UNSUPERVISED STACKED CAPSULE AUTOENCODER FOR HYPERSPECTRAL IMAGE CLASSIFICATION

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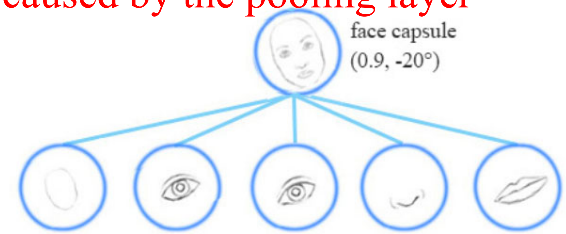
Outline

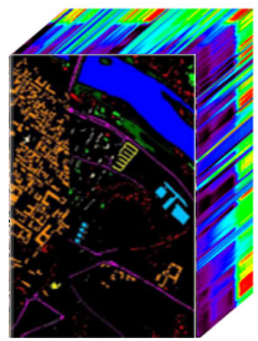
- **Challenge & Motivation**
  - Challenge
    - Insufficient labeled samples
    - High computational cost
    - Unavoidable loss of valuable information
  - Motivation
    - Capsule
    - Structural characteristics of hyperspectral data
- **Methodology**
  - Overview
  - Part Capsule Autoencoder
  - Object Capsule Autoencoder
- **Experiments**
  - Quantitative and qualitative results on Pavia Center dataset
- **Conclusion**

Challenge & Motivation

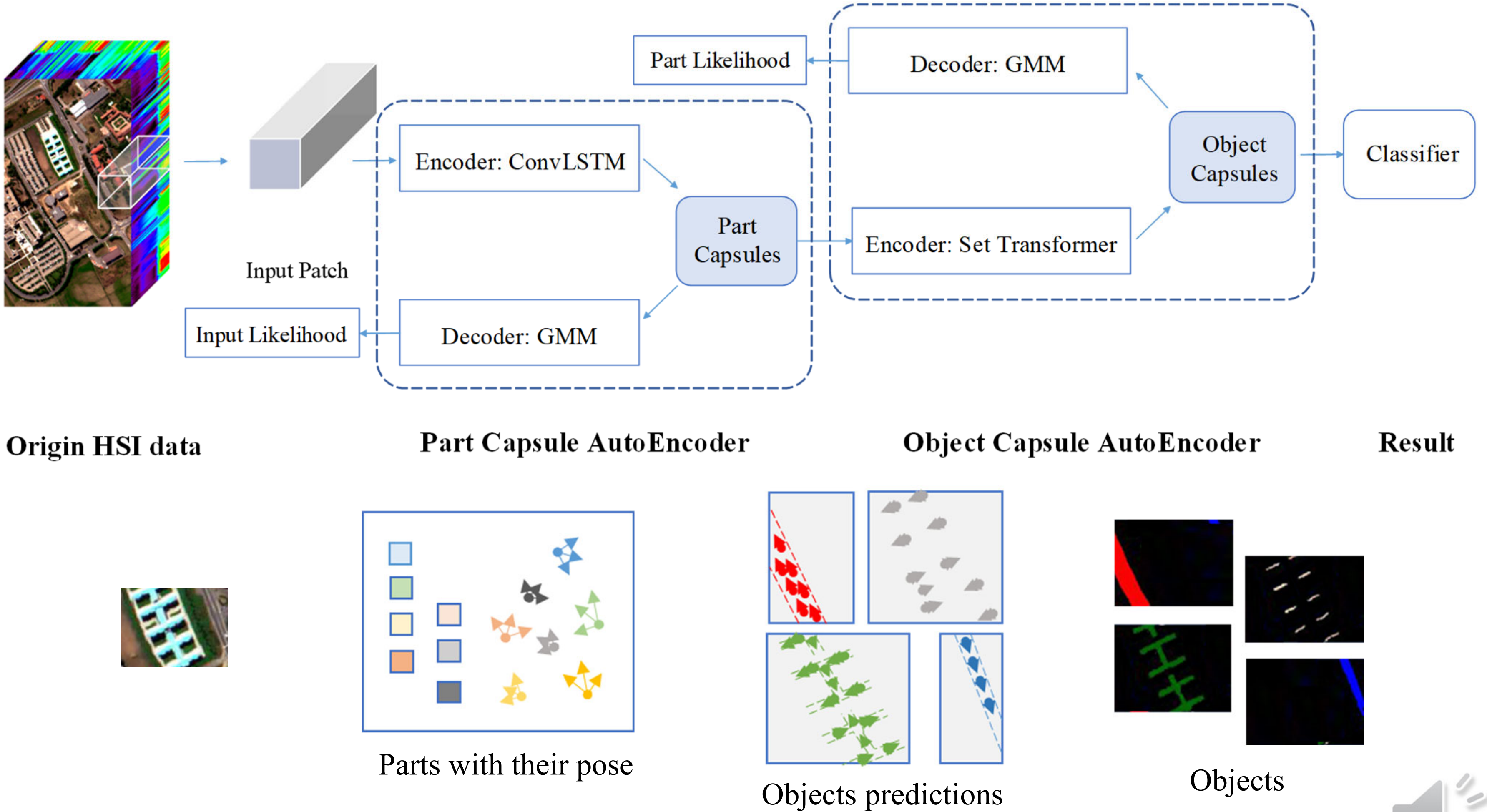
- Superiority performance of existing deep learning methods
- **Challenge**
  - ➢Insufficient labeled samples caused by expensive cost in collecting and labeling hyperspectral data.
  - ➢High computational cost caused by complex network structure
  - ➢Unavoidable loss of valuable information in CNNs caused by the pooling layer



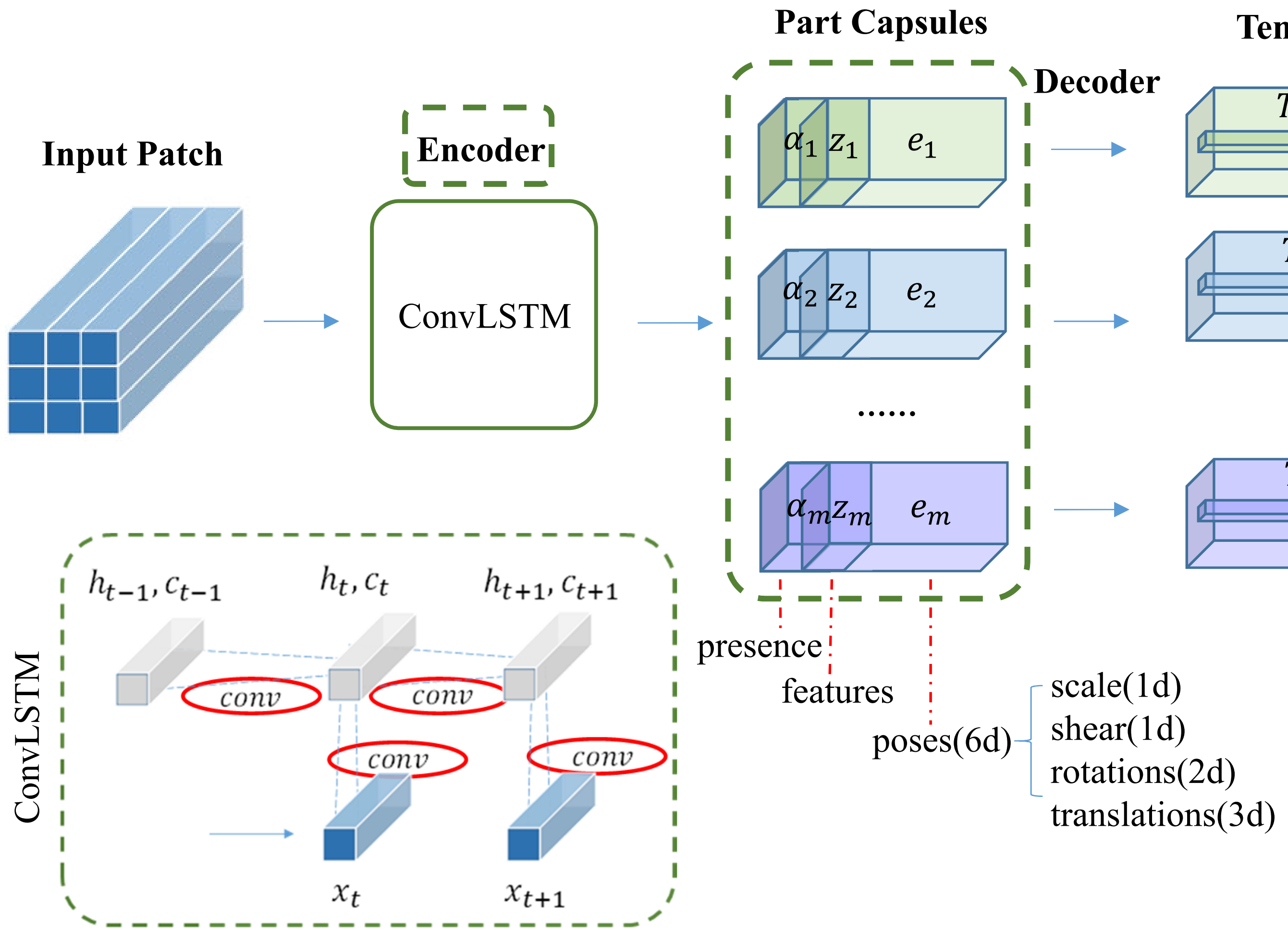
- **Motivation**
  - ➢Capsule
    - It interprets an object by the geometrical arrangements of parts
    - Representing attributes such as presence, position, scale orientation...
  - ➢Hyperspectral data
    - Spectral dimension —— inherent properties of land-covers
    - Spatial domain——Spatial dependence and distributions



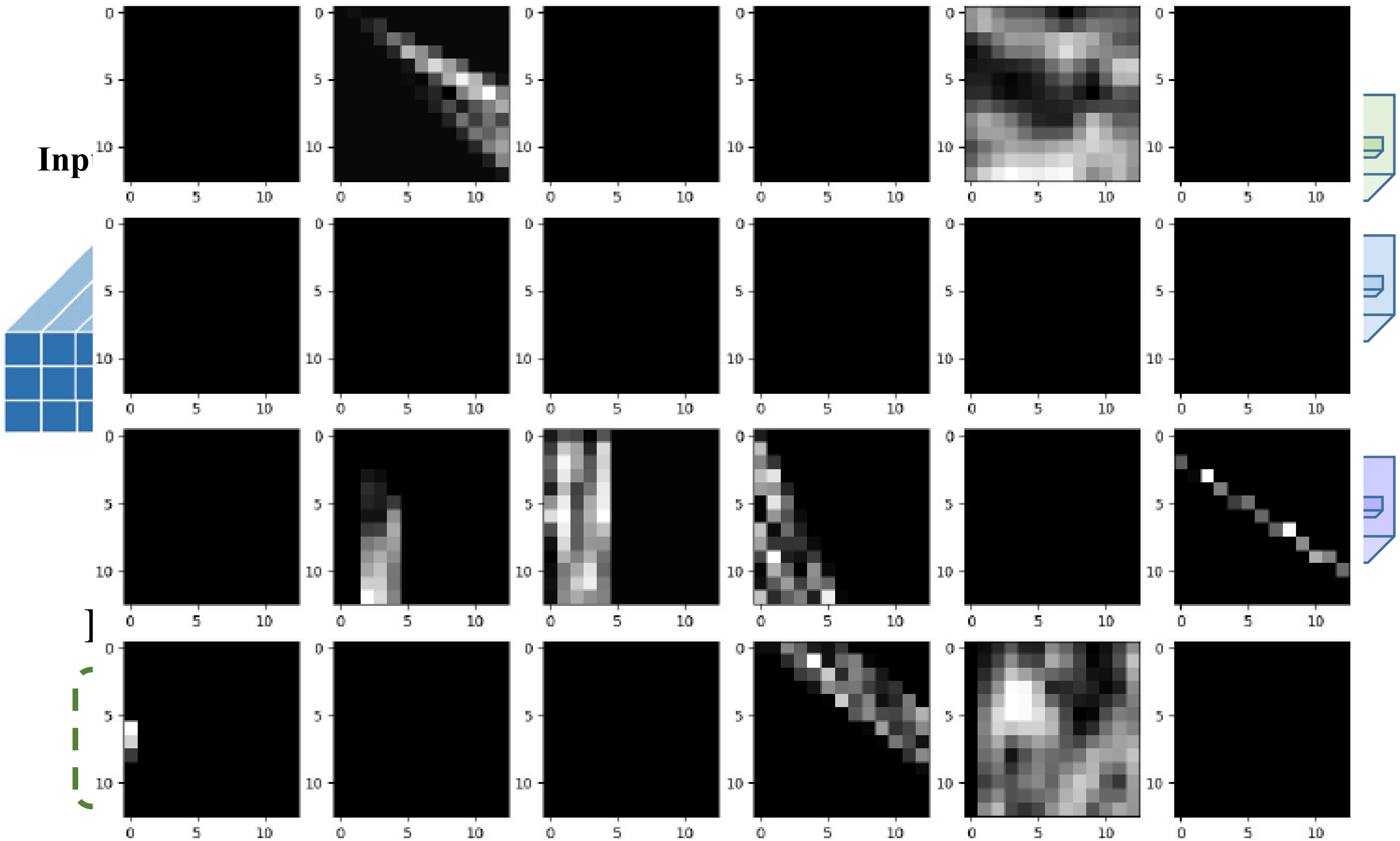
Methodology



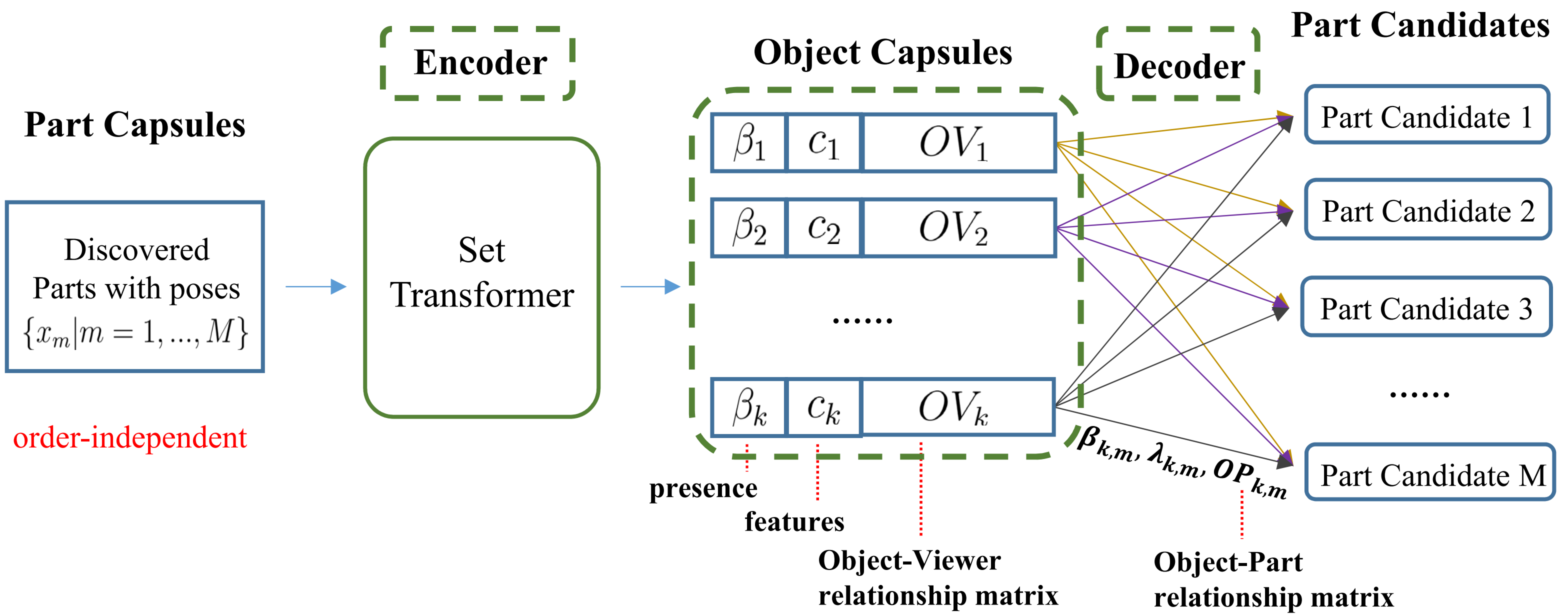
Part Capsule Autoencoder



Part Capsule Autoencoder



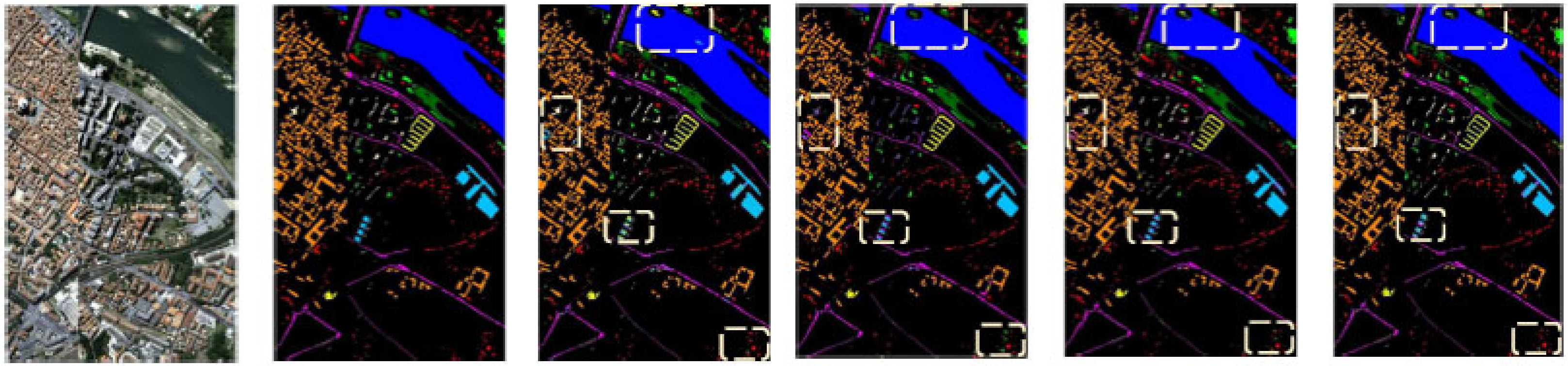
Object Capsule Autoencoder



GMM: $\boxed{p(z_m, \alpha_m)} = \prod_{m=1}^{M} [\sum_{k=1}^{K} \frac{\beta_k \beta_{k,m}}{\sum_i \beta_i \sum_j \beta_{i,j}} \mathcal{N}(z_m | \mu_{k,m}, \lambda_{k,m})]^{\alpha_m}$

$\mu_{k,m} = OV_k \cdot OP_{k,m}$

Experiments



(a) False-color | (b) Ground truth | (c) RNN | (d) 2DCNN | (e) ConvLSTM | (f) Ours

Label	KNN	RNN	2DCNN	ConvLSTM	our method
OA	88.29	90.75	92.75	93.47	**96.39**
AA	89.14	93.88	87.33	96.25	**97.16**
Kappa	82.59	87.66	89.94	90.16	**95.88**

Conclusion

Unsupervised stacked capsule autoencoder

- Modeling the spatial distribution of different land-covers
- Explore Object-Viewer and Object-Part correlations in HSI
- Employ ConvLSTM as the encoder of Part Capsule Autoencoder

THANKS FOR YOUR ATTENTION

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