Projective geometry-aware anisotropic convolutional filters

Poster @ Pacific Ballroom #147

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Motivation

Photo credits:
https://www.ti.uni-bielefeld.de/html/research/equipment.html
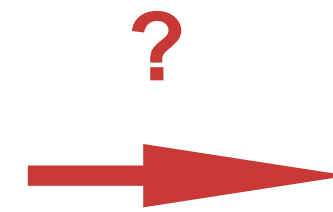https://www.t3.com/features/best-drone
https://www.zemax.com/blog/zemax-blog/october-2017/getting-to-the-finish-line-faster-optical-technolo
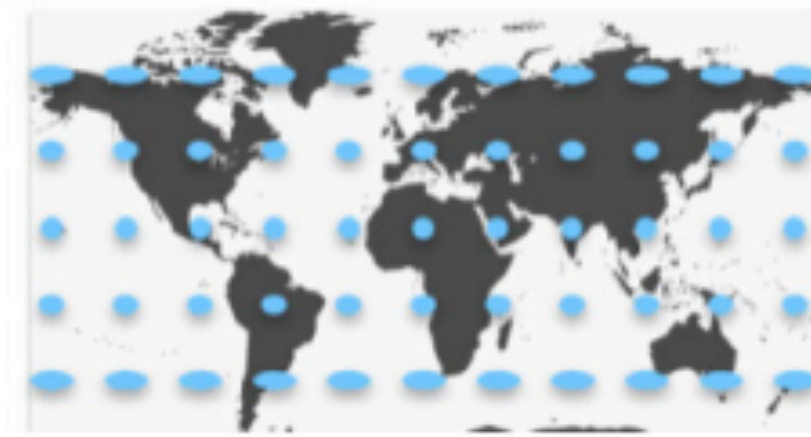
Omnidirectional camera representation
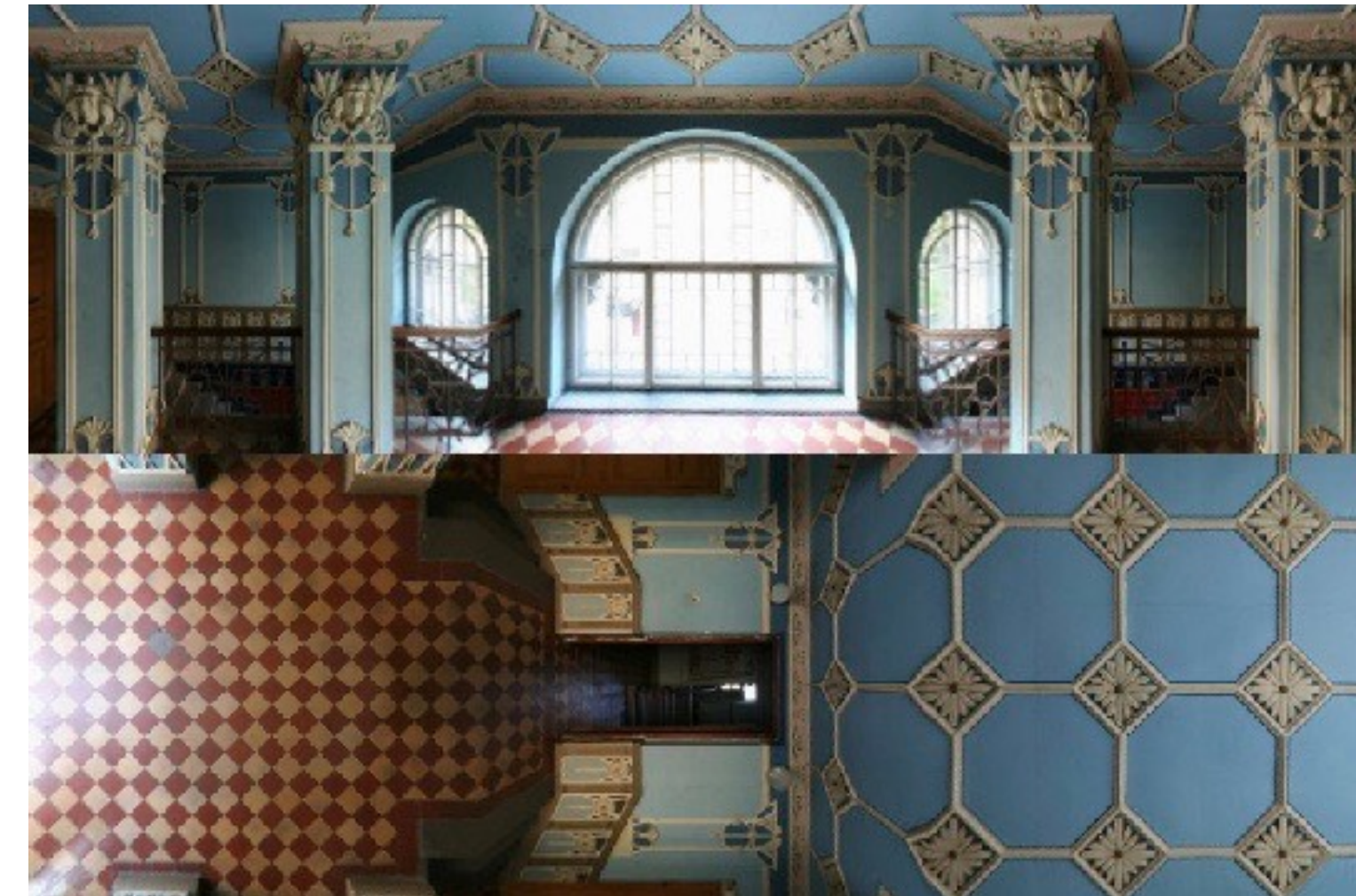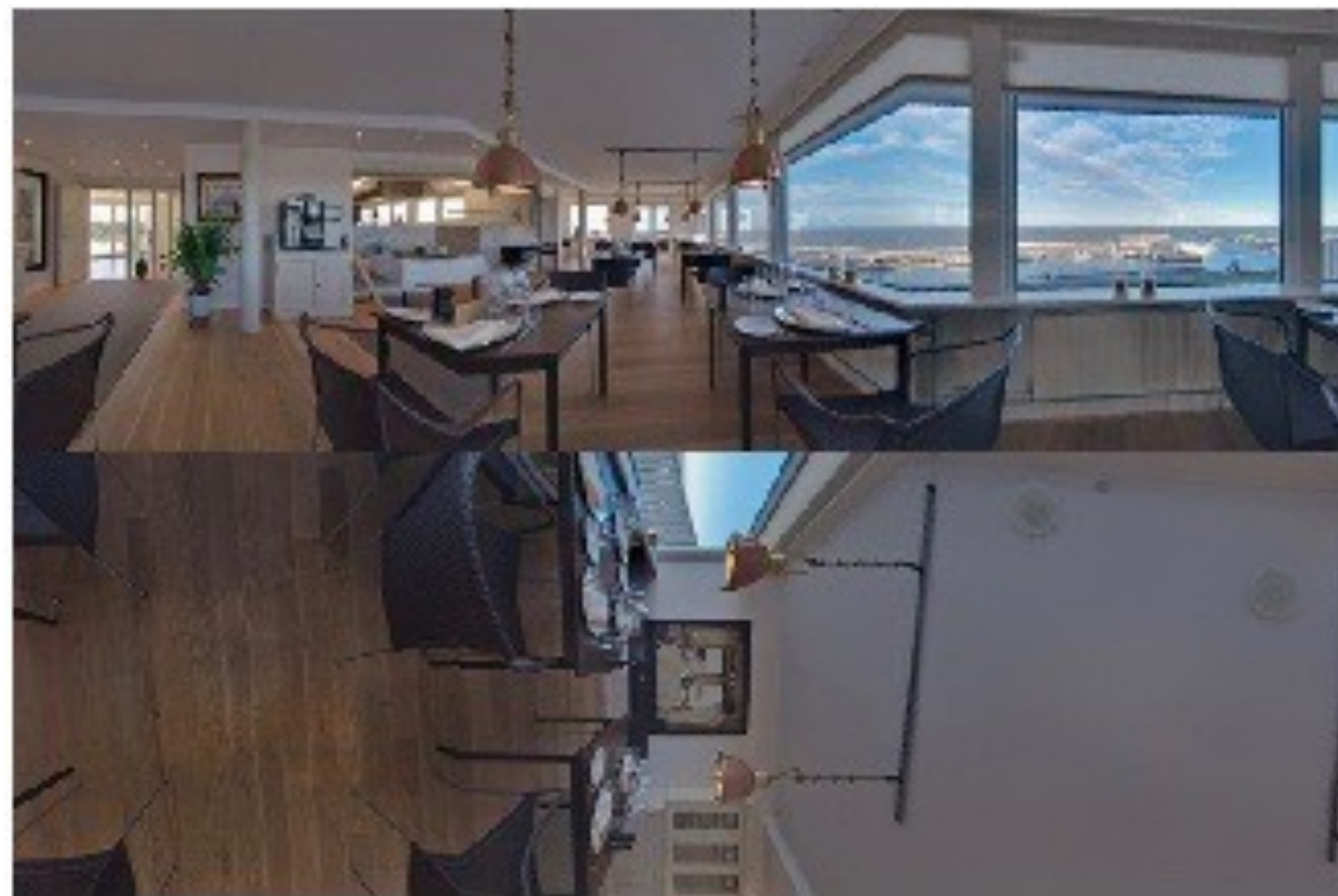

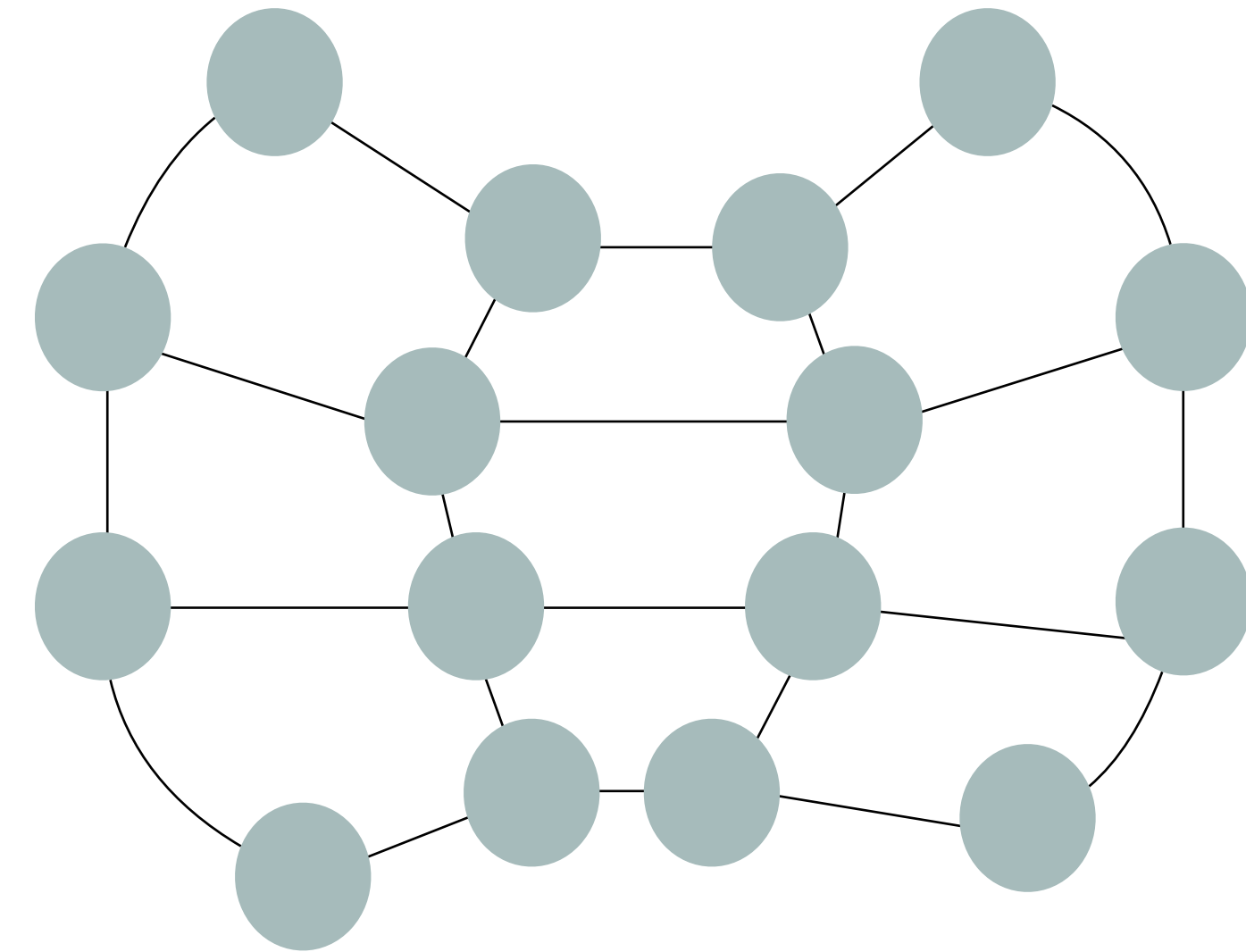Spherical surface   ?→   Rectangular representation

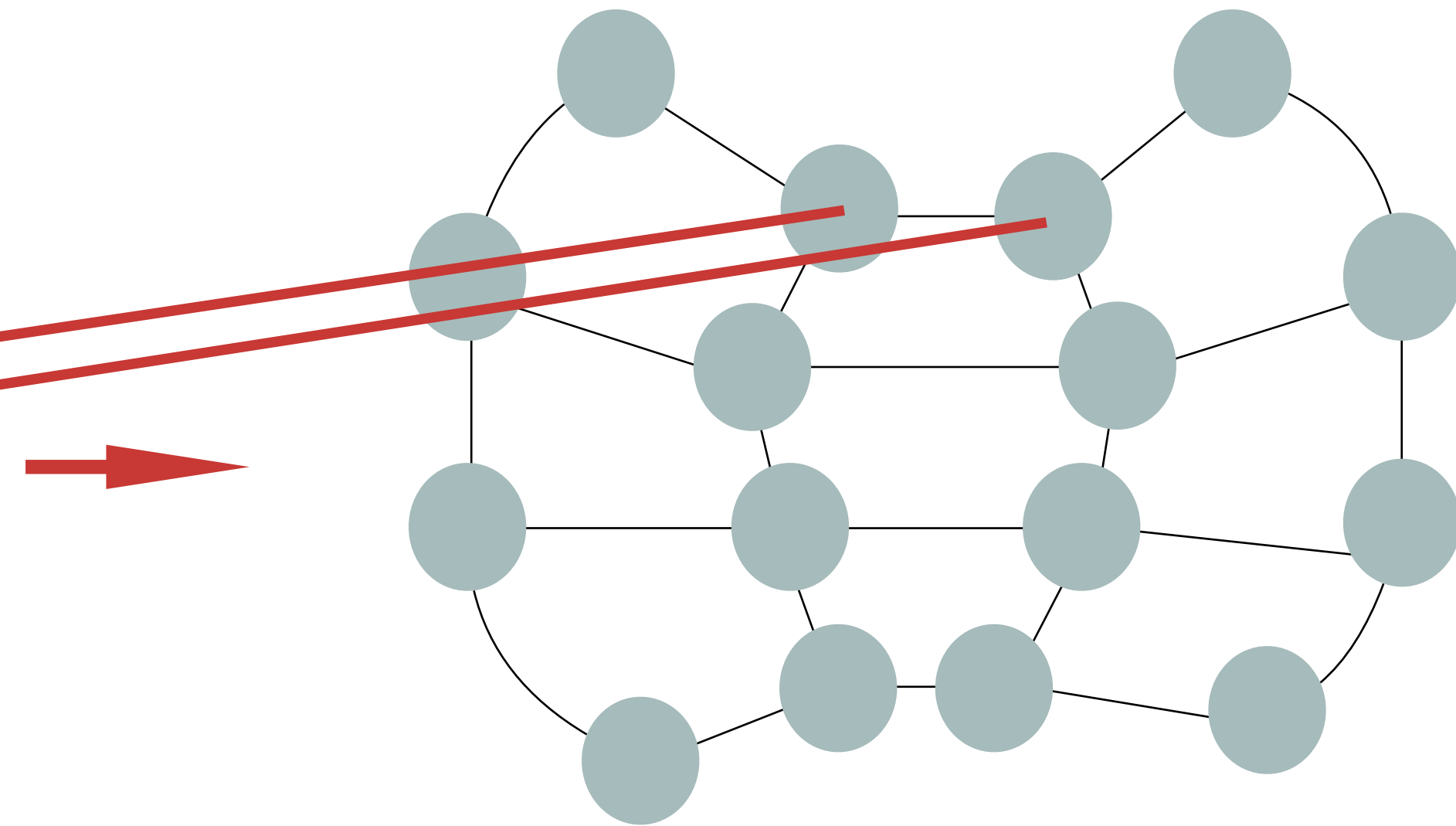# Geometric distortion of equirectangular images

Geometric distortion of cube-map images

Graphs for geometry modelling
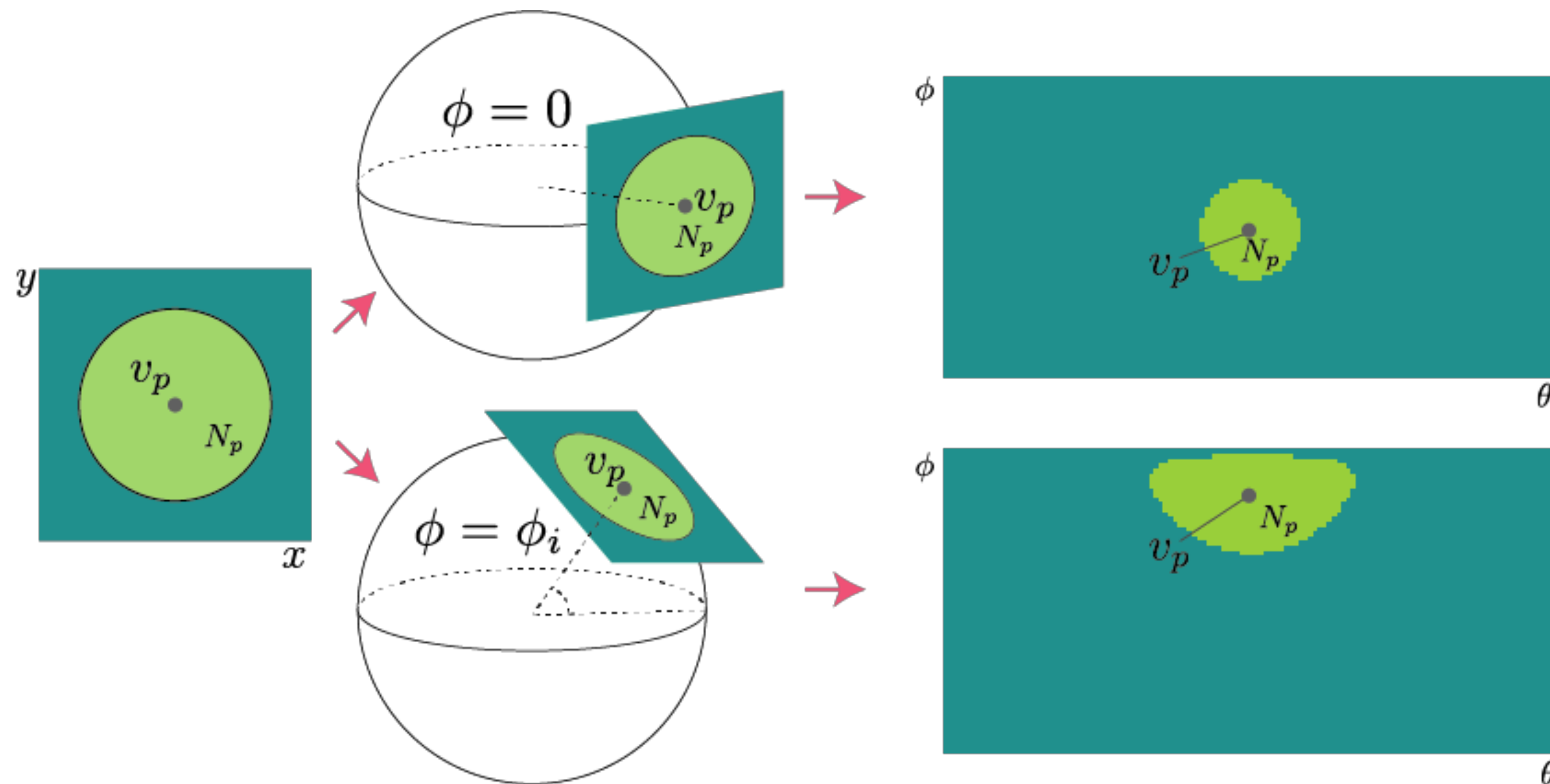
Graphs for geometry modelling

pixel — node

pixel's intensity — node's signal
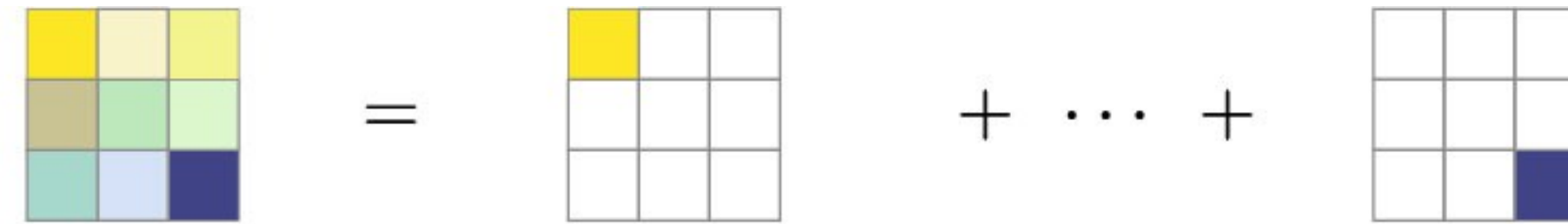
Geometry aware graph filters

Idea: adapt filters depending on image location

Example of a filter applied to equirectangular projection
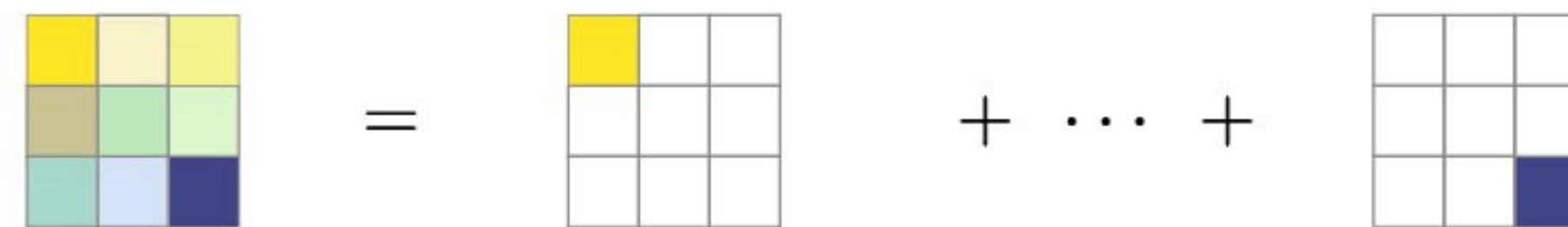
Geometry aware graph filters

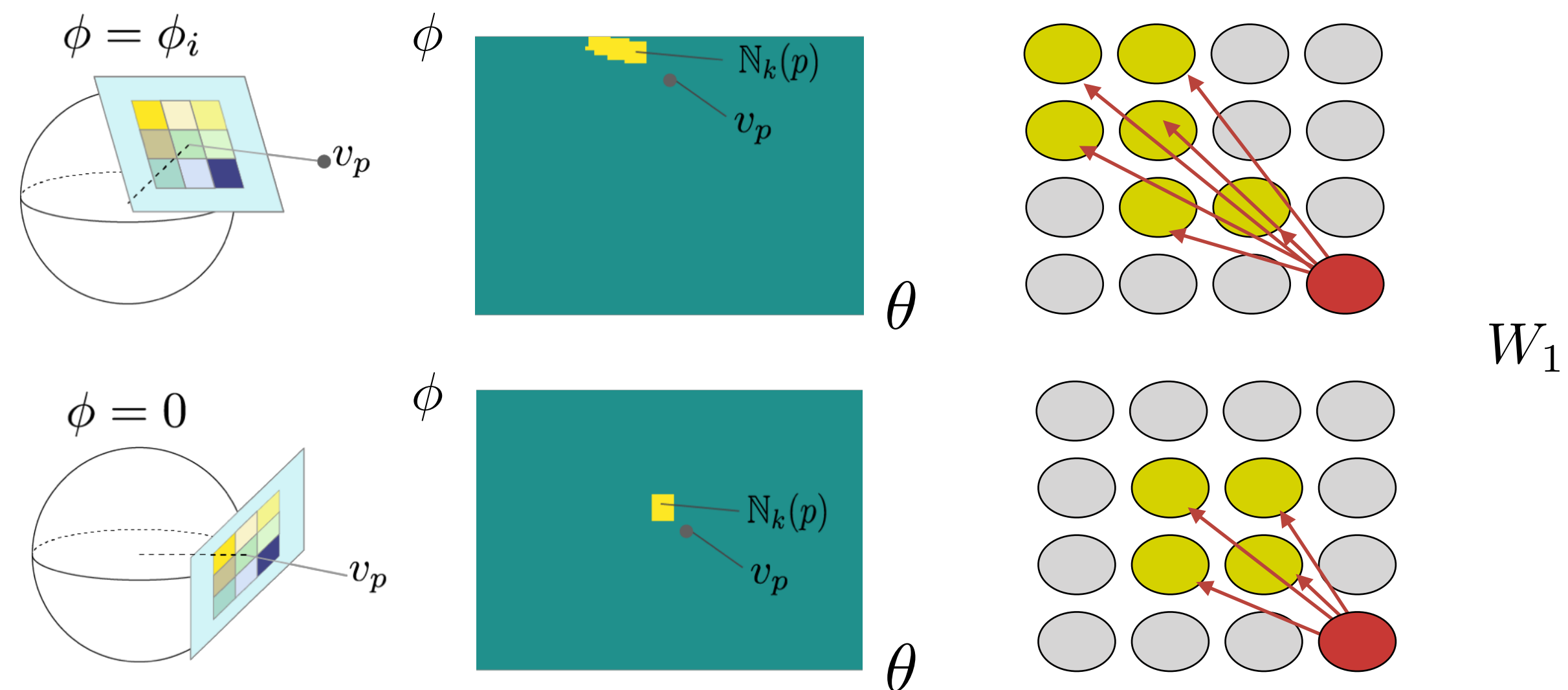Multiple directed graphs for anisotropic filters

Example of filters

Geometry aware graph filters

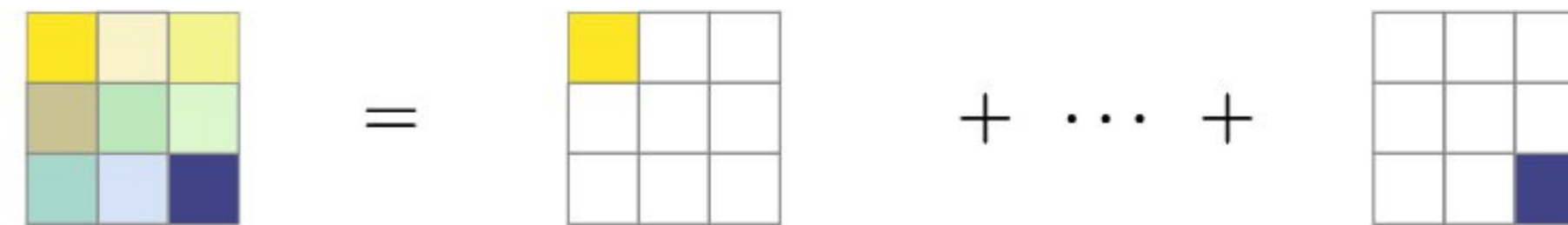Multiple directed graphs for anisotropic filters
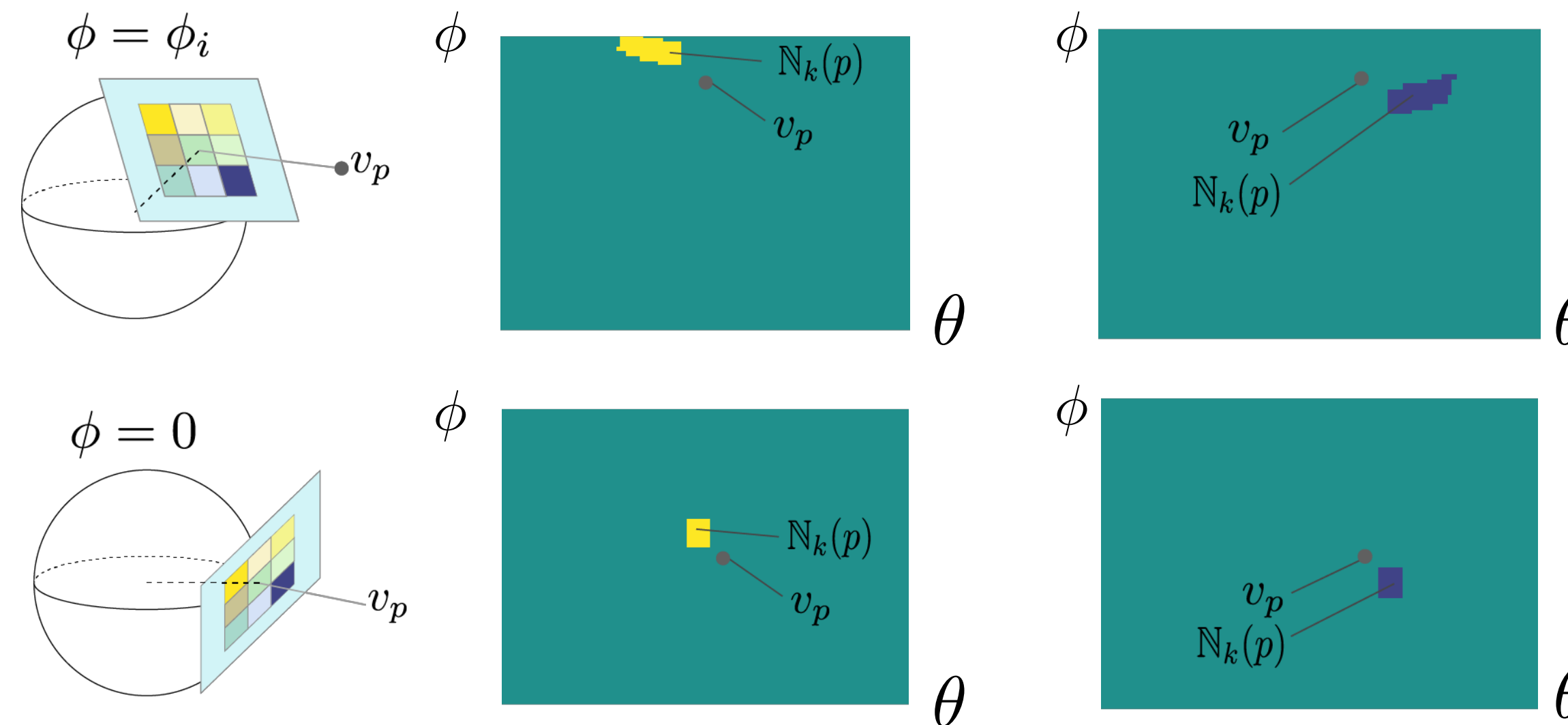

Example of filters

Directed graph construction with adjacency matrix W_1

Geometry aware graph filters

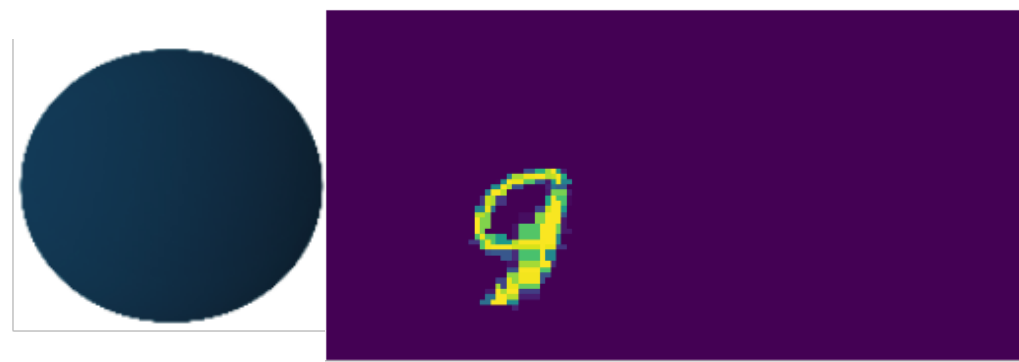Multiple directed graphs for anisotropic filters

Example of filters

Directed graphs construction

Classification: adaptation to various projective geometries
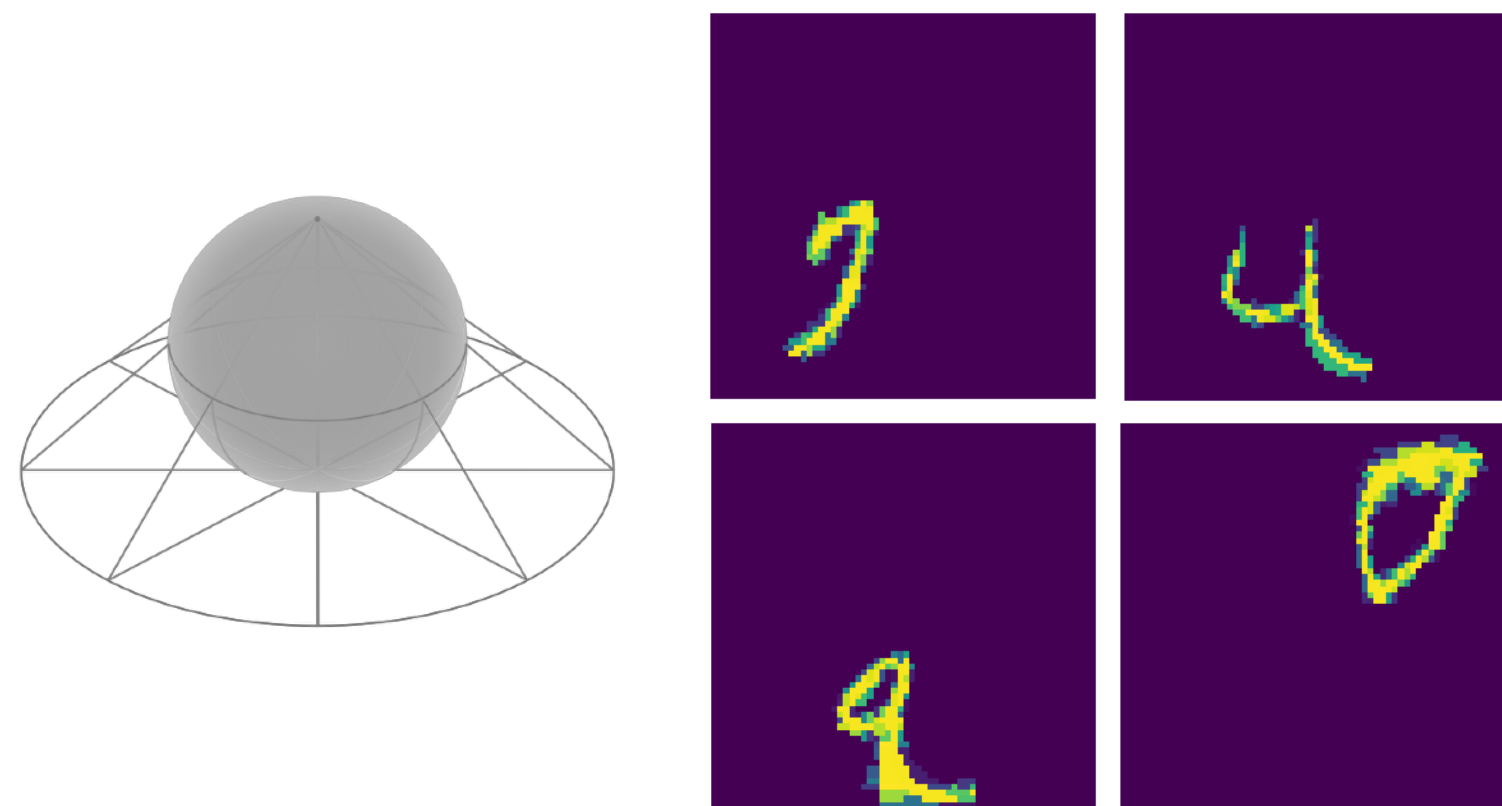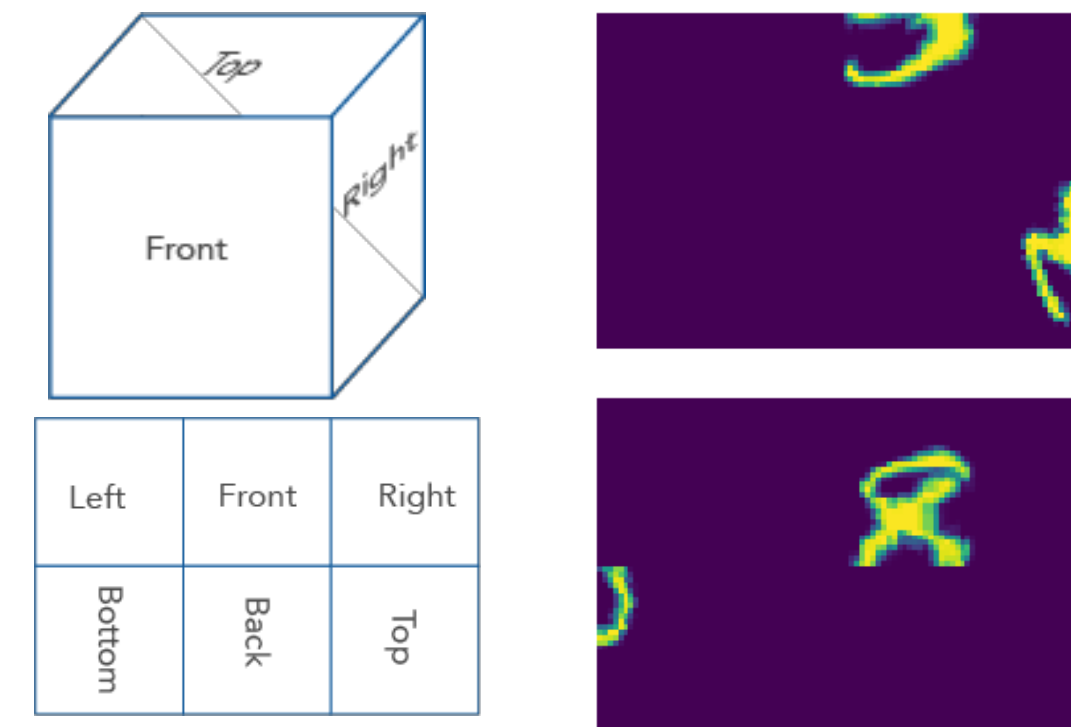
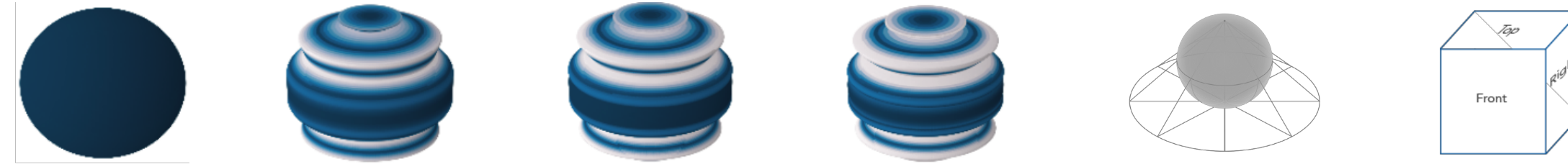Dataset — projected MNIST

Spherical (S)

Modified spherical (MS1, MS2, MS3)

Fish-eye stereographic projection (F)

Cube-map (CM)

Classification results
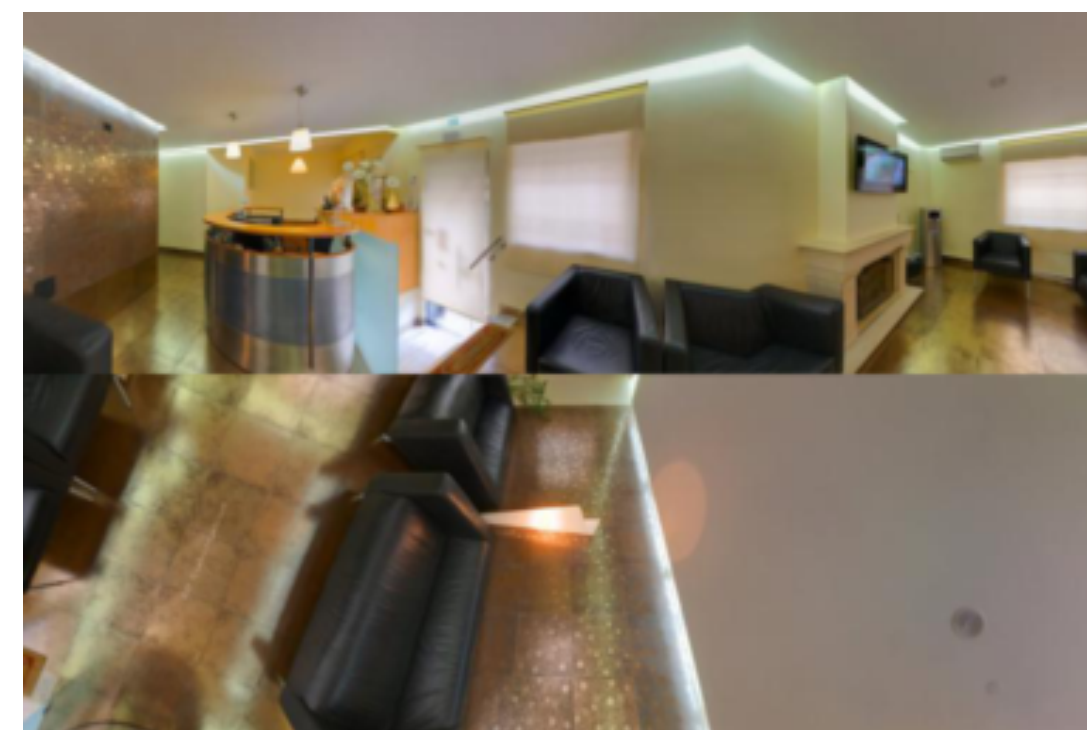
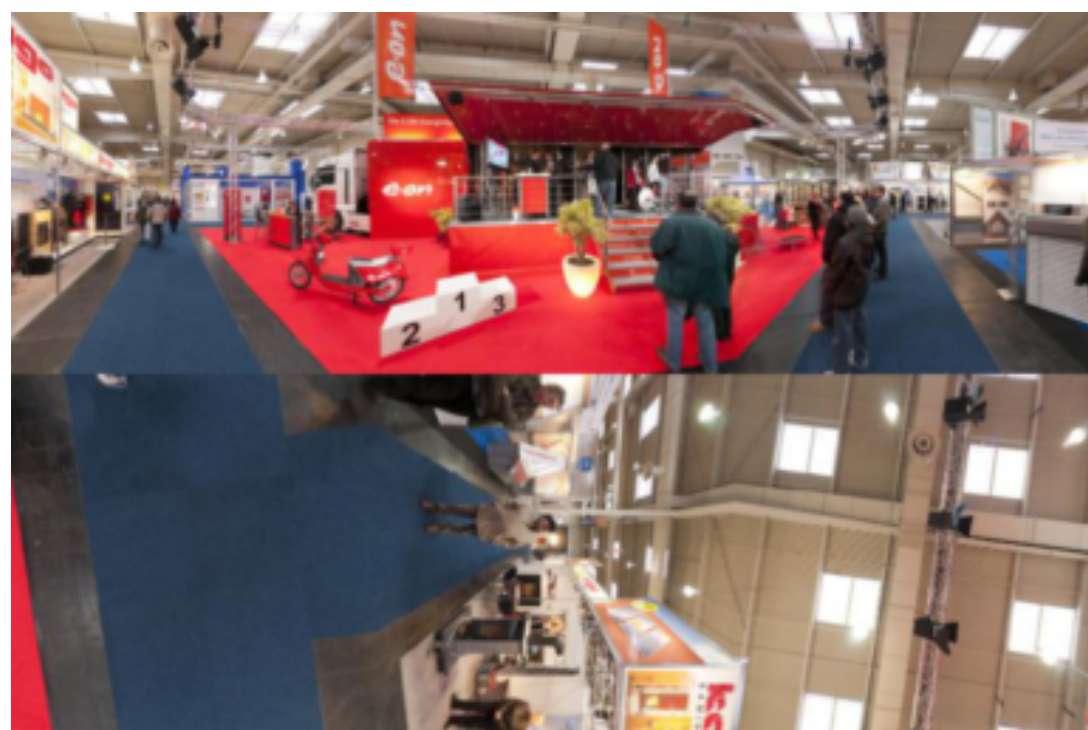| Method	S	MS1	MS2	MS3	F	CM
regular graph (w=1)	69.4	64.3	64.1	62.8	71.8	40.0
regular graph (w=1/d)	69.8	63.4	64.5	62.5	70.2	40.5
GA graph (w=1/d)	70.2	63.9	62.5	62.8	72.1	44.2
ConvNets	94.2	91.3	91.2	90.5	93.4	79.4
SphereNet	94.8	—	—	—	—	—
SphericalCNN	95.2	84.5	83.3	80.9	94.9	—
Ours	*96.9*	*95.1*	*95.3*	*94.9*	*95.7*	*84.3*

Compression

Cube-map projection of SUN* dataset with 360-indoor images

*https://groups.csail.mit.edu/vision/SUN/
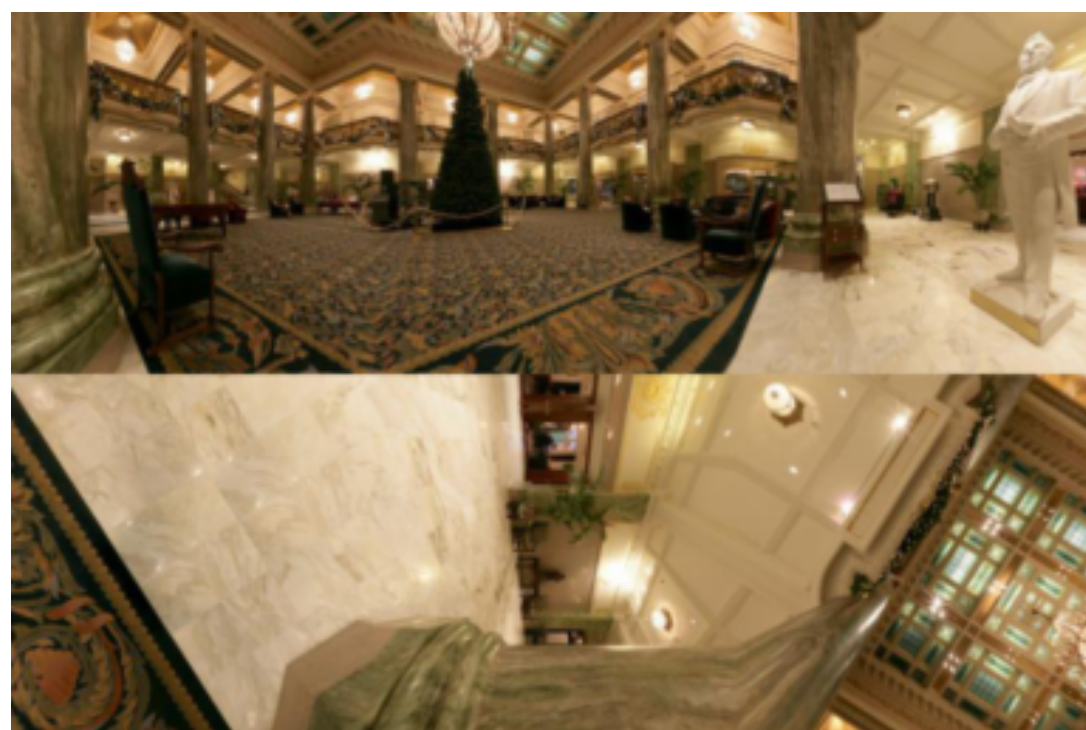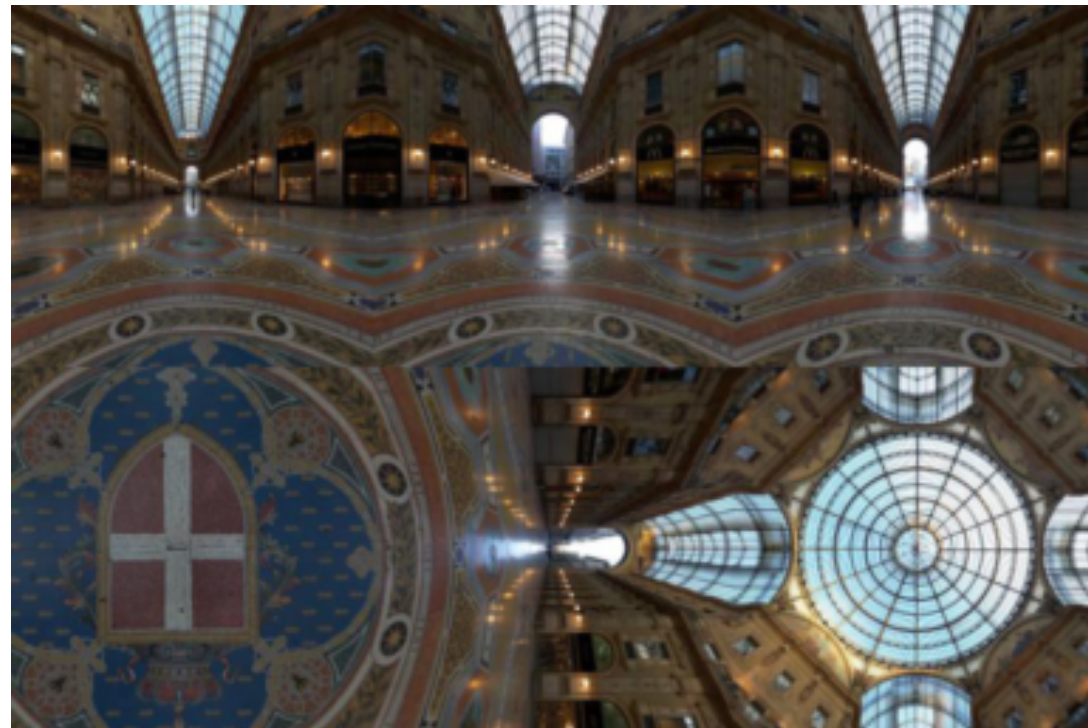
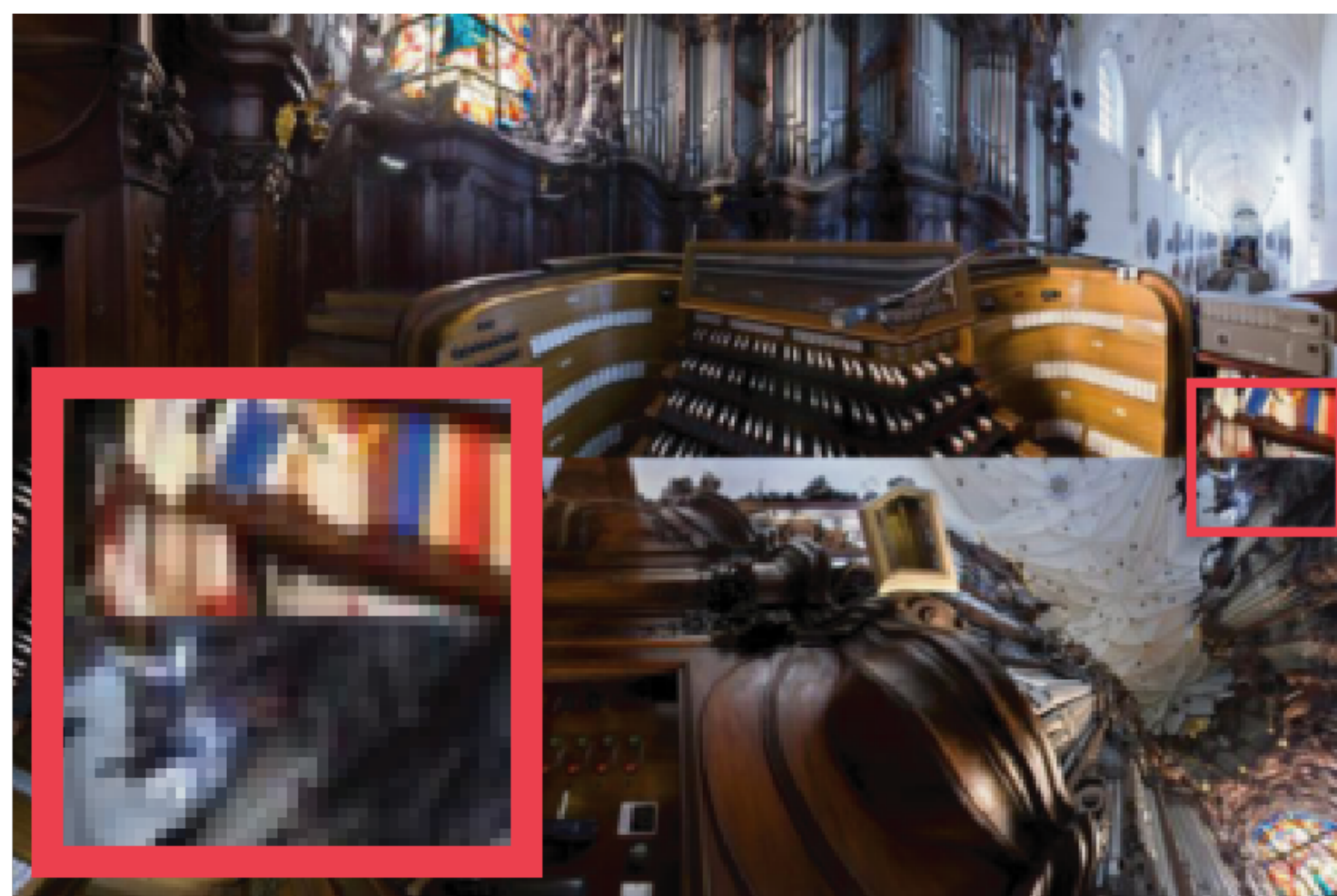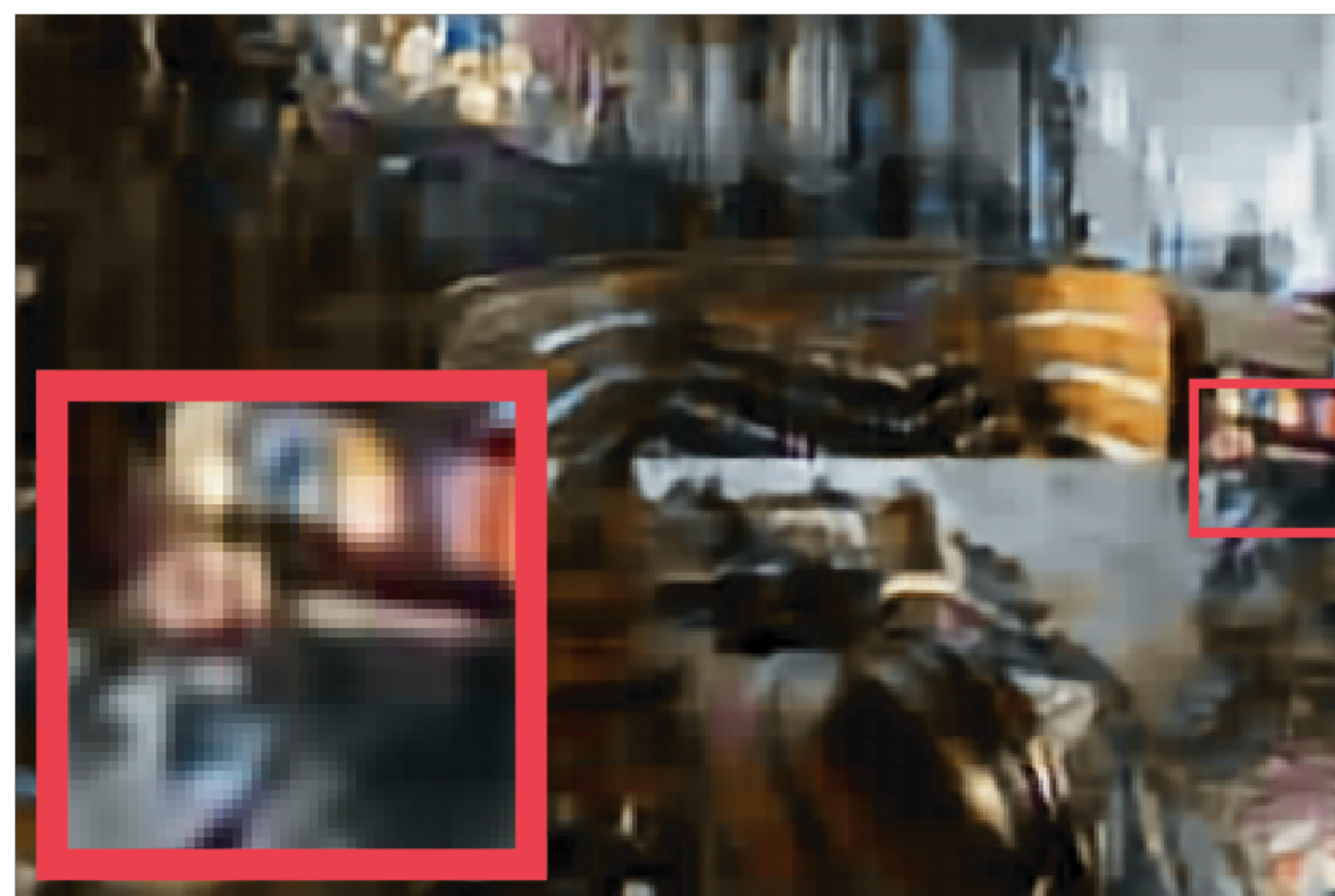# Decompression challenges

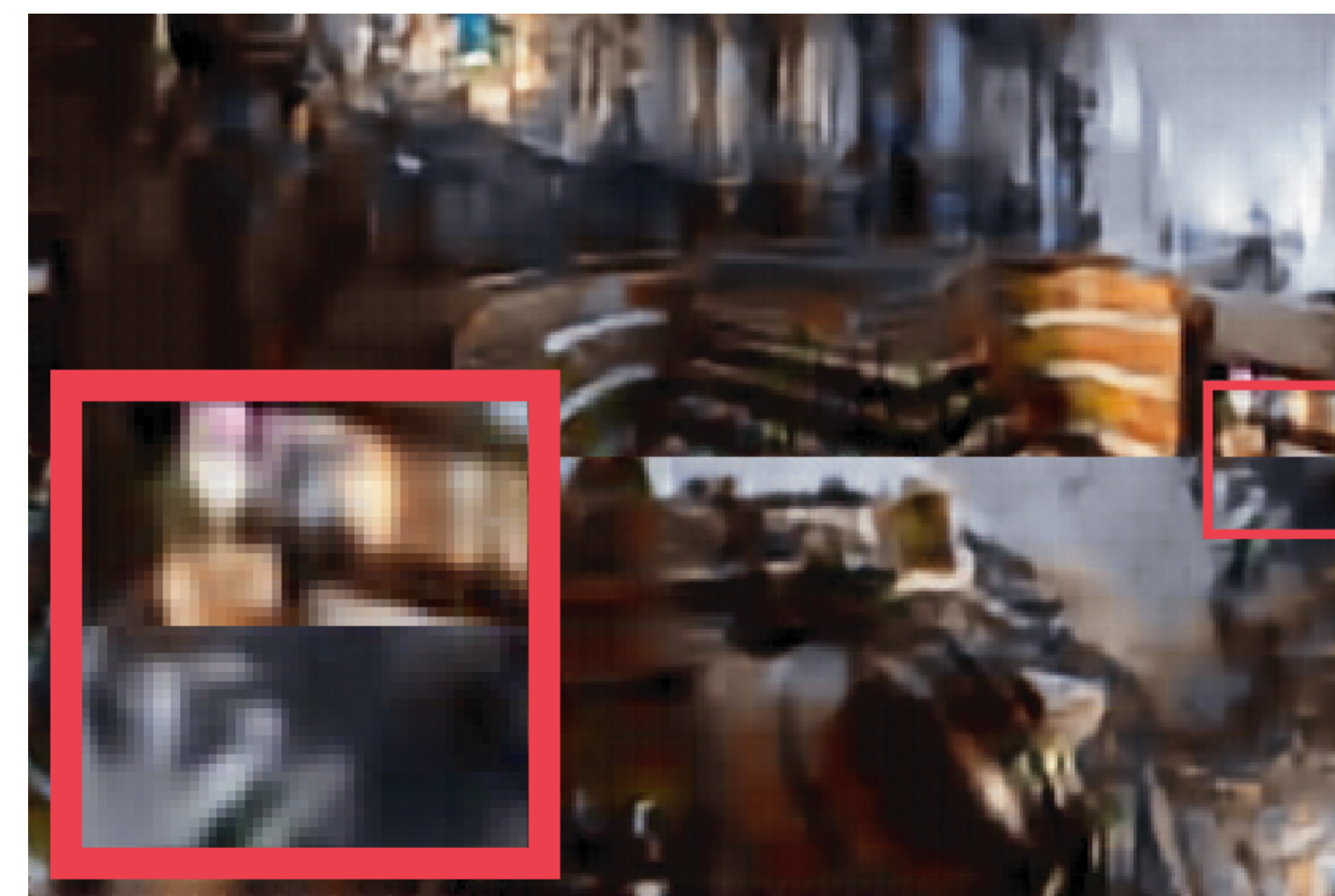# Visual decompression result

Original   Balle et. al (2017)   Ours

Summary

- Novel graph construction approach to define a filter, which adapts to the specific geometry of the wide-angle images

- Our filters are anisotropic, which permits richer representation

- Our filters can be applied to a wider class of tasks compared with standard graph-based filters

- Our approach reaches state-of-the-art performance on classification and compression tasks

Thank you!

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Code: https://github.com/RenataKh/GAfilters