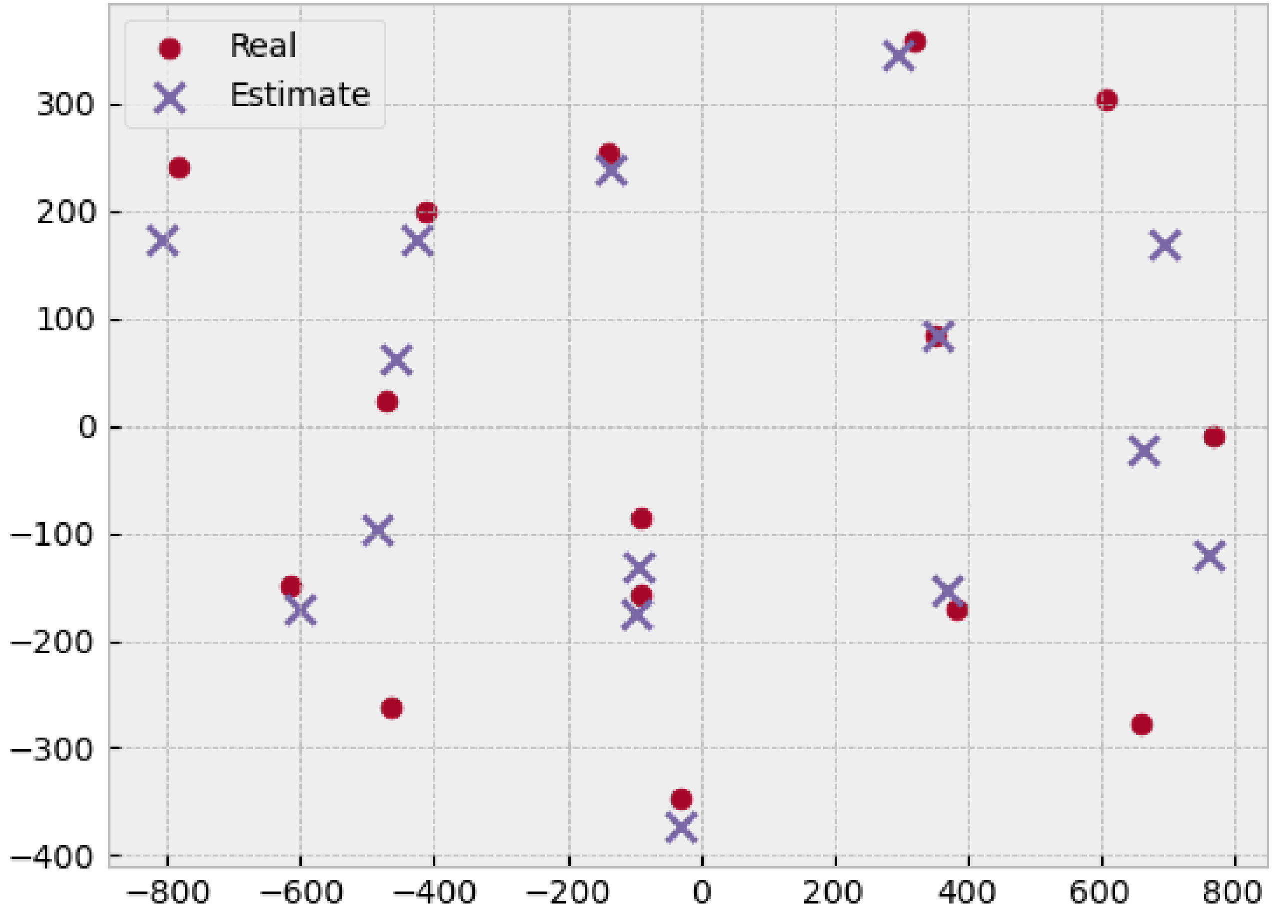
Total pipeline $(m = 18, n = 6)$



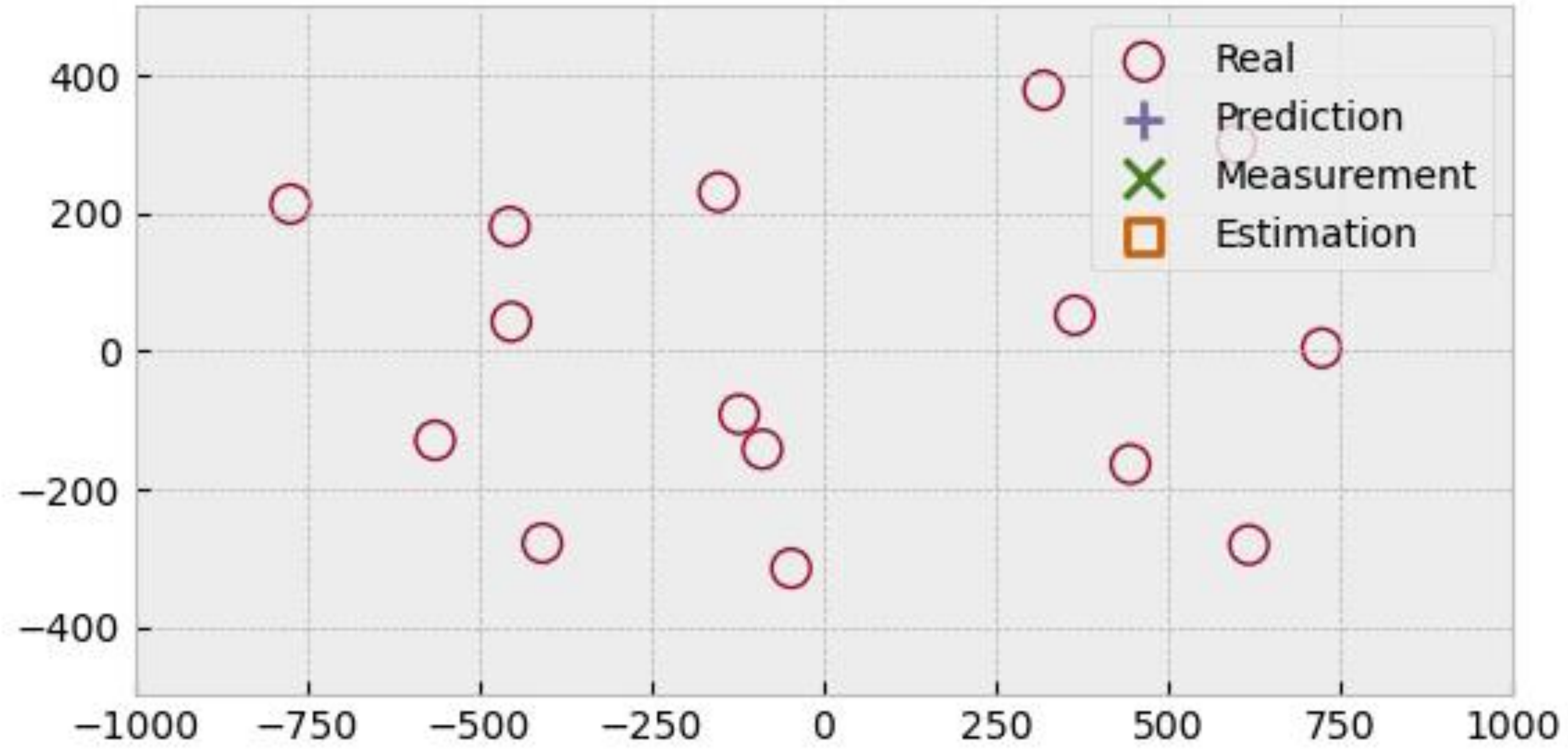
Total pipeline ($m = 18, n = 6$)



Total pipeline ($m = 105, n = 15$)



Total pipeline ($m = 105, n = 15$)



Next steps

- Periodic resetting with Riemannian Elevator
- Replace Kruskal