WORKING WEEK 2025
AND Locate25
THE NATIONAL GEOSPATIAL CONFERENCE
Collaboration, Innovation and Resilience: Championing a Digital Generation
FIG Geospatial Council of Australia
Brisbane, Australia 6–10 April

中国测绘科学研究院 Chinese Academy of Surveying & Mapping
武漢大學 CartoLab 佳图实验室

Measurement and Calculation of Single-View 3D Building Shape

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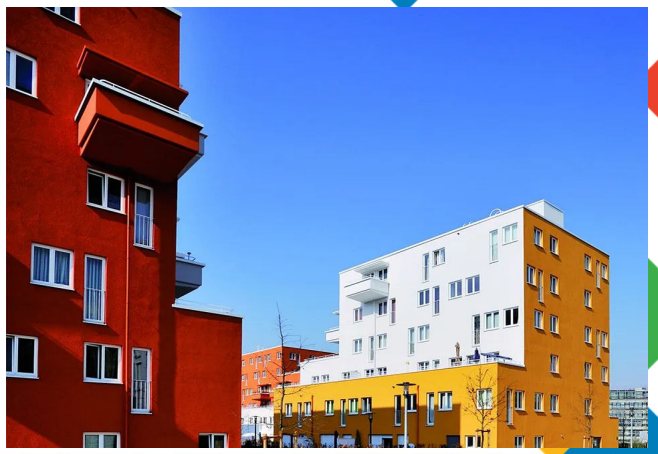
Buildings, as a primary feature of urban areas, serves not only as the main venue for people's living, learning, working, and entertainment activities, but also embodies the overall image of a city or region in terms of appearance, form, color, materials, proportion, and style. It is a vital reflection of the era's characteristics, ethnic traits, local distinctiveness, and cultural identity.



The identification, description, and quantitative analysis of building shape serve as crucial measurement criteria and analytical foundations for:

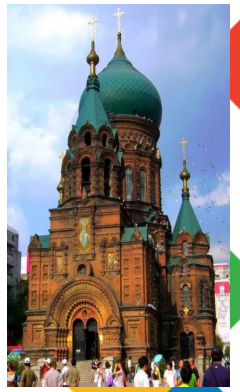
1) formulating urban planning standards and implementation methods (including architectural style planning and landmark building design)

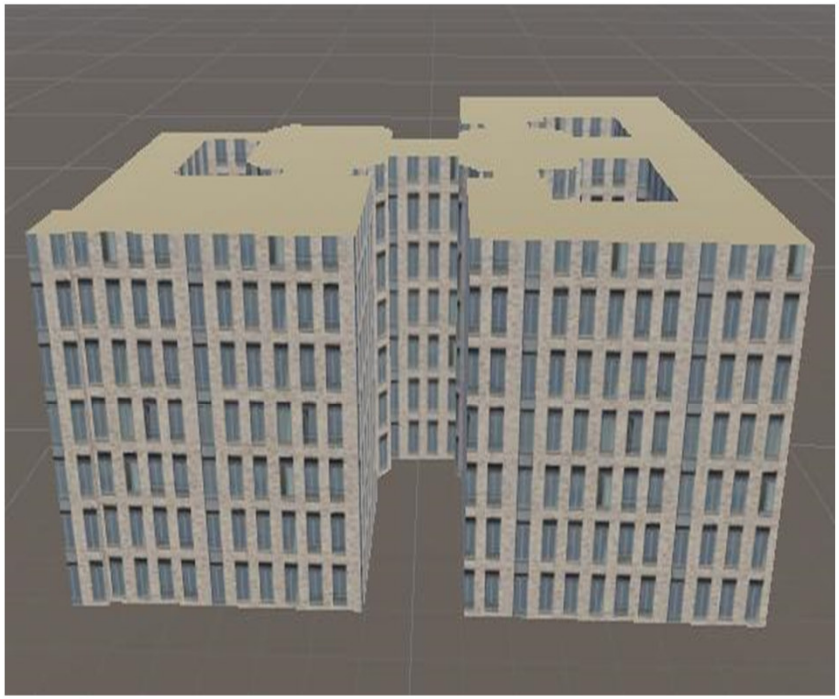
2) visual perception positioning in smart city development and intelligent transportation systems.

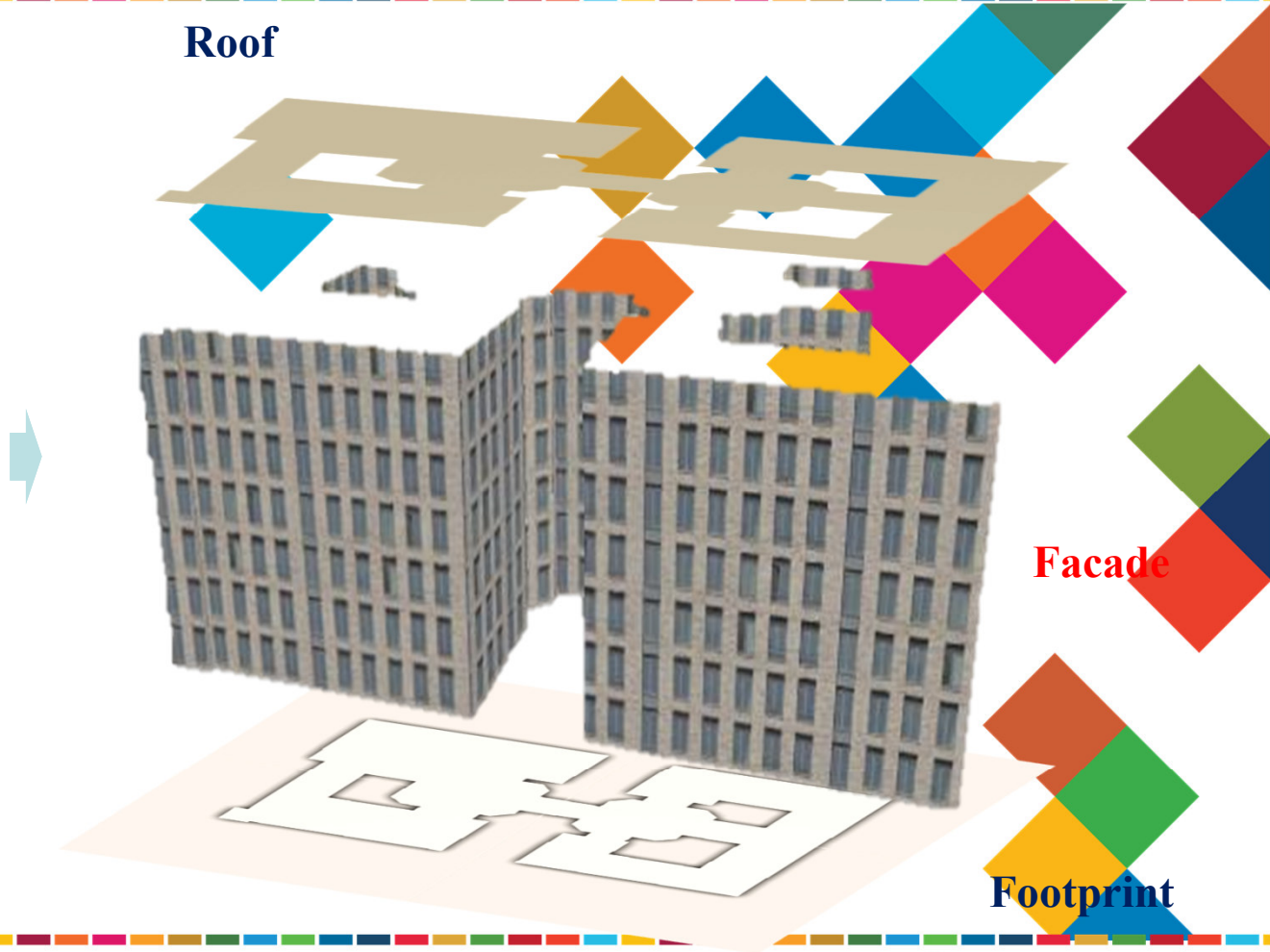




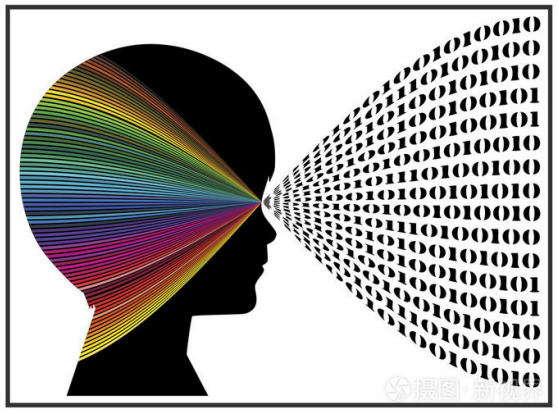






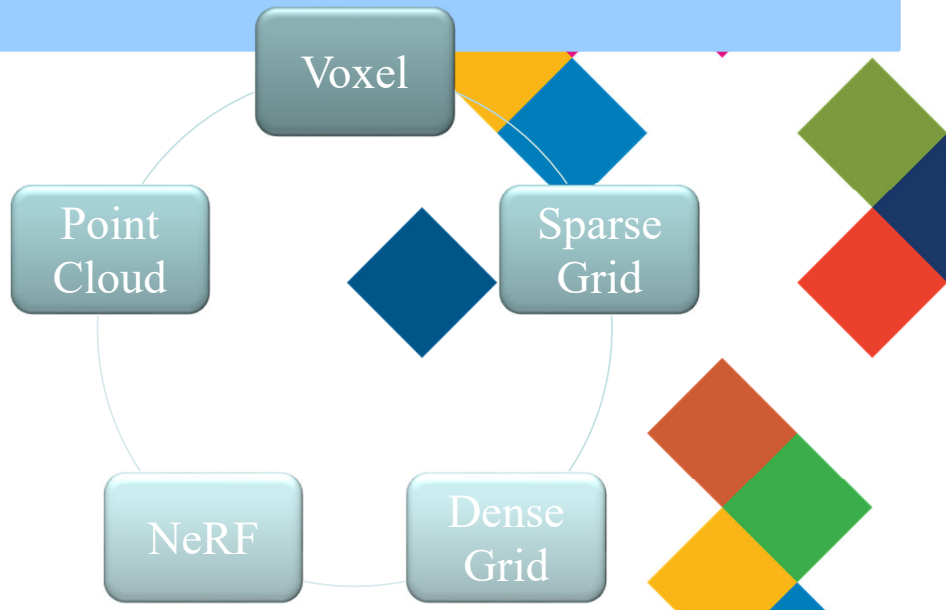

Roof
Facade
Footprint

To reduce processing constraints caused by data acquisition, fully leverage the flexibility of image utilization in the era of massive image data, and achieve low-cost sensing.



Visual perception

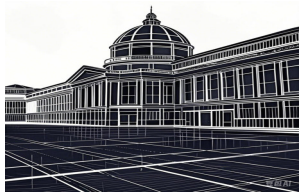
Image



Single Building Pair

Multiple Buildings

Monocular Image-Based 3D Shape feature of Buildings



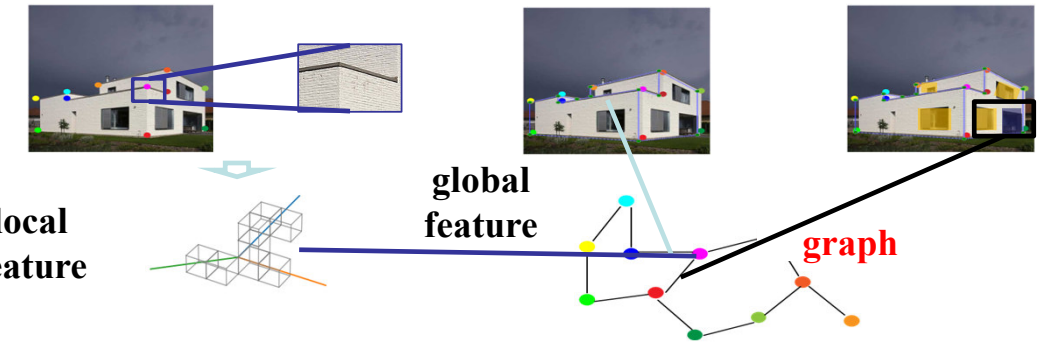
building 3D structure

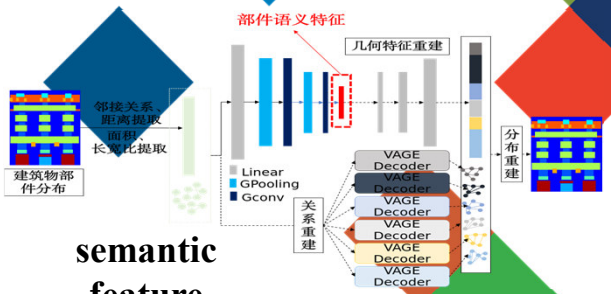
Feature type

- **Geometric Contour**: points, lines
- **Component Semantics**: door, window, balcony, eave, ...

Feature Description Method

- **local 3D shape** → local feature
- **global contour structure** → global feature → graph
- **component layout** → semantic feature learning





Global Feature of 3D Building Shapes by Modeling Local Feature Line Distributions

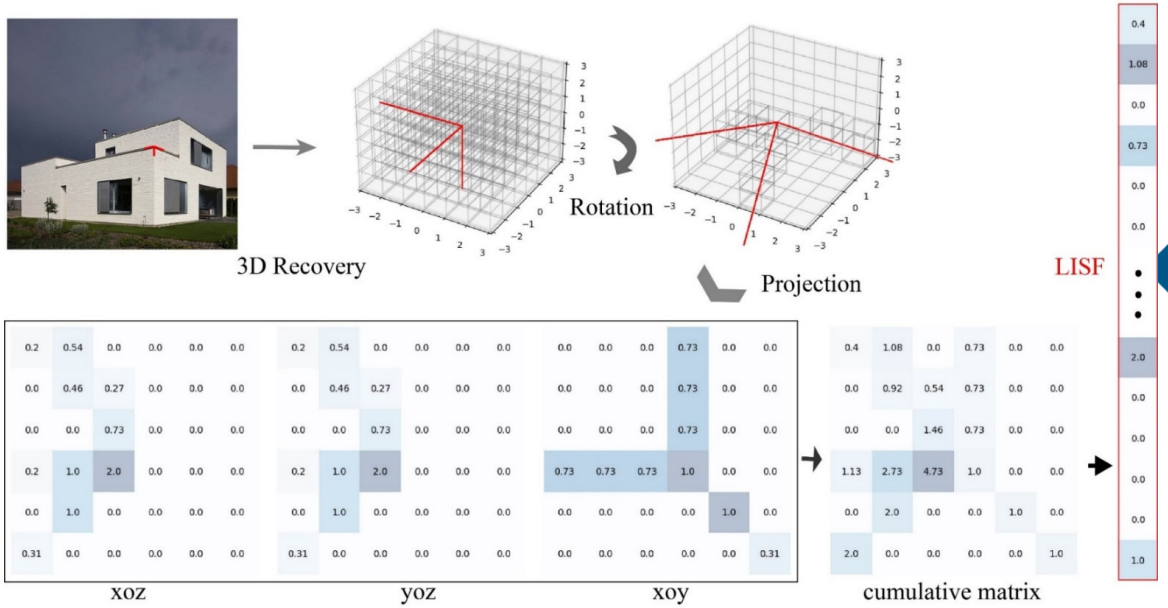
Edge Extraction

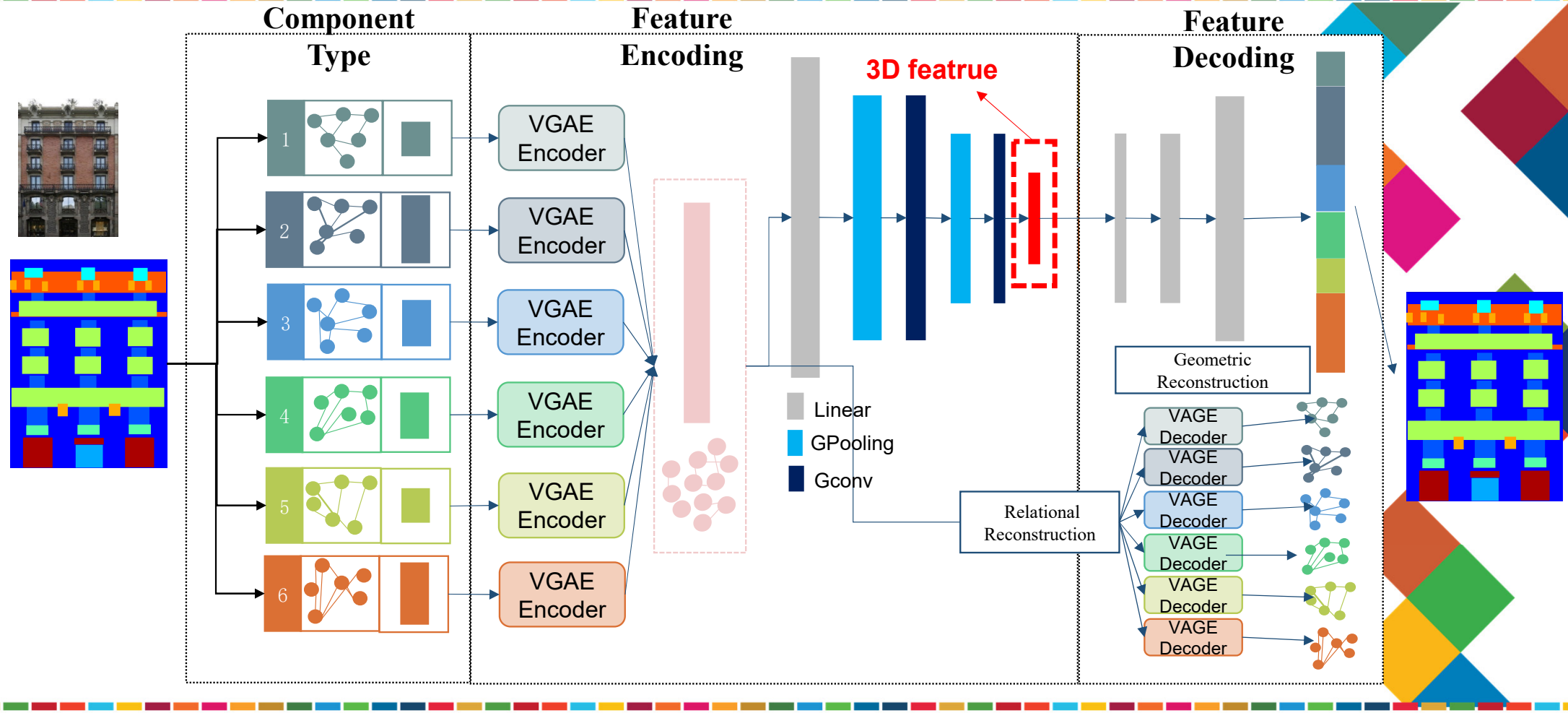
Vanishing Point Detection / Edge Segment Grouping

Intersection Point Extraction

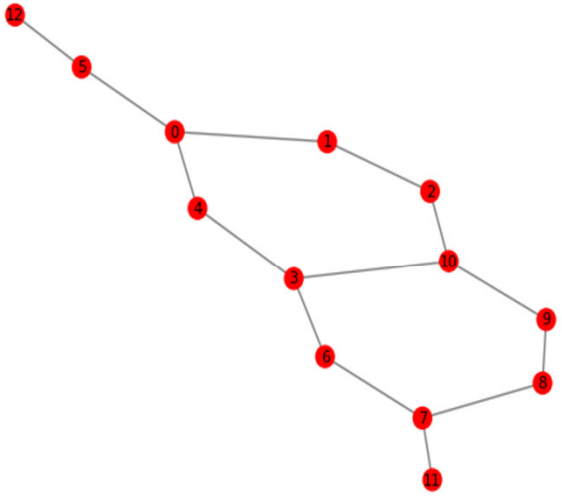
Local 3D Information Estimation

3D Spatial Distribution Statistics of Intersecting Lines




Component Type
Feature Encoding
Feature Decoding
3D featrue
1
2
3
4
5
6
VGAE Encoder
VGAE Encoder
VGAE Encoder
VGAE Encoder
VGAE Encoder
VGAE Encoder
Linear
GPooling
Gconv
Geometric Reconstruction
Relational Reconstruction
VAGE Decoder
VAGE Decoder
VAGE Decoder
VAGE Decoder
VAGE Decoder
VAGE Decoder

Graph Representation



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Viewpoint-Invariant 3D Similarity measurement for Architectural Structures

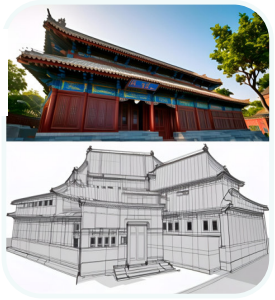
Target incompleteness

Detail inconsistency

. . .

single-view

3D target

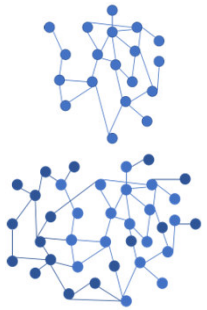


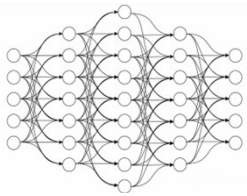
Multi-scale Measurement Regime

shape similarity

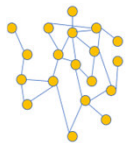
feature matching

Contrastive Structural Features

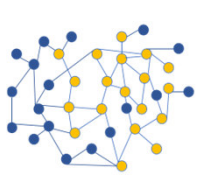




Shape Feature Similarity Model Construction



Similar Target Pairs

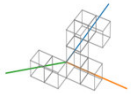


Featrue Learning

Attention

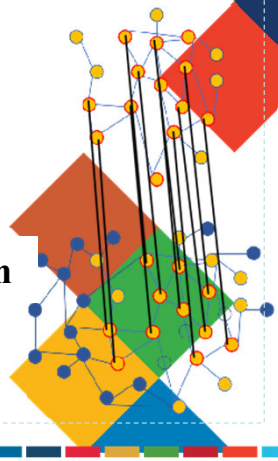
Filtering

Optimization



Local Structure

Component Semantics



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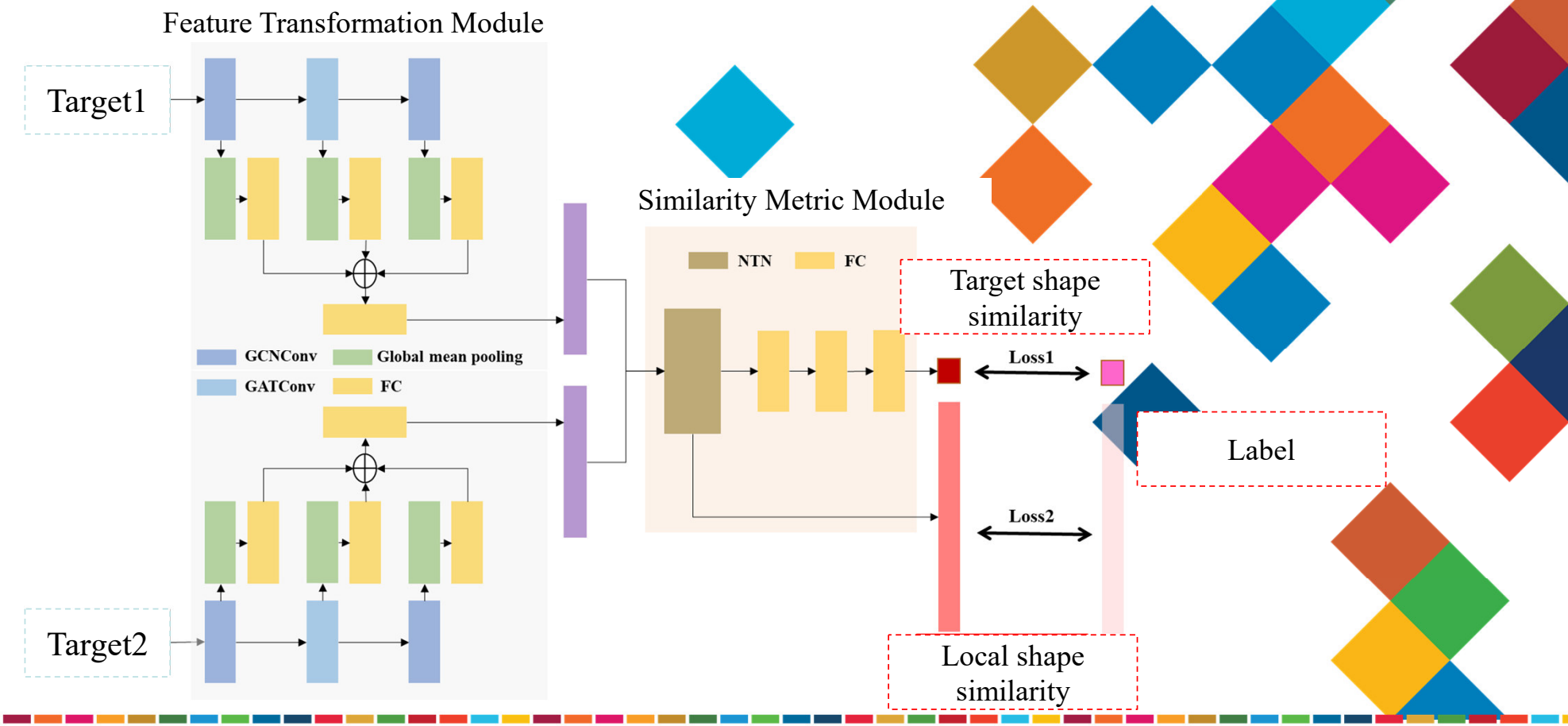
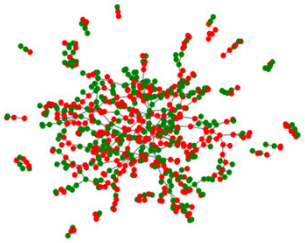
Feature-Based Weakly-Supervised Metric Learning Method for Building 3D Shape



Weakly-Supervised Label Construction

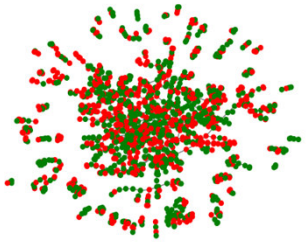


Building 3D shape graph feature

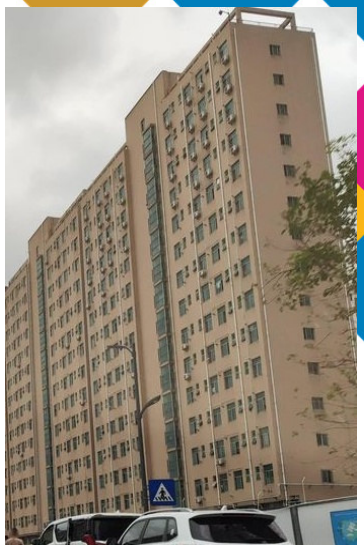
WLkernel

0.4907

Target level label

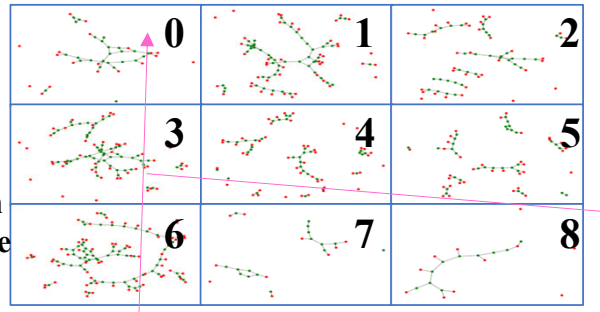


Building 3D shape graph feature



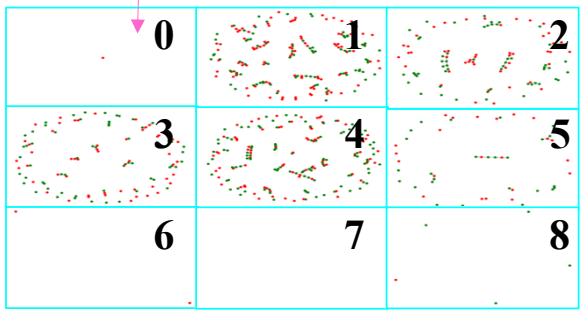
Weakly-Supervised Label Construction

graph feature



WL Kernel

graph feature



Guided Learning for Defining Interpretable Local Partition Shape Similarity

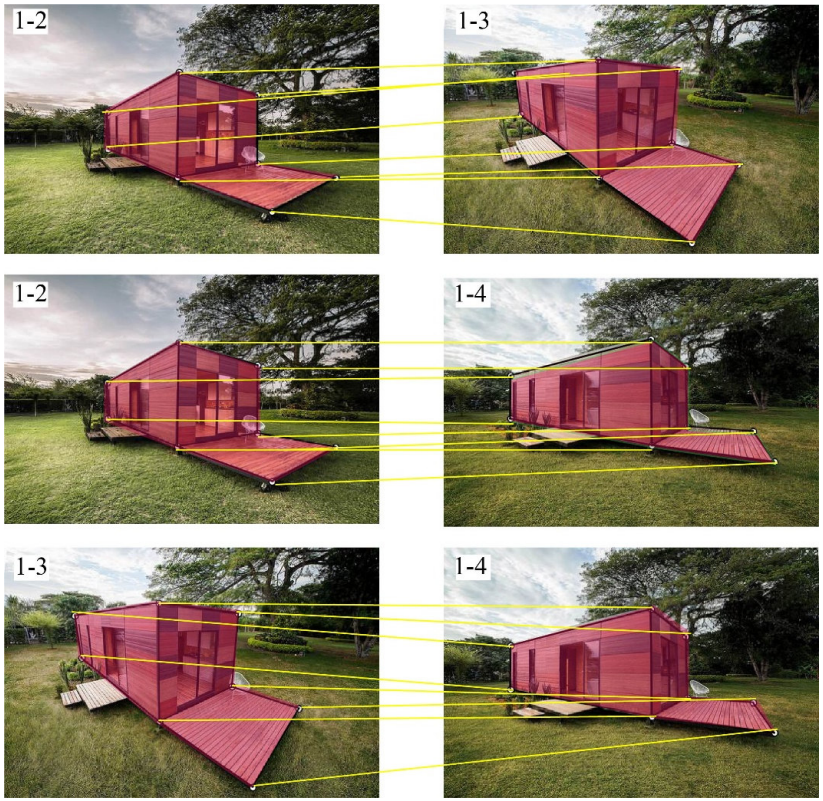
Local shape similari martix

	0	1	2	3	4	5	6	7	8
0	0.02	0.22	0.45	0.32	0.21	0.74	0.18	0.23	0.43
1	0.01	0.46	0.94	0.67	0.44	0.65	0.38	0.48	0.9
2	0.01	0.35	0.72	0.51	0.34	0.85	0.29	0.37	0.68
3	0.01	0.5	0.98	0.73	0.48	0.6	0.41	0.52	0.97
4	0.01	0.53	0.92	0.78	0.51	0.56	0.44	0.56	0.97
5	0.01	0.32	0.65	0.47	0.31	0.93	0.26	0.34	0.62
6	0.01	0.6	0.82	0.87	0.58	0.5	0.49	0.63	0.86
7	0.03	0.12	0.24	0.17	0.11	0.39	0.1	0.12	0.23
8	0.04	0.1	0.21	0.15	0.1	0.35	0.08	0.11	0.2

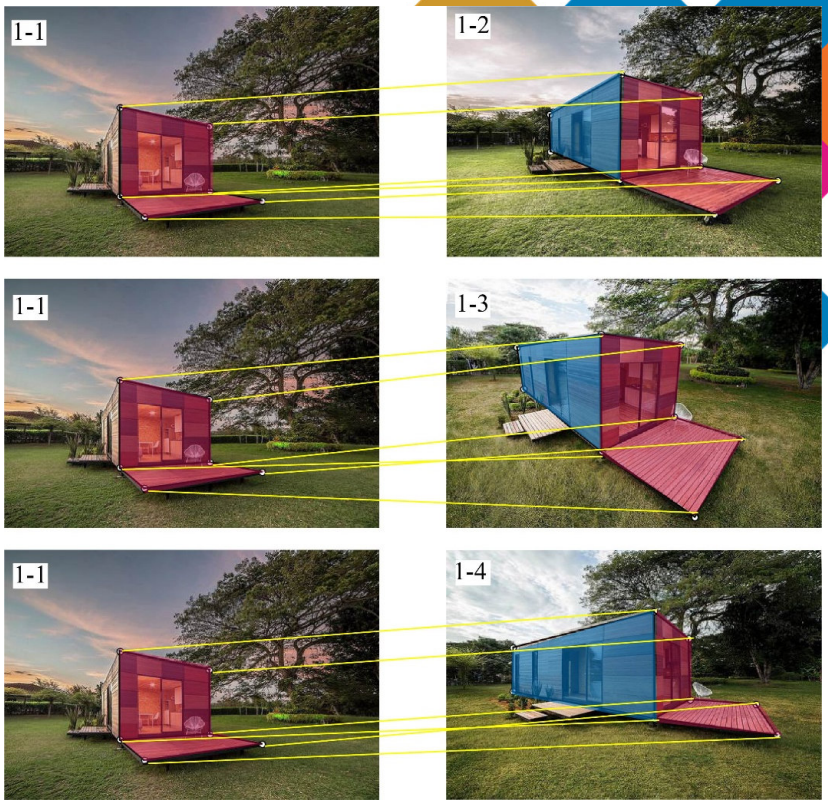
Local shape level Label

Cross-view Metric for Identical Buildings

Similarity=1



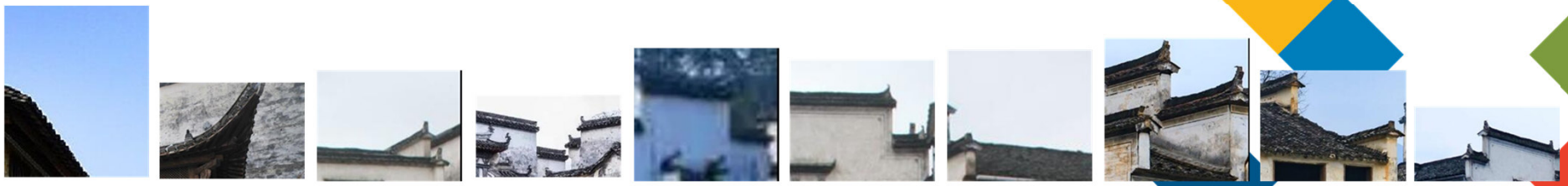
Similarity=0.75



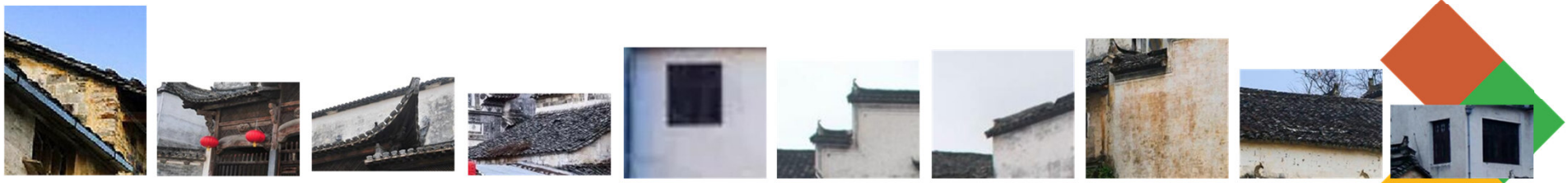
Arbitrary Single-View Building Object Similarity Metric

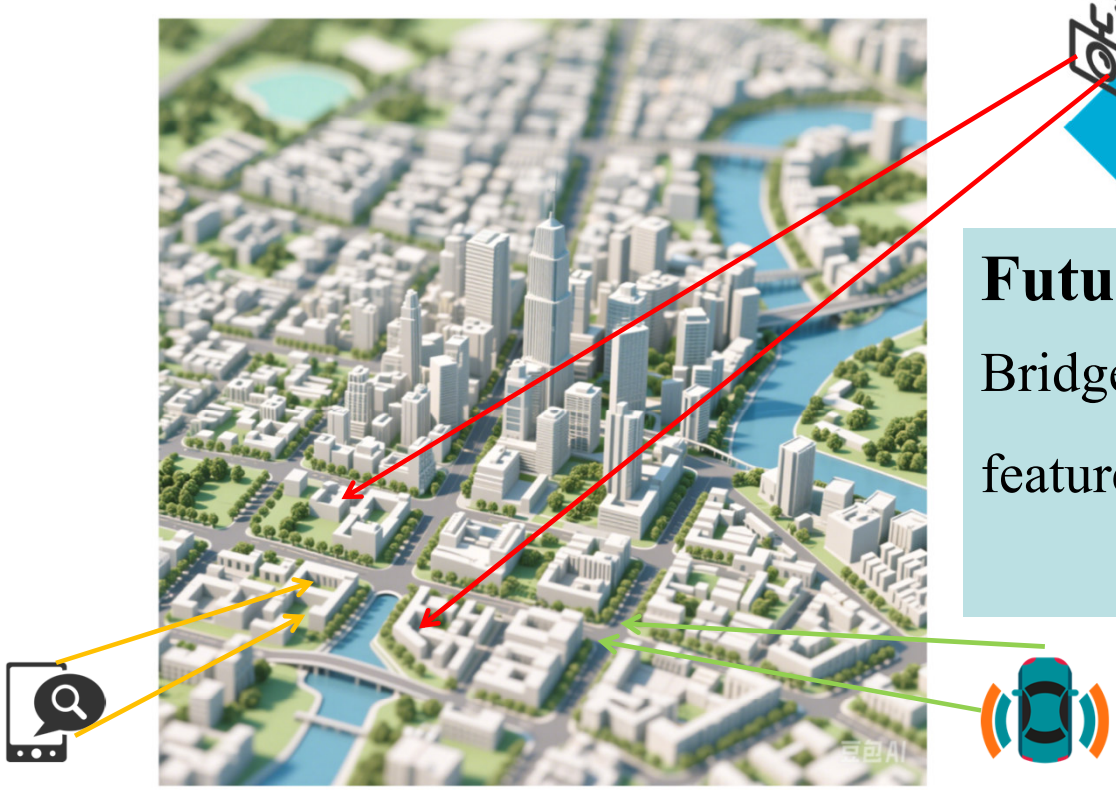
Local Shape Matching Analysis for Same-Style Buildings

Most Frequent Shape



Most Similar Shape





Future Work:

Bridge real-time data with the digital space through feature matching to drive 3D applications.

Thanks!

SUSTAINABLE DEVELOPMENT GOALS | *International Federation of Surveyors supports the Sustainable Development Goals*

STEP 1: SELECT HERE THE THREE MOST RELEVANT SDGs
STEP 2: COPY THE SDG INTO PREVIOUS SLIDE