Hierarchical Localization with hloc and SuperGlue

ECCV 2020 Workshop on
Long-Term Visual Localization under Changing Conditions

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ECCV'20 ONLINE
23-28 AUGUST 2020

ETH zürich

Computer Vision and Geometry Lab

hloc - a toolbox for visual localization

with Mihai Dusmanu, Viktor Larsson, Marc Pollefeys

ETH zürich

SuperGlue - a graph neural network for feature matching

with Daniel DeTone, Tomasz Malisiewicz, Andrew Rabinovich

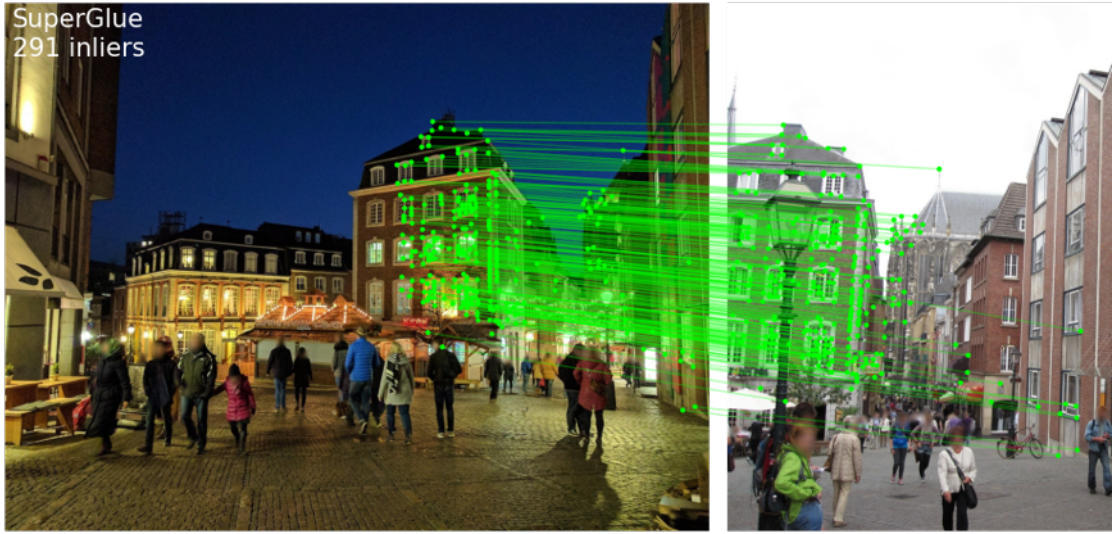
magic leap

First place in 6 localization challenges!

At CVPR 2020: 2 challenges, local features & handheld devices

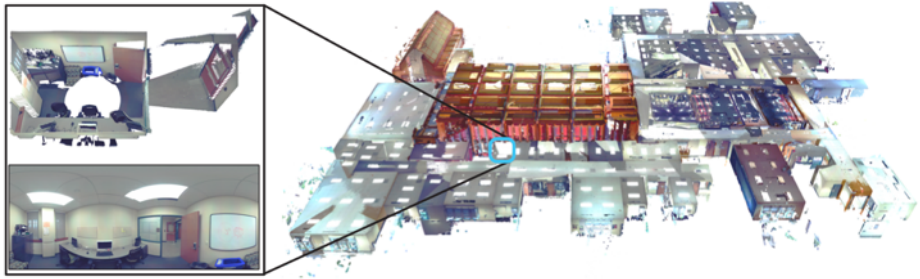
At ECCV 2020, workshops:

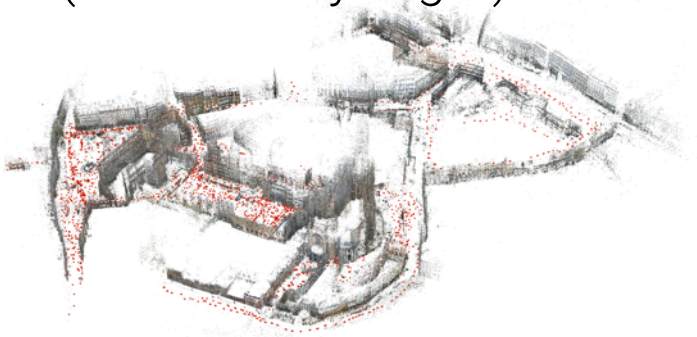
- 1x Map-based Localization for Autonomous Driving — last Sunday
- 3x Long-Term Visual Localization under Changing Conditions — this talk



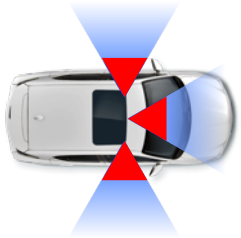
First place in all 3 challenges

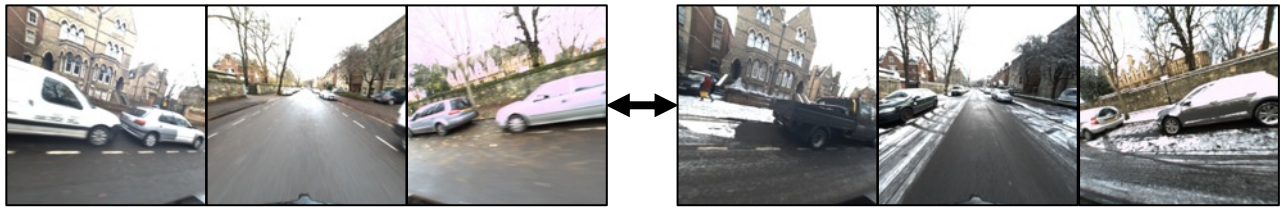
- Handheld devices: indoor (InLoc) & outdoor (Aachen Day Night)





- Autonomous vehicles: multi-camera & cross-season





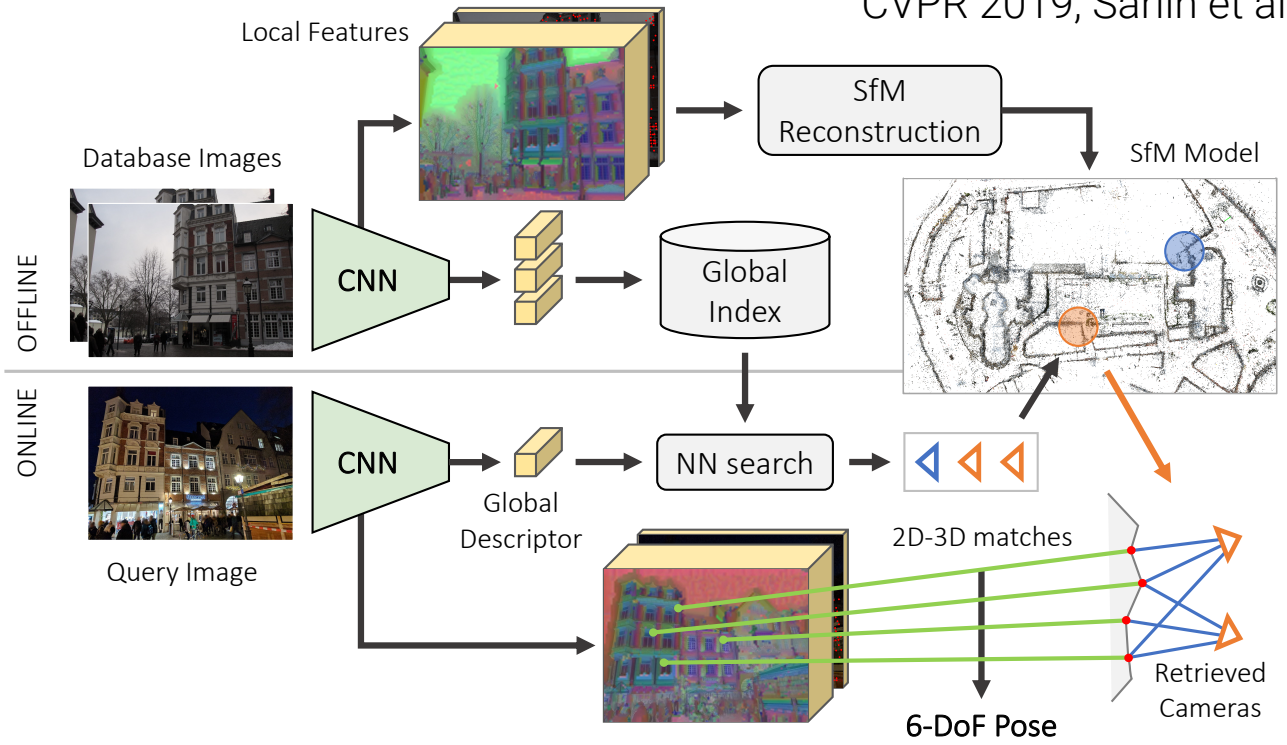
3 datasets:
RobotCar
CMU
SILDa

- Local feature challenge: Aachen Night with perfect retrieval

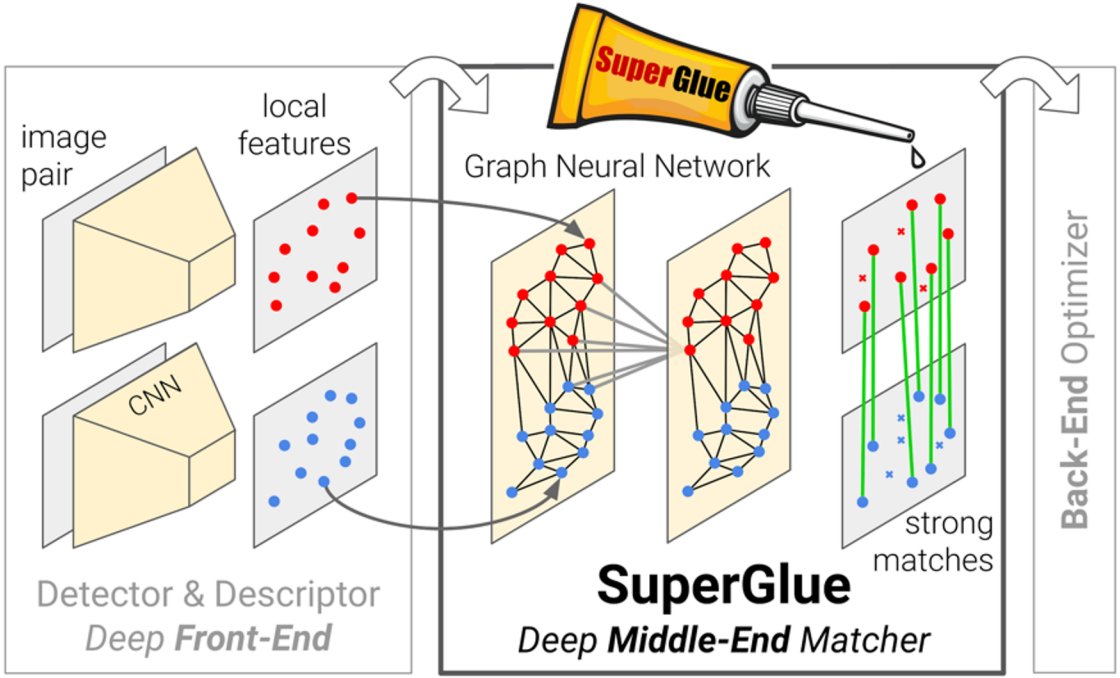
Hierarchical Localization

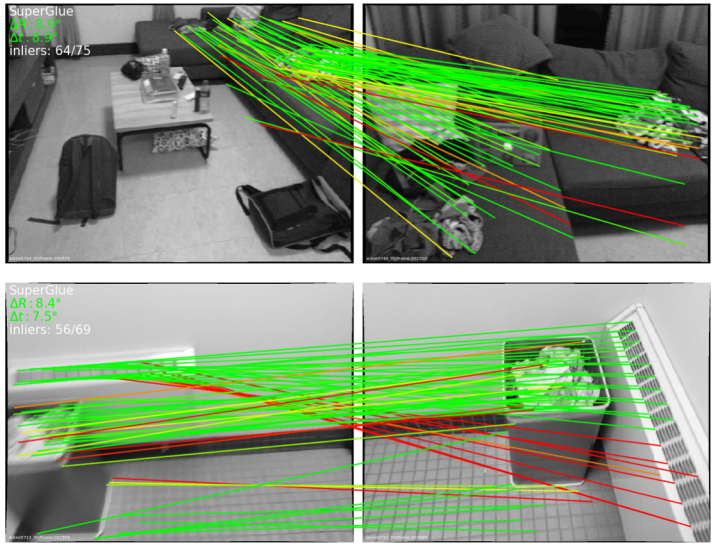
Winner of last year's challenge:

From Coarse to Fine: Robust Hierarchical Localization at Large Scale. CVPR 2019, Sarlin et al.



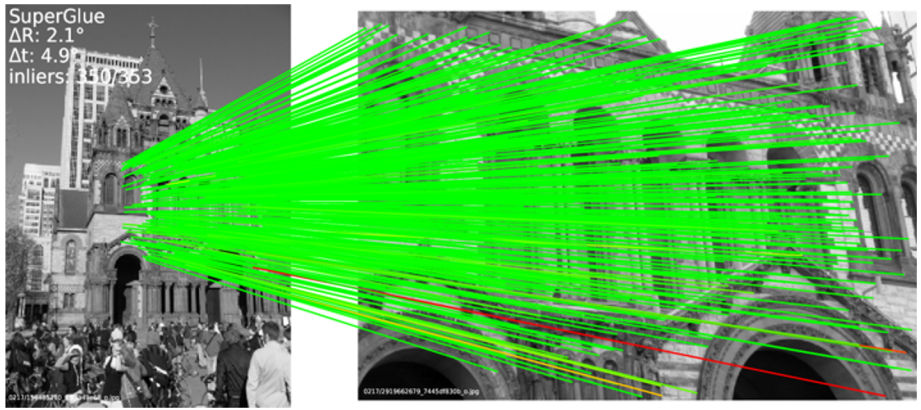
SuperGlue = Graph Neural Nets + Matching

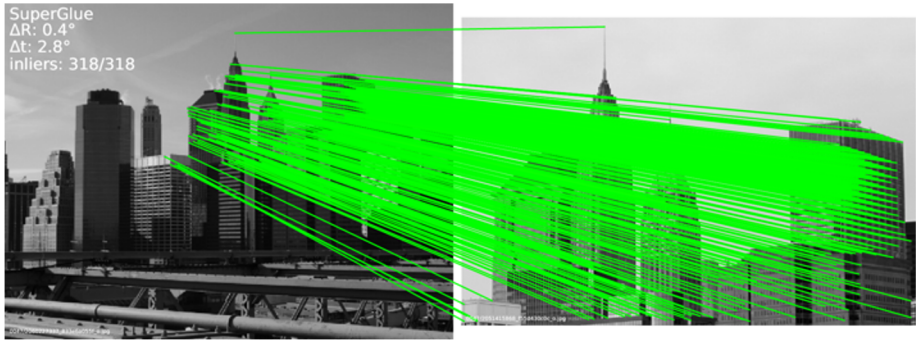


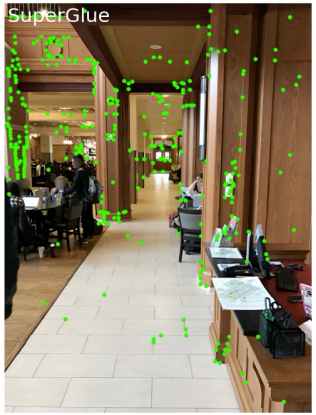


- Extreme **wide-baseline** image pairs in **real-time on GPU**
- State-of-the-art **indoor+outdoor** matching with **SIFT** & **SuperPoint**

SuperGlue = Graph Neural Nets + Matching







CVPR 2020

Paper + code + talks:

psarlin.com/superglue

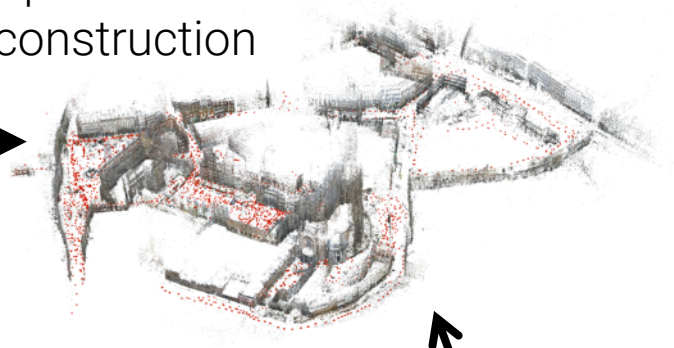
hloc – a toolbox for SfM & localization

images

3D reconstruction

hloc

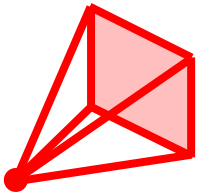
sparse 3D reconstruction



query

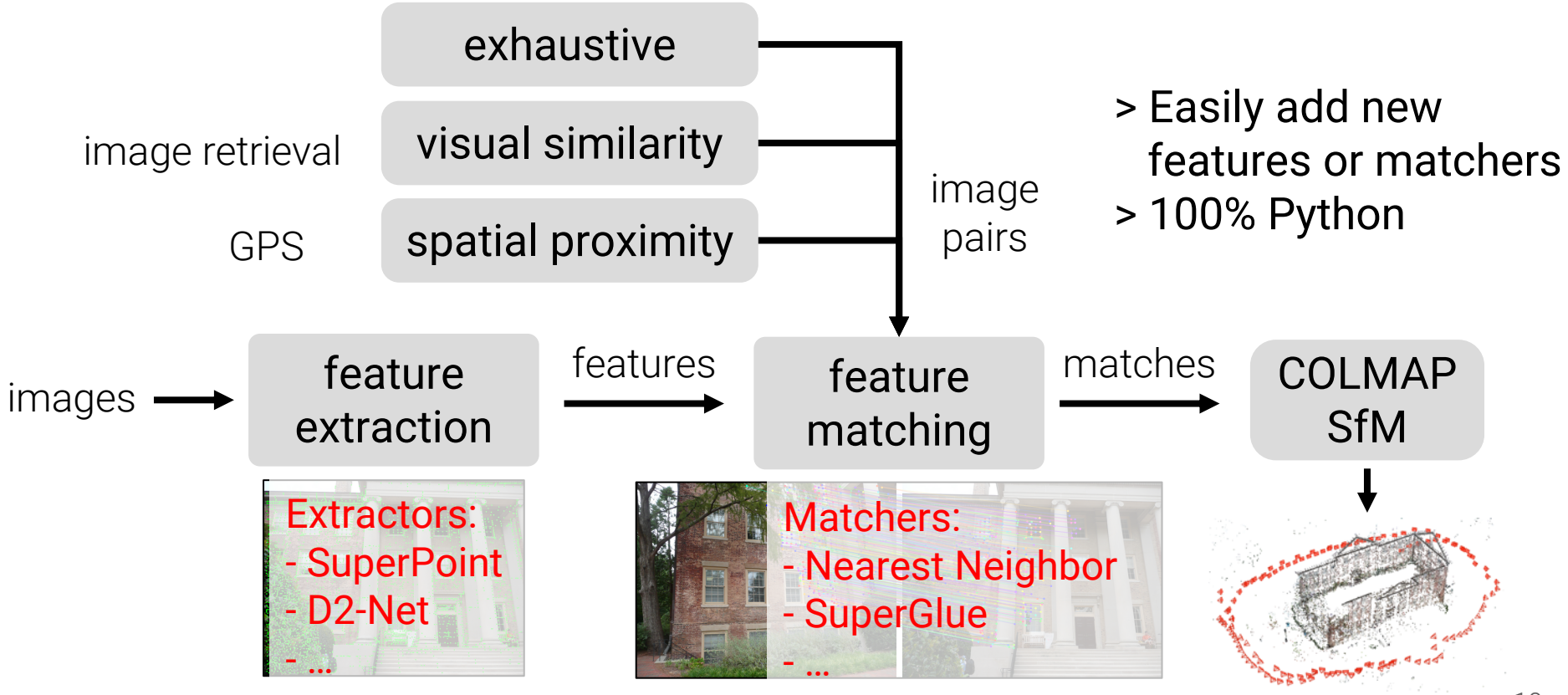
localization

hloc

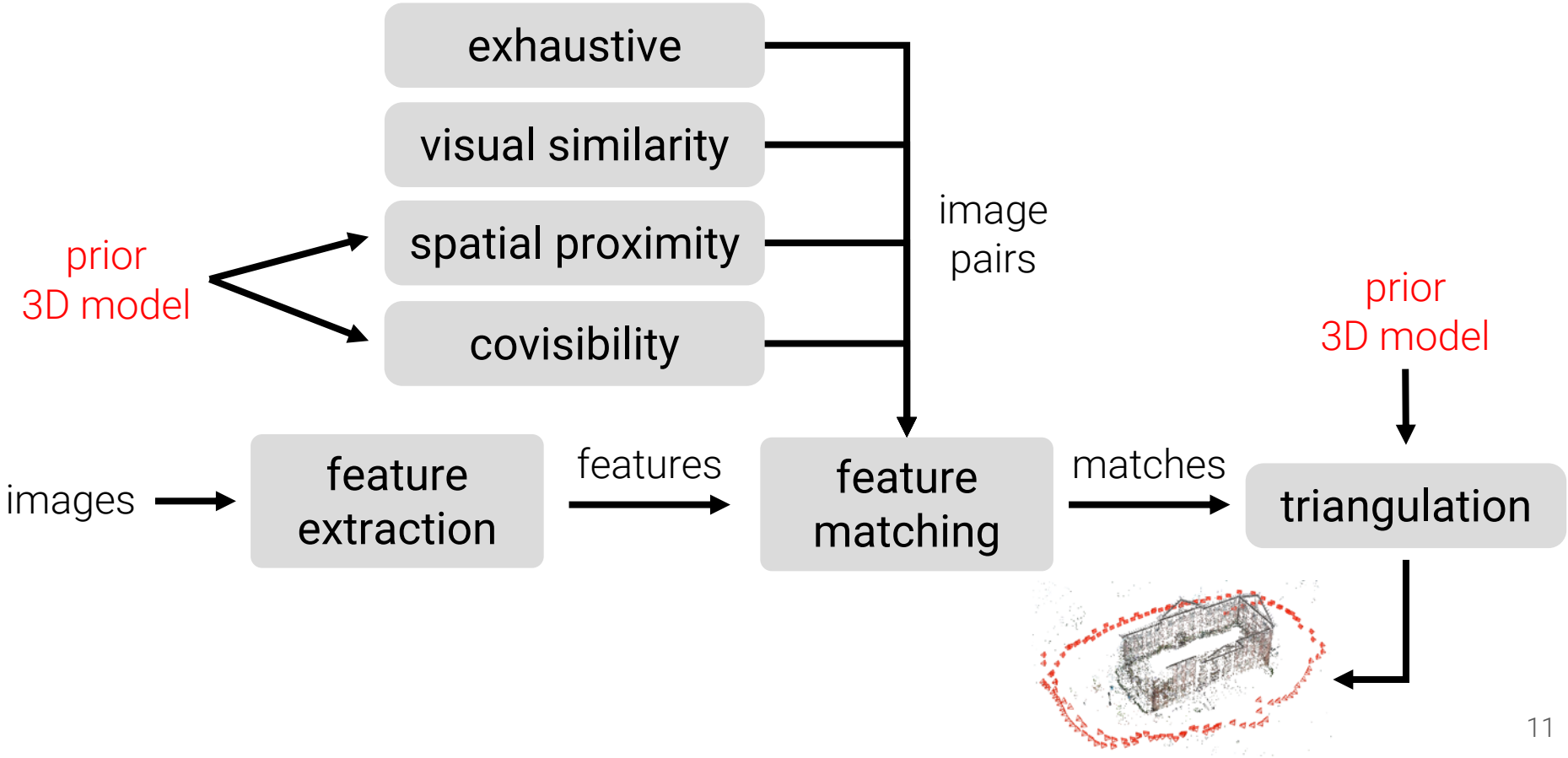


github.com/cvg/Hierarchical-Localization

hloc – reconstruction



hloc – triangulation



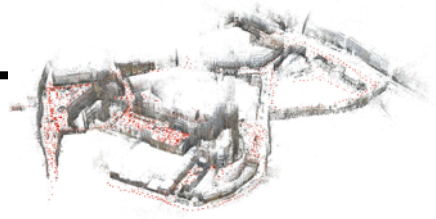
hloc – localization

reference

- 3D model
- images
- features

visual similarity

image pairs



query

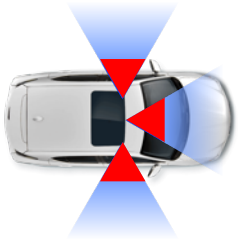
feature extraction

features

feature matching

matches

Localization
PnP+RANSAC



Multi-camera rig
with generalized PnP

6 DoF
pose

Supported datasets: outdoor vs indoor

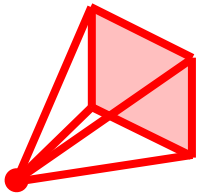
from www.visuallocalization.net

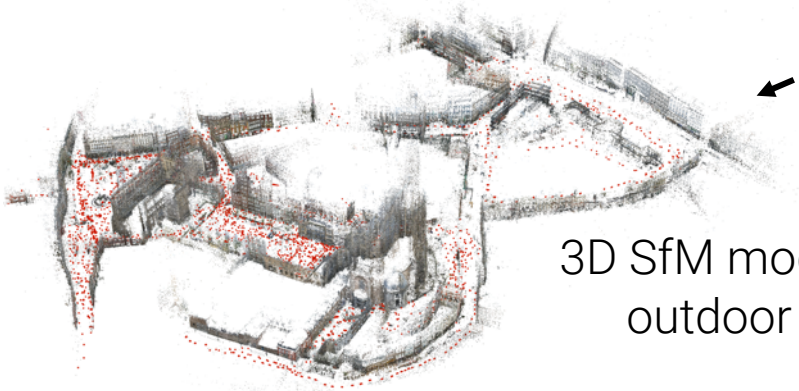
Query

top 20-50 retrieval with NetVLAD

2D-2D matches

lift to 2D-3D using

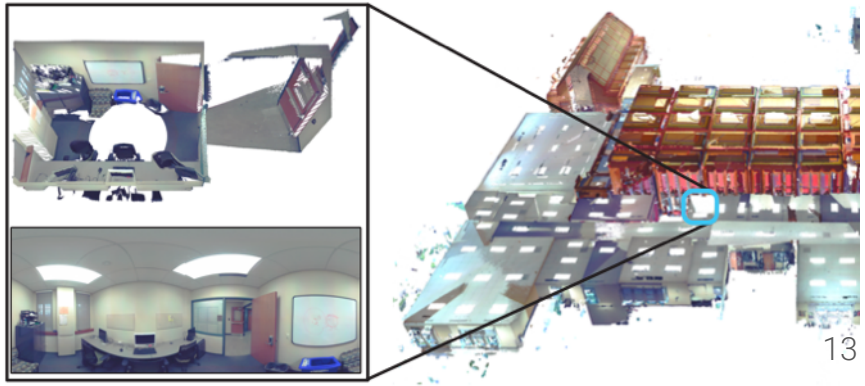




3D SfM model outdoor

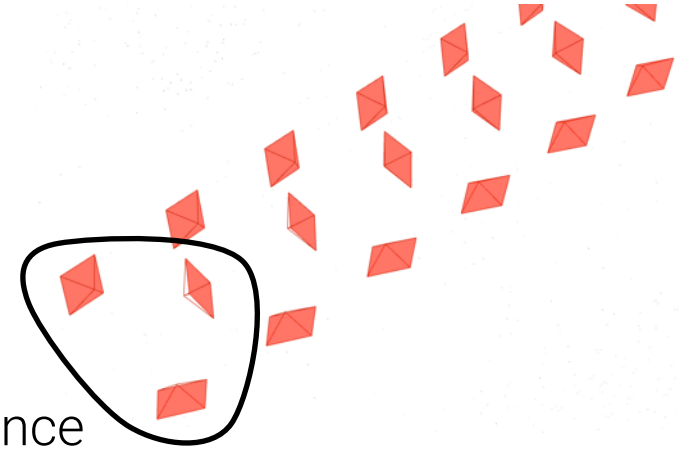
Aachen Day-Night (v1.0 & v1.1), RobotCar, CMU, SILDa

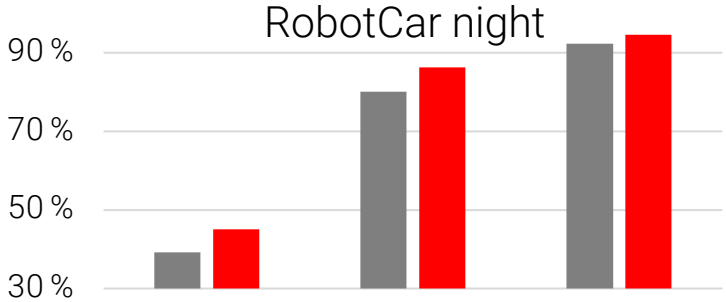
3D Lidar scans indoor - InLoc



Multi-Camera Localization for autonomous driving

- For RobotCar, CMU and SILDa
- LO-MSAC + GP3P (RansacLib + PoseLib)
  Wald et al., ECCV 2020
  github.com/tsattler/MultiCameraPose
- Estimate rig extrinsics:
  rotation + translation averaging on reference
- Increase robustness in hard cases + better constrains the pose

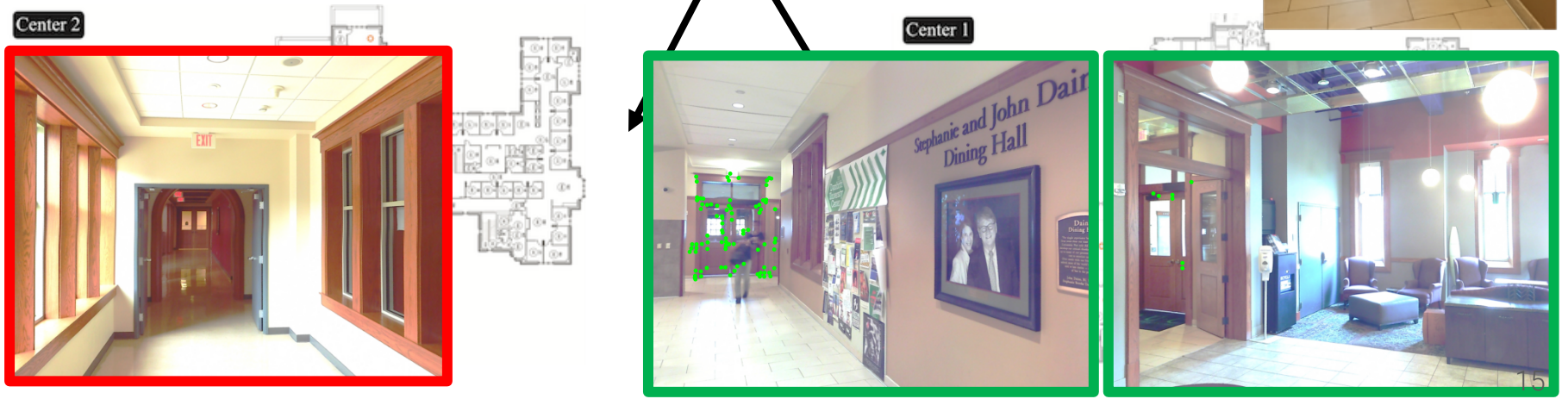




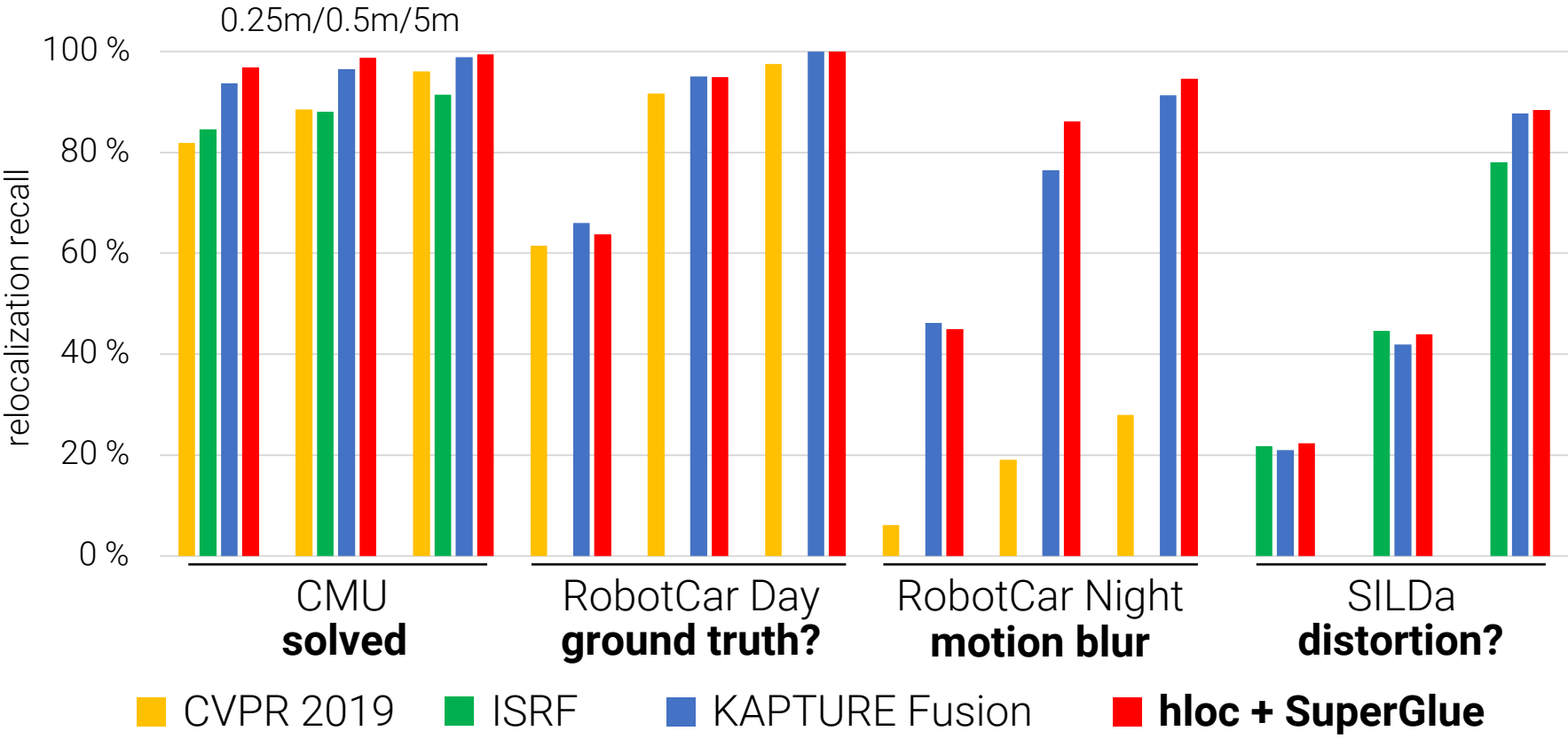
Boost indoor retrieval with temporal consistency

Queries belong to 2 floors and are ordered as a sequence

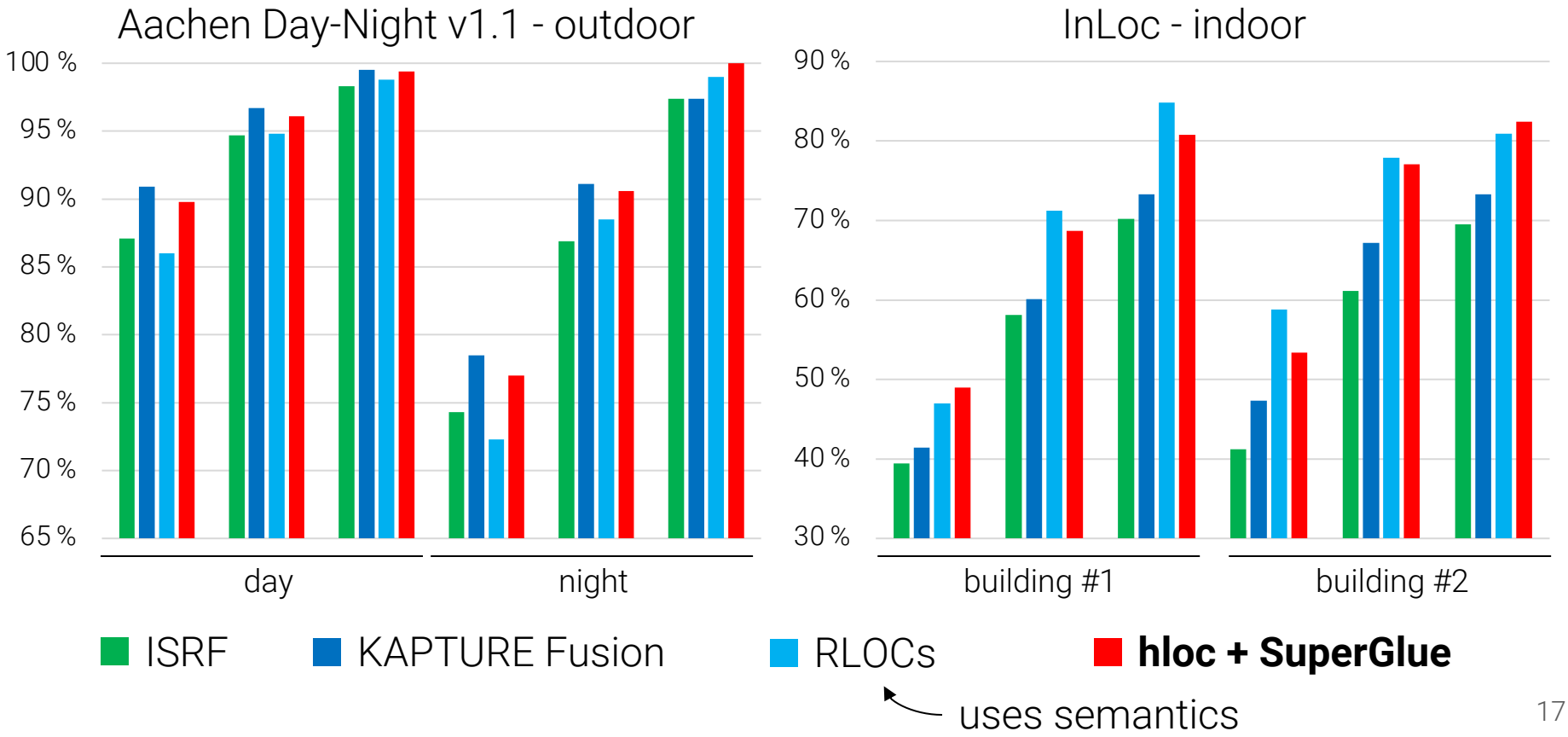
1. **Localize easy queries** and save their floor (1 or 2)
2. Temporal consistency: **deduce the floors of hard queries**
3. **Restrict the retrieval** to the relevant floors



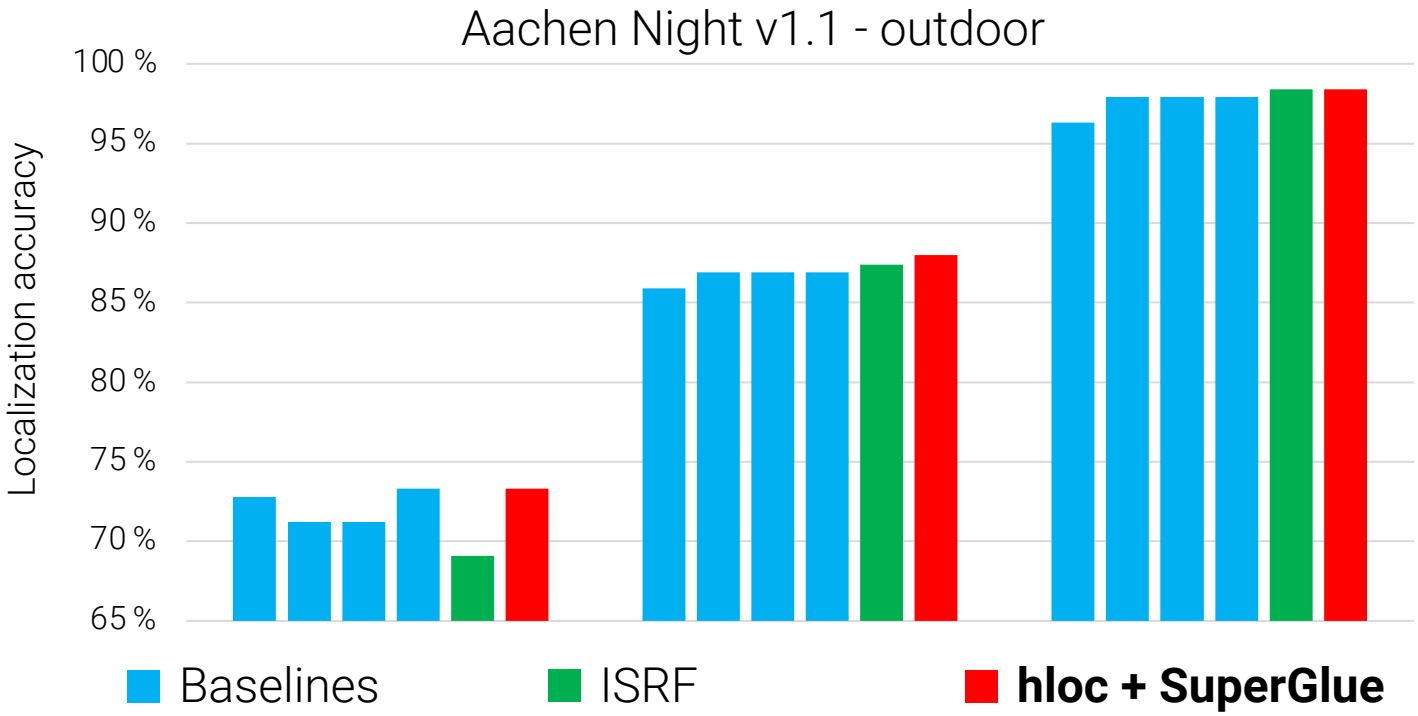
Challenge results – Autonomous Vehicles



Challenge results – Handheld Devices



Challenge results – Local Features



Saturated – noisy ground truth?

What should we work on?

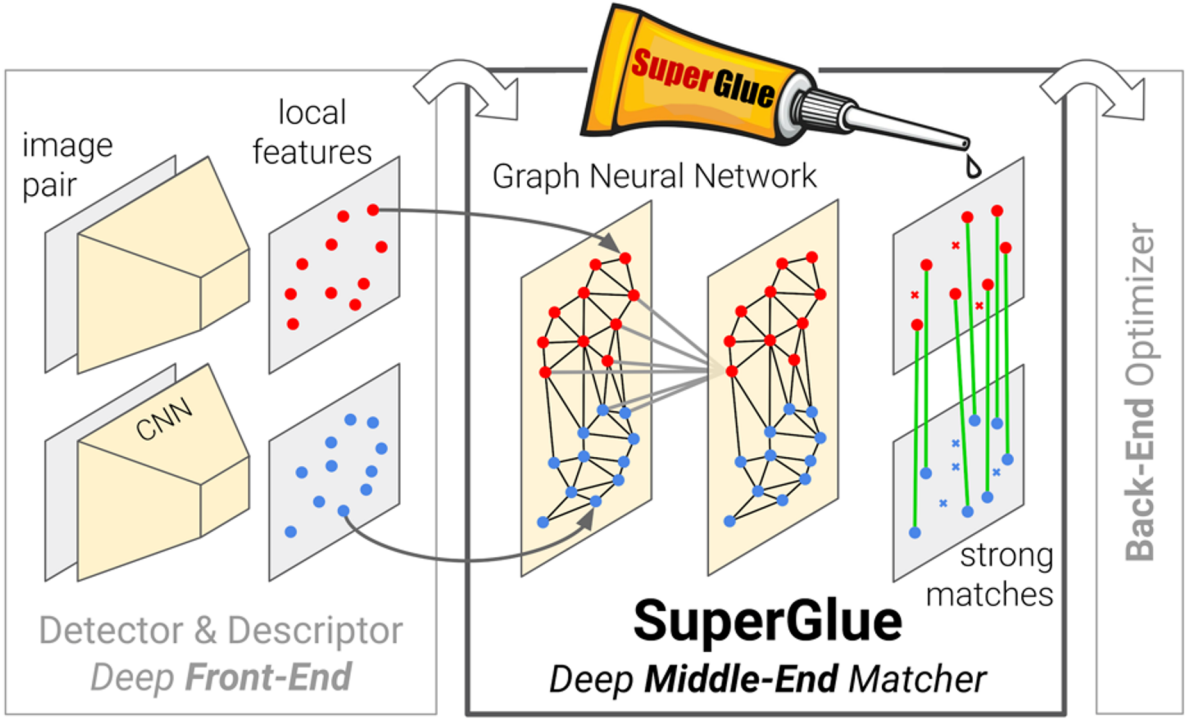
1. Going **beyond keypoints**:
   combining the **robustness** of keypoint-based localization
   with the **accuracy** of direct image alignment
2. More **powerful image retrieval**:
   here we have localization priors, what if we don't?
   image retrieval is **often the bottleneck**
3. Leveraging **sequential information**:
   localize single queries vs sequences

hloc + SuperGlue

hloc = a simple & clean toolbox for visual localization

1. Reproduce our **CVPR & ECCV 2020 winning results**
2. Run SfM with SuperGlue **to localize with your own datasets**
3. **Evaluate your own** local features or image retrieval for localization
4. **Easily implement & debug** new localization pipelines 🔥

github.com/cvg/Hierarchical-Localization



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