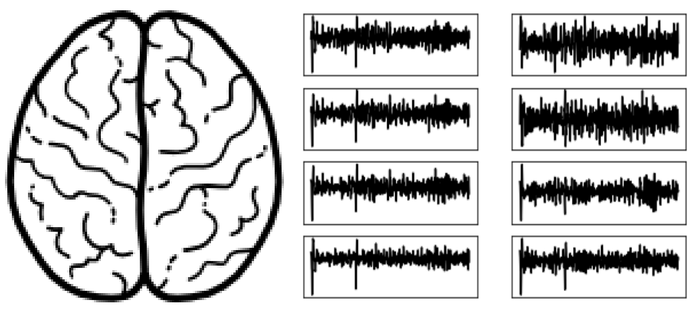
# EEG-BASED VIDEO IDENTIFICATION USING GRAPH SIGNAL MODELING AND GRAPH CONVOLUTIONAL NEURAL NETWORK

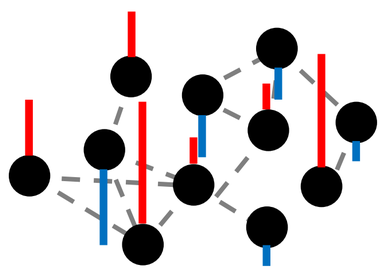
## Introduction

**EEG signals**



**Low spatial resolution**

**Difficult to obtain rich graph signal representation**



- **Expanding graph to overcome low spatial resolution of EEG**
- **Application of graph signal modeling and graph convolutional neural network for EEG signals**

## Graph Signal Modeling

### Bands

$\delta$ $\quad$ $\beta_{low}$

$\theta$ $\quad$ $\beta_{mid}$

$\alpha_{low}$ $\quad$ $\beta_{high}$

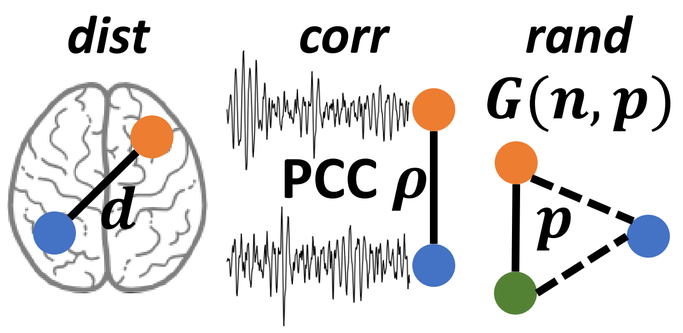
$\alpha_{high}$ $\quad$ $\gamma$

### Signal

**Power**

**Entropy**

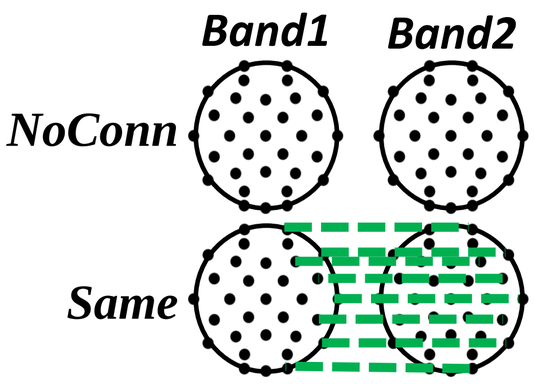
### Intra-band



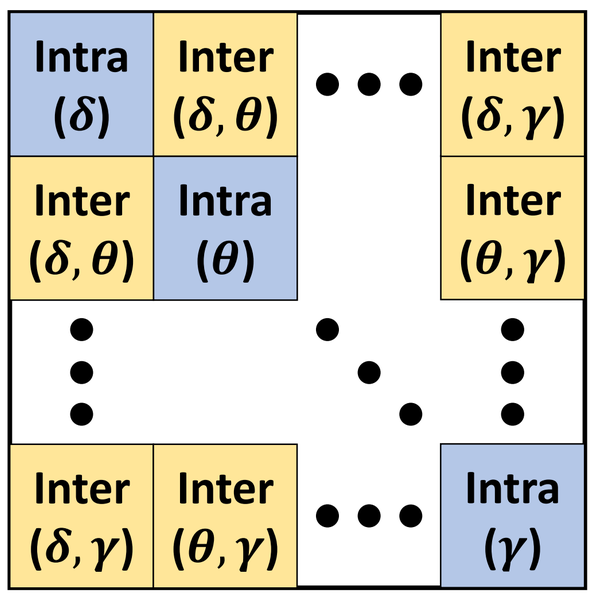

**Sparsity control**

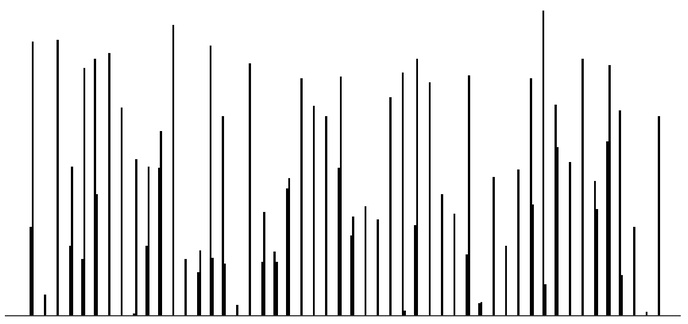
- ***dist*, *corr*: top-$k$** $(k = 4,8,12)$
- ***rand*: edge prob.** $(p = 0.3,0.5,0.7)$

### Inter-band



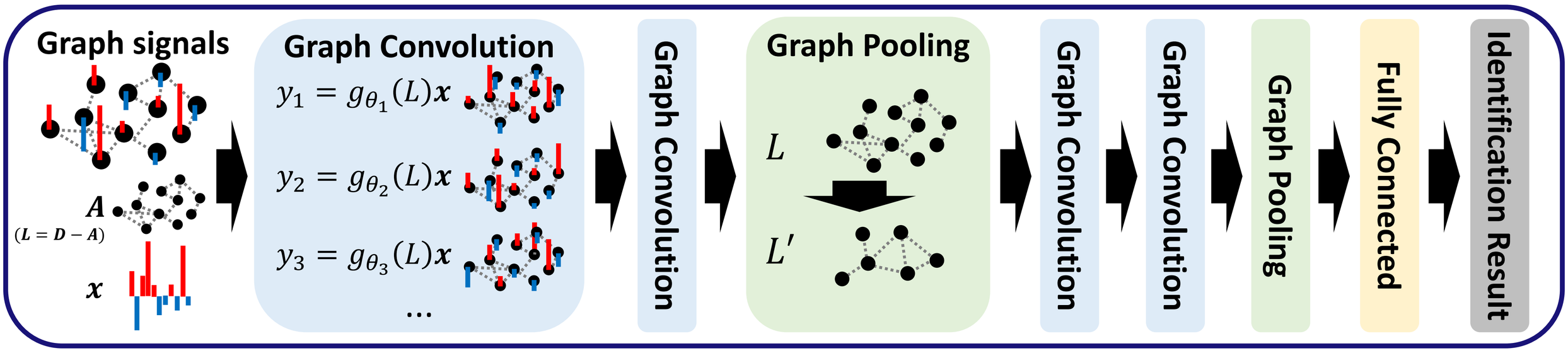

### Merged graph & signal



$$x = [x_0^\delta \dots x_{31}^\delta x_0^\theta \dots x_{31}^\gamma]$$

## Graph Convolutional Neural Network[1]



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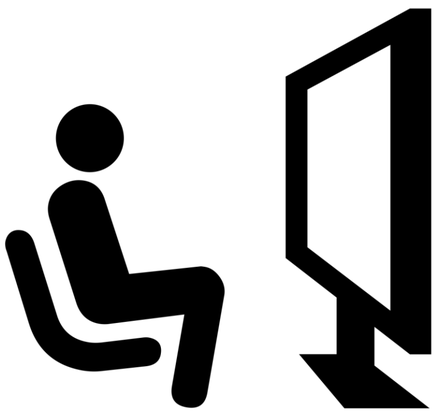
# Experiments & Results

## Experiment

**DEAP dataset**[2]



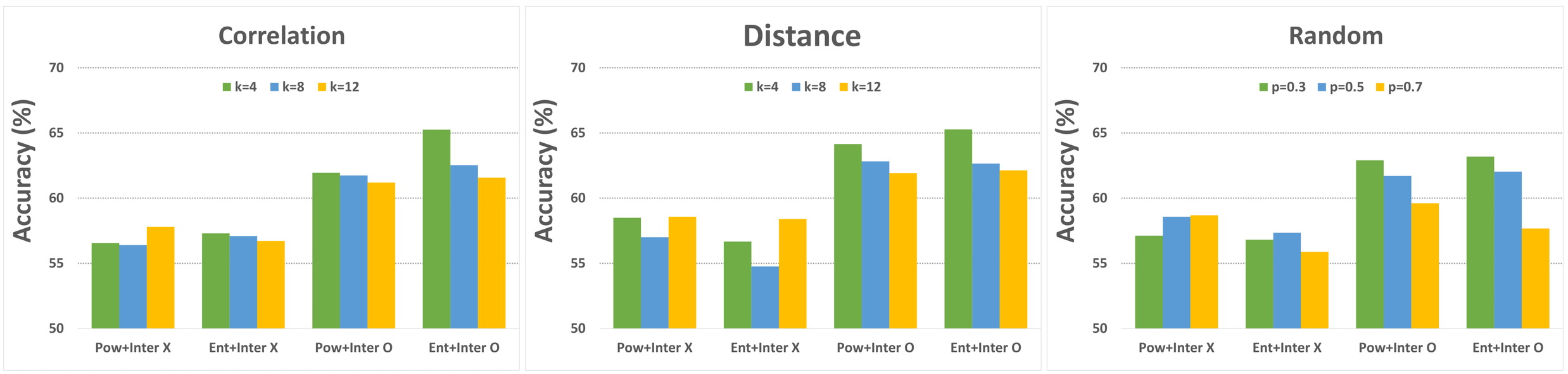
- 32 subjects
- 40 music videos

- 32 EEG channels
- 60 sec. EEG + 3 sec. baseline
- 128Hz sampling

- 3 sec. window + 2 sec. overlap
- 74,240 samples
  - 80% training
  - 20% test

**Video identification task**

## Results




- Graph expansion with inter-band connection helps extracting useful representations between multiple bands.
- Elaborating intra-band graph structure leads to slight advantage in performance.
- Excessive complexity of the graph is not beneficial.

# References


[1] M. Defferrard, X. Bresson, and P. Vandergheynst, “Convolutional neural networks on graphs with fast localized spectral filtering,” in Advances in Neural Information Processing Systems, 2016, pp. 3844–3852.

[2] S. Koelstra, C. M¨uhl, M. Soleymani, J.-S. Lee, A. Yazdani, T. Ebrahimi, T. Pun, A. Nijholt, and I. Patras, “DEAP: A database for emotion analysis; using physiological signals,” IEEE Transactions on Affective Computing, vol. 3, no. 1, pp. 18–31, 2012.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