CVPR JUNE 17-21, 2024 SEATTLE, WA

Universidad Zaragoza 1542

From Correspondences to Pose:

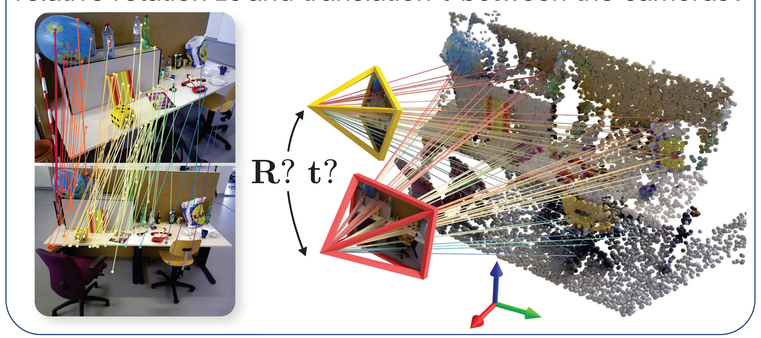
Non-minimal Certifiably Optimal Relative Pose *without Disambiguation*

Javier Tirado-Garín Javier Civera

```
pip install nonmin-pose
github.com/javrtg/C2P
```

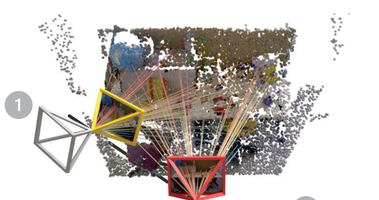
Task: Relative Camera Pose

Given $n > 5$ 2D-2D matches,
relative rotation $\mathbf{R}$ and translation $\mathbf{t}$ between the cameras?



Problem: four-fold ambiguity

Standard approaches minimize **epipolar errors**



Wrong poses:

1 $\mathbf{R}_\pi$, $\mathbf{t}$
2 $\mathbf{R}$, $-\mathbf{t}$ 3 $\mathbf{R}_\pi$, $-\mathbf{t}$

$$\mathbf{E} = [\mathbf{t}]_\times \mathbf{R}$$

$$\min_{\mathbf{E}} \sum_i (\mathbf{f}_{0,i}^\top \mathbf{E}\, \mathbf{f}_{1,i})^2$$

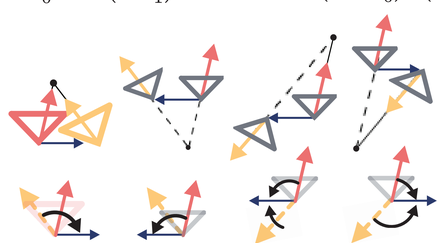
Necessary and Sufficient Constraints

Global optimization with **geometric** and **manifold** constraints:

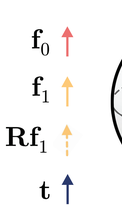
1 To disambiguate $\mathbf{t}$: $\mathbf{f}_0^\top \mathbf{t} - (\mathbf{R}\mathbf{f}_1)^\top \mathbf{t} \geq 0$

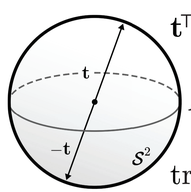
2 To disambiguate $\mathbf{R}$: $(\mathbf{t} \times \mathbf{f}_0) \cdot (\mathbf{t} \times \mathbf{R}\mathbf{f}_1) > 0$

3 4 5 Ensure $\mathbf{E} \in \mathcal{M}_\mathbf{E}$
Ensure $\mathbf{t}, \mathbf{q} \in \mathcal{S}^2$



	$\mathbf{R}$, $\mathbf{t}$	$\mathbf{R}$, $-\mathbf{t}$	$\mathbf{R}_\pi$, $-\mathbf{t}$	$\mathbf{R}_\pi$, $\mathbf{t}$
1	✓	✗	✓	✗
2	✓	✓	✗	✗





$\mathbf{t}^\top\mathbf{t} = 1$

$\mathrm{Adj}(\mathbf{E}) = \mathbf{q}\mathbf{t}^\top$

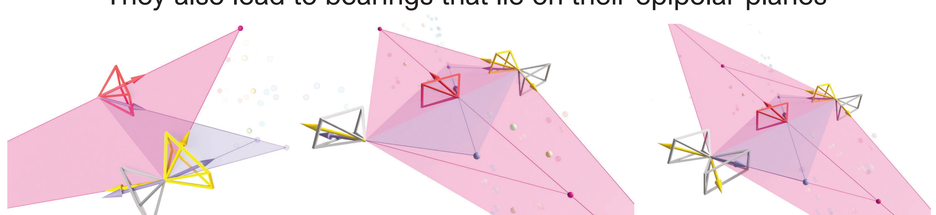
$\mathrm{tr}(\mathbf{E}\mathbf{E}^\top) = 2$

Valid for all central cameras

Quadratic in the unknows

Why three wrong relative poses?

They also lead to bearings that lie on their epipolar planes

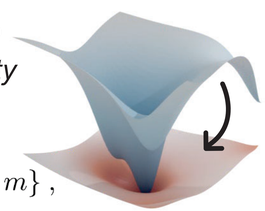


1 $\mathbf{R}_\pi$, $\mathbf{t}$ 2 $\mathbf{R}$, $-\mathbf{t}$ 3 $\mathbf{R}_\pi$, $-\mathbf{t}$

SDP Relaxation

Our QCQP leads to a **tight SDP**
→ solvable with *global optimality*

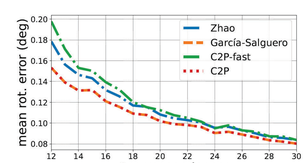
$$\min_{\mathbf{X} \in \mathcal{S}^d} \quad \mathrm{tr}(\mathbf{C}_0\mathbf{X}),$$
$$\text{s.t.} \quad \mathrm{tr}(\mathbf{A}_i\mathbf{X}) = b_i, \quad i \in \{1, .., m\},$$
$$\mathbf{X} \succeq 0.$$

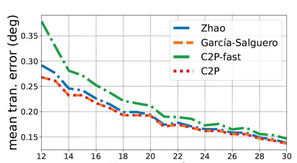


*conceptual visualization

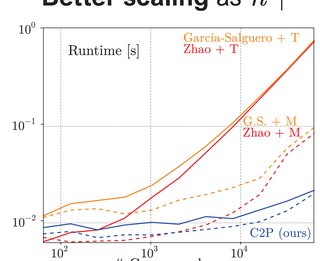
Experiments

Highest accuracy
among globally-optimal alternatives





Better scaling as $n \uparrow$



Same conclusions
on real data