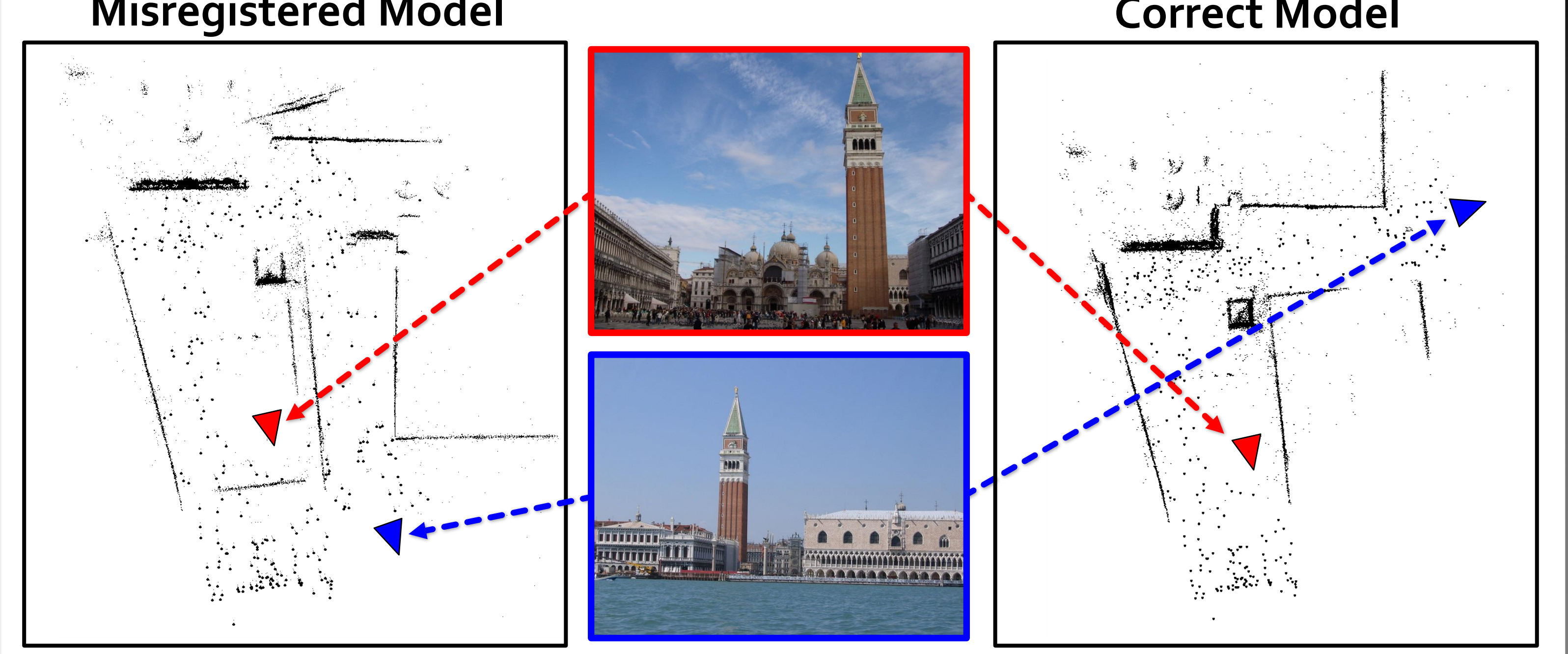# Recovering Correct Reconstructions from Indistinguishable Geometry
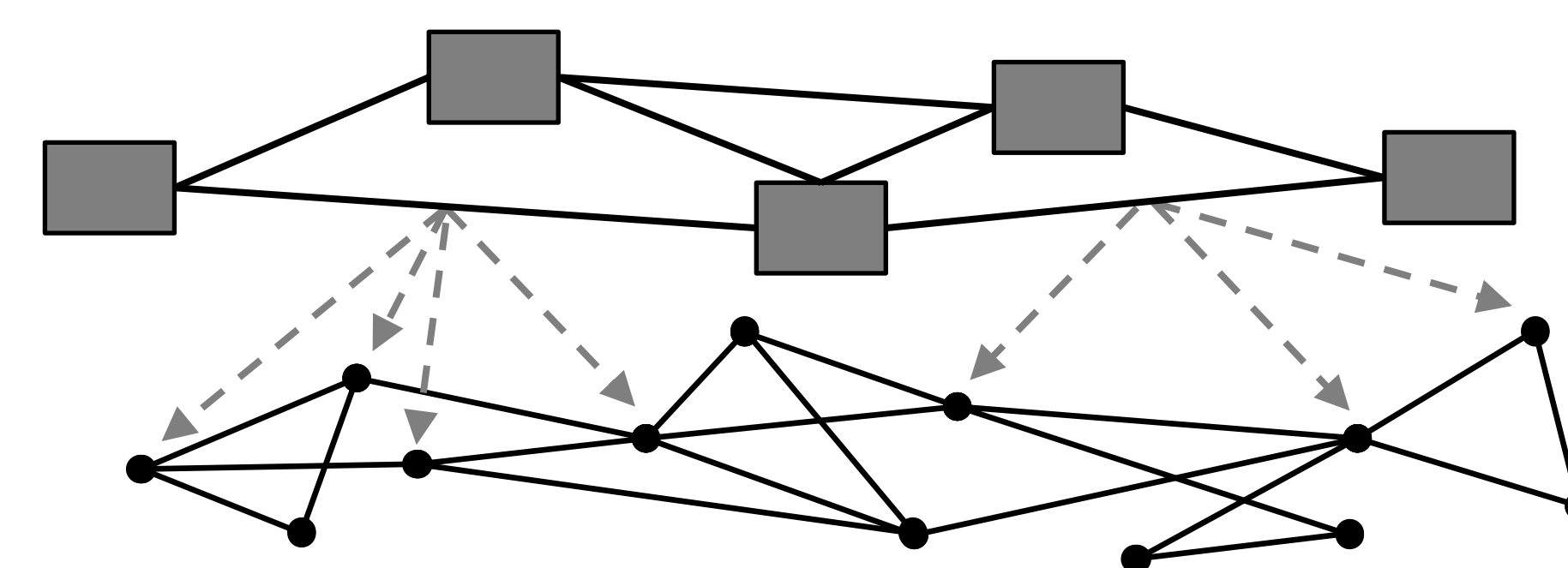
Jared Heinly, Enrique Dunn, Jan-Michael Frahm

University of North Carolina at Chapel Hill

Motivation

Misregistered Model

Correct Model

Contributions

- Method is a post-process step to existing structure-from-motion (SfM) pipelines

- Efficiently split reconstruction into consistent sub-models

- Recover correct reconstruction by merging sub-models

Input

Image Set   Match Graph   3D Model

Results

Misregistered Model   Corrected Model

Misregistered Model   Corrected Model

Dataset Name	# Cameras	# Points	Time	Time [1]
San Marco (using iconics)	3372	410592	3.0 m	5.6 m
Brandenburg Gate	50	8046	18 s	12 s
Arc de Triomphe	192	32708	1.7 m	2.7 m
Giotto's Campanile	211	52620	4.4 m	22.5 m

[1] Heinly, Dunn, Frahm, "Correcting for Duplicate Scene Structure in Sparse 3D Reconstruction", ECCV 2014
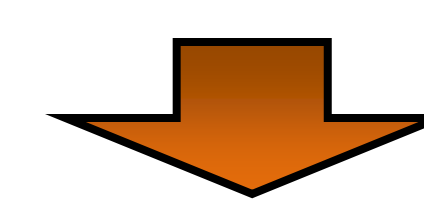
Local Clustering Coefficient

Camera Graph

3D Point Co-occurrence Graph

- Construct point co-occurrence graph

- Take union of co-occurrence entries for 3D points that are spatial neighbors in 2D images

- Compute local clustering coefficient (lcc) for each point

- Measures connectivity of a vertex to its neighbors

$$lcc = \frac{2\,(\#\ of\ edges\ between\ neighbors)}{(\#\ of\ neighbors)(\#\ of\ neighbors - 1)}$$

Model Splitting

- Iteratively remove points with lowest lcc from co-occurrence graph, and discard an edge from the camera graph when all of its points have been removed

- Stop removing points when the camera graph no longer forms a single connected component

- Analyze correctness of split in the camera graph using overlapping correspondences

Overlapping Correspondences   Duplicate Structure   Overlapping Correspondences

Projected Unique Structure

Projected Unique Structure
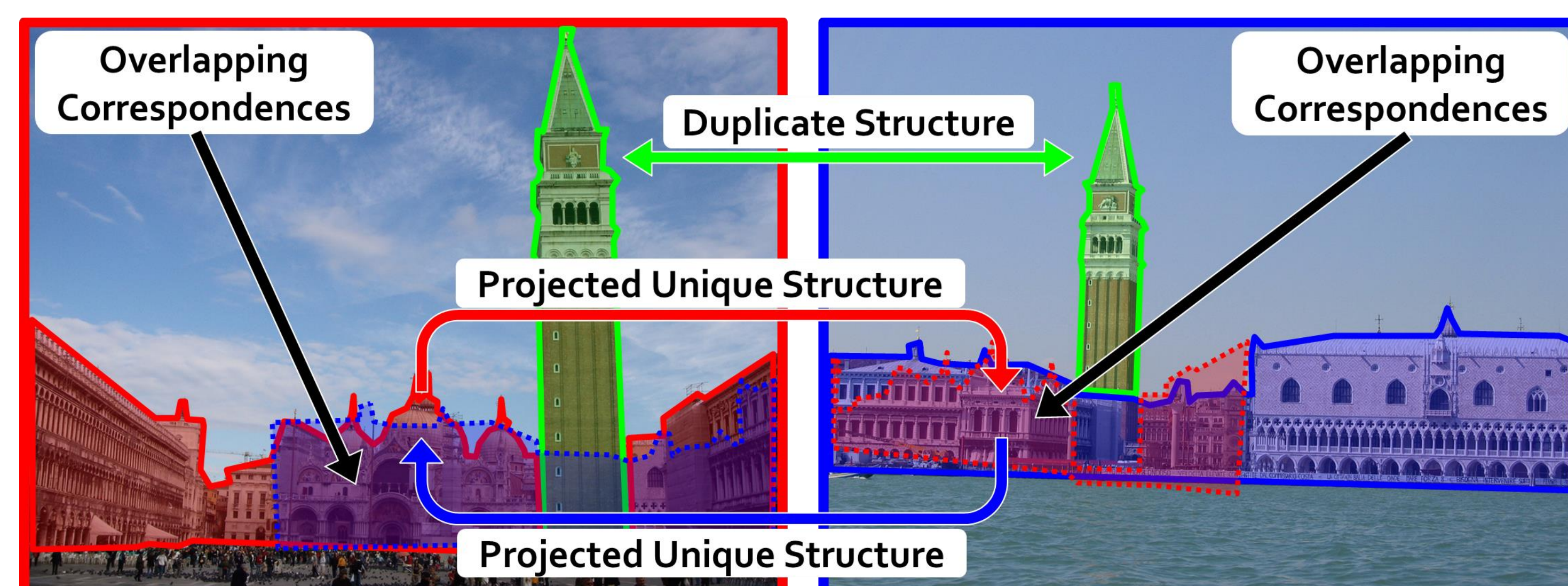
- If non-negligible overlap, identify indistinguishable points

- Expand indistinguishable point set to inliers and nearby 2D image points

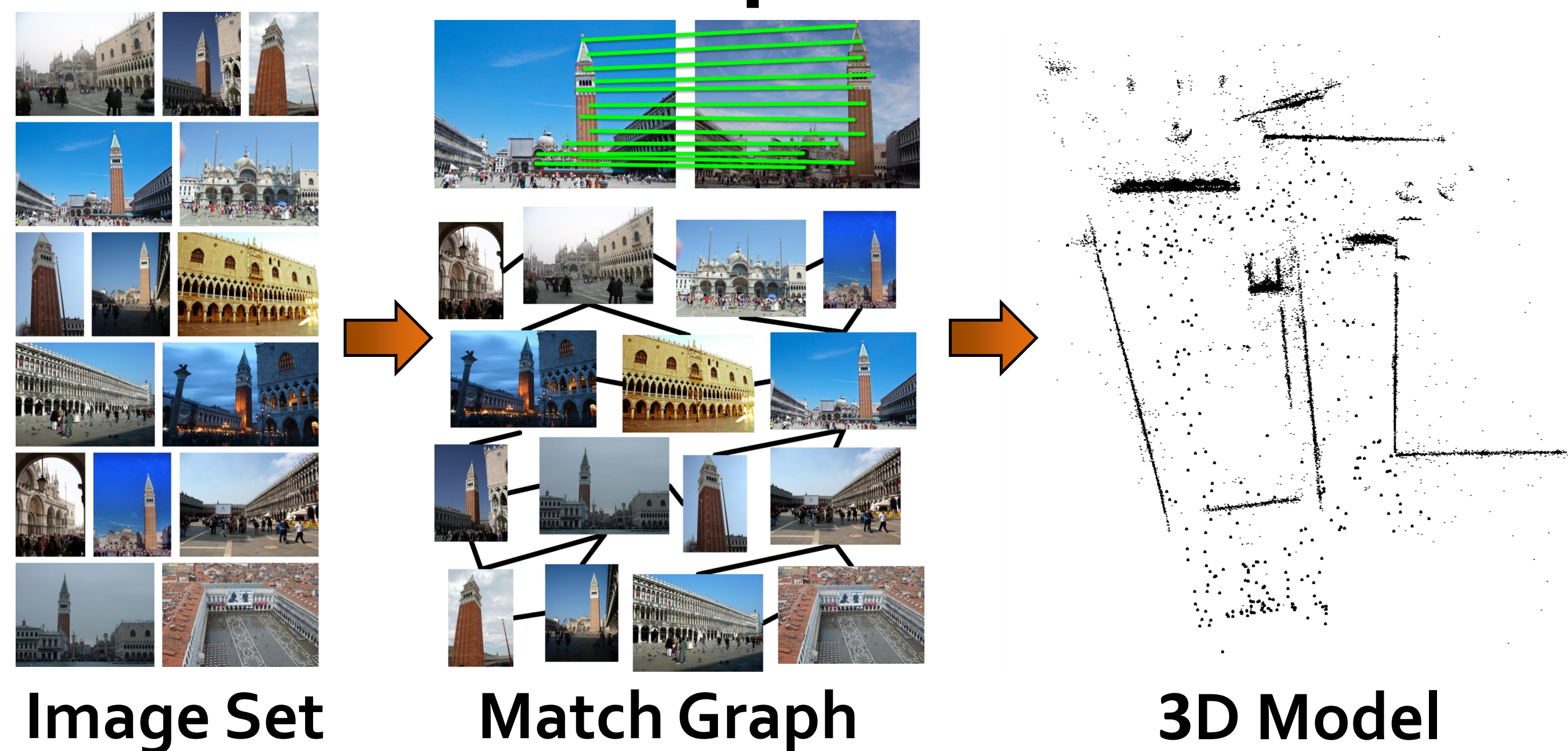- Re-split reconstruction using updated indistinguishable point set
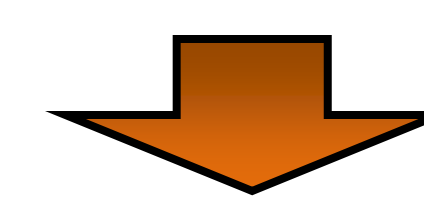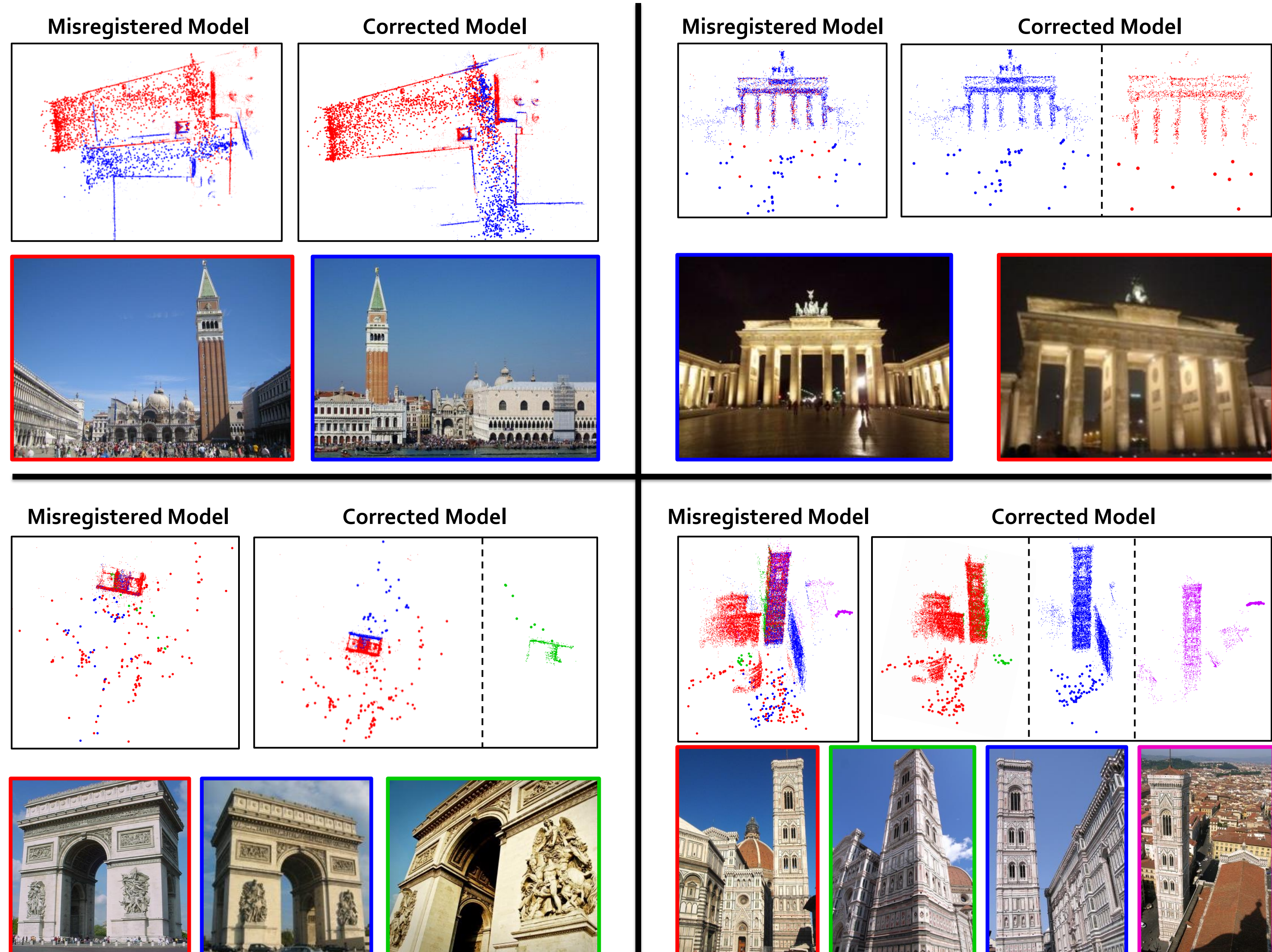
Model Merging
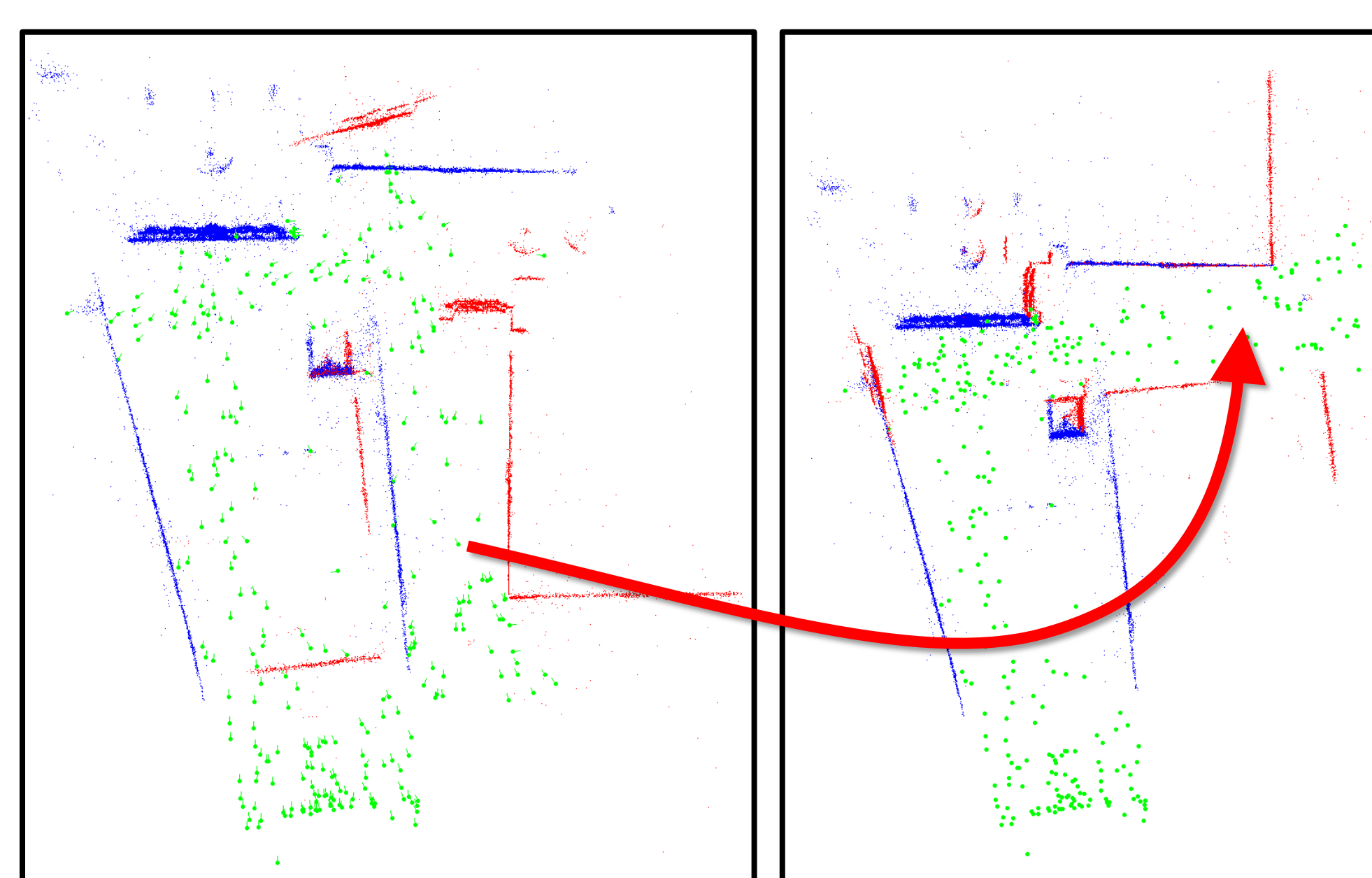
- Find camera pairs from match graph that were not used in final 3D model

- Propose similarity transform to align sub-models by sampling unused camera pairs