# Point triangulation through polyhedron collapse using the $\ell_\infty$ norm

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## Multiview geometry: triangulation

In triangulation we wish to estimate the location $r$ of a point given observations $\tilde{u}_k$ from known viewpoints $[R_k|c_k]$.

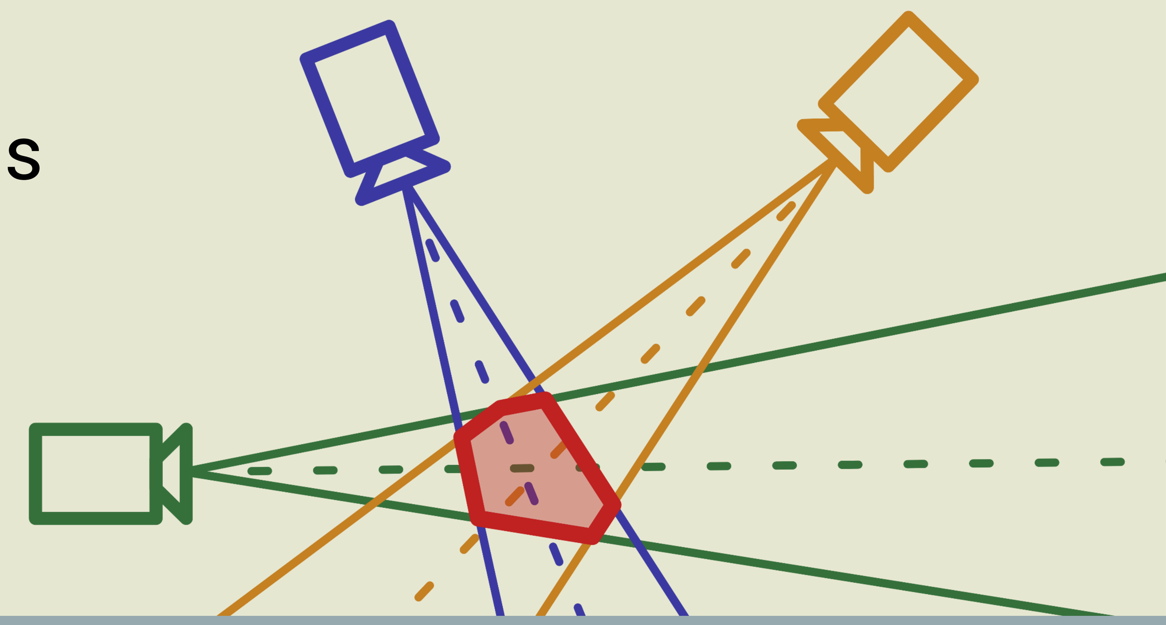
$\ell_\infty$ triangulation means we minimize the worst fit over all observations:

$$\min_r \max_k \|Z_k(r)\tilde{u}_k - r_k(r)\|_\infty / Z_k(r) = \min_r \gamma(r)$$

$$r_k(r) = [R_k|c_k][r^T|1]^T = [X_k(r), Y_k(r), Z_k(r)]^T$$

Given any point estimate $\check{r}$, the sublevel set $\{r|\gamma(r)<\gamma(\check{r})\}$ is a convex polyhedron.

The whole problem is hence quasi-convex and easier to solve.



## Iterative approach

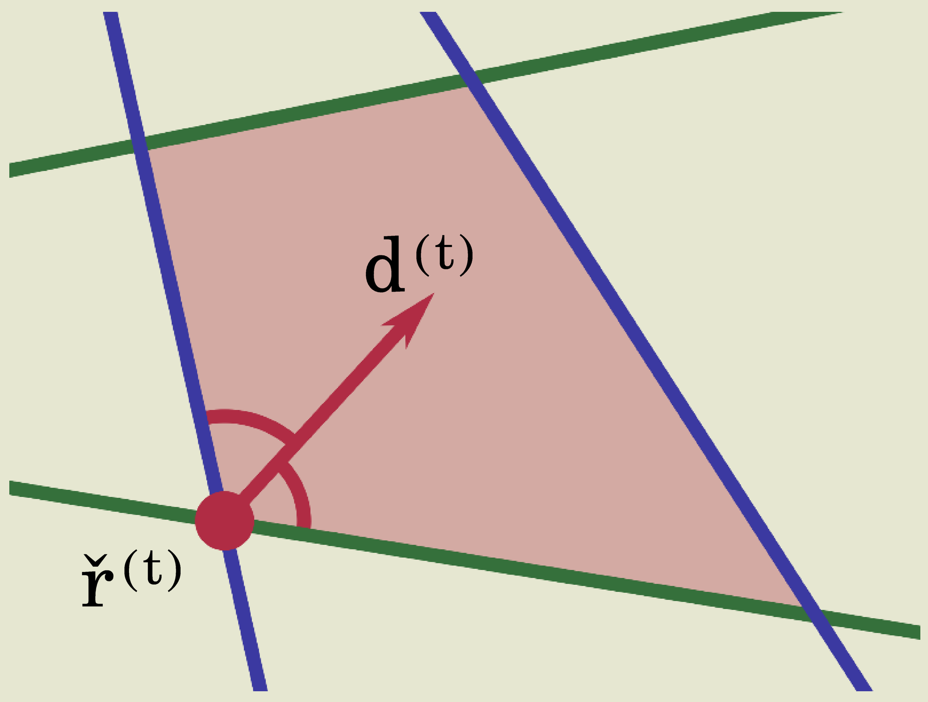
We iteratively perform line search. The choice of improving direction $d$ is straightforward, and the line search comes down to a set of quadratic equations.

Contrary to existing bisection techniques, we do not require complex auxiliary feasibility problems (SOCP or LP).

Optimization is performed directly in the spatial domain.

## Improving direction

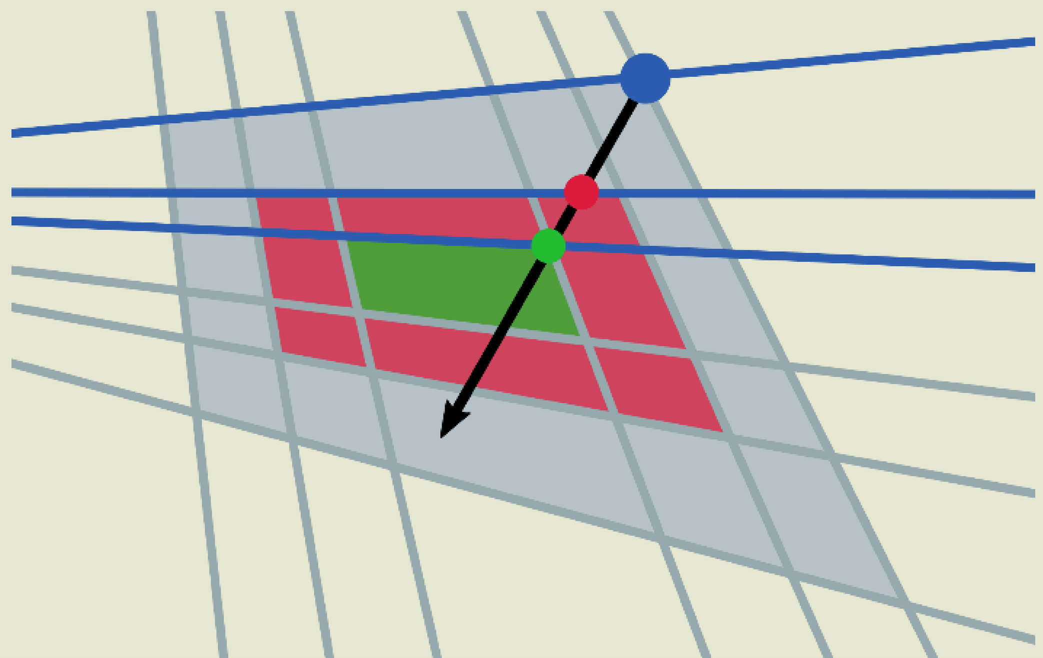
The improving direction is chosen locally: we step away from all active constraints.




The active constraints are the edges of the polyhedron the current estimate lies on.

## Line search

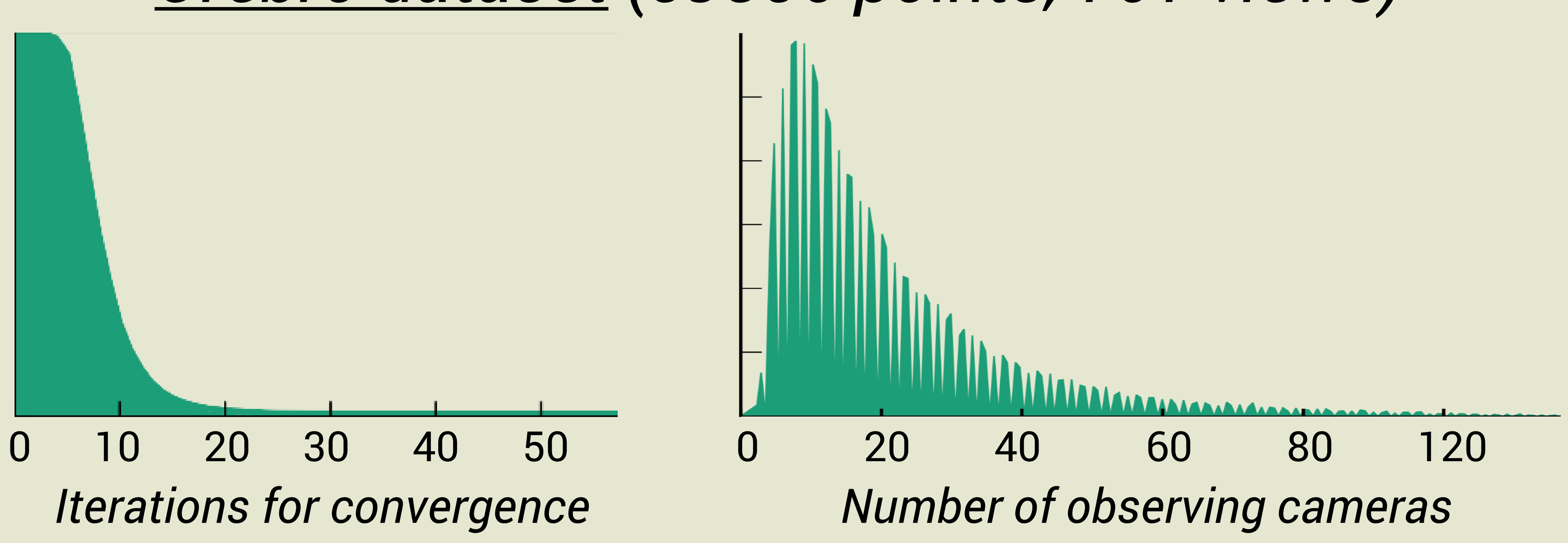
The *master* constraint is the active constraint that decreases the slowest along the chosen direction.
The step size $\alpha$ is the smallest one for which the master constraint is equal to another constraint.



## Experiments and results

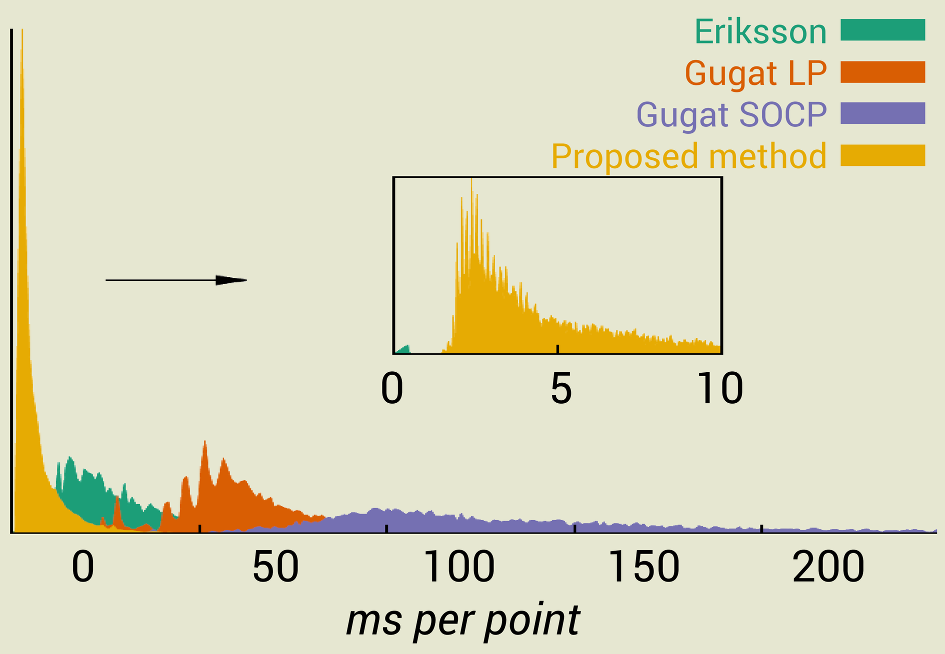
The simple direction choices are much faster than the existing complex auxiliary problems for bisection methods, but require more iterations until convergence.

*Örebro dataset* (59856 points, 761 views)

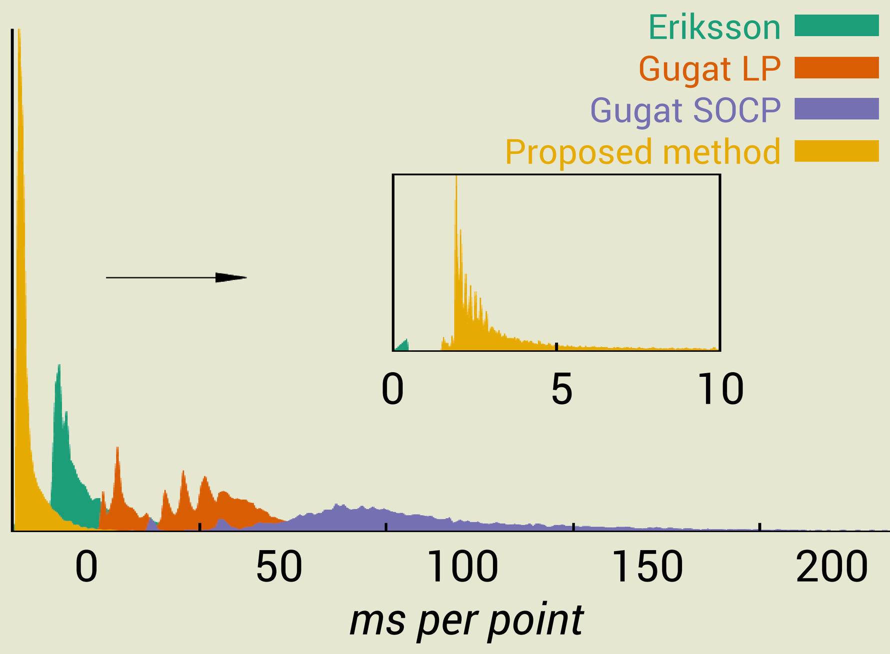


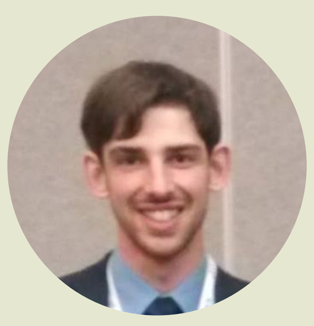

The trade-off between faster, but more, iterations ends in favor of the proposed method.

*Alcatraz dataset* (65072 points, 419 views)




*Église du Dôme* (84792 points, 85 views)



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