EFFICIENT INDEXING AND RETRIEVAL OF GRAPHS USING TECHNIQUES FOR EMBEDDING GRAPHS IN REAL-VALUED FEATURE SPACES

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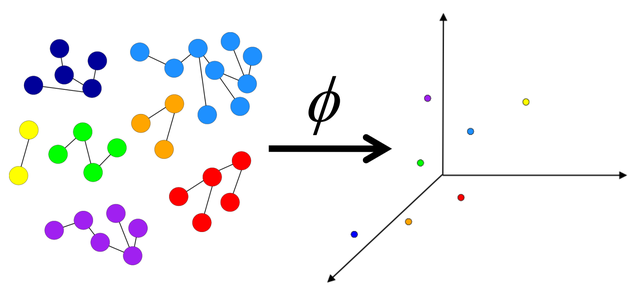
FUZZY GRAPH EMBEDDING (FGE)

- FGE is an explicit graph embedding function ϕ. It maps an attributed graph $AG=(V,E,\mu^V,\mu^E)$ from graph space G to a point $(f_1,f_2,\ldots,f_n)$ in an n-dimensional feature vector space R^n.

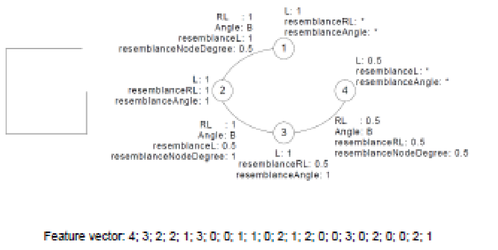
Mathematically,

$$\phi : G \rightarrow R^n$$
$$AG \mapsto \phi(AG) = (f_1, f_2, \ldots, f_n)$$

Pictorially,

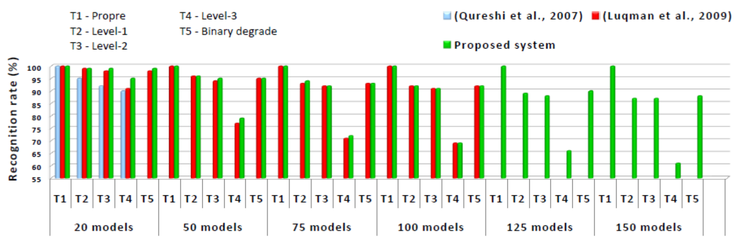


- Application to graphics recognition and object recognition.



Feature vector: 4; 3; 2; 2; 1; 3; 0; 0; 1; 1; 0; 2; 1; 2; 0; 0; 3; 0; 2; 0; 0; 2; 1

Figure : A primitive shape, its attributed graph representation and the feature vector representation obtained after explicit graph embedding.



Experimentation on model symbols from GREC 2005 database

- Multilevel analysis of graph:

Graph Level Information [macro details]	Structural Level Information [intermediate details]	Elementary Level Information [micro details]

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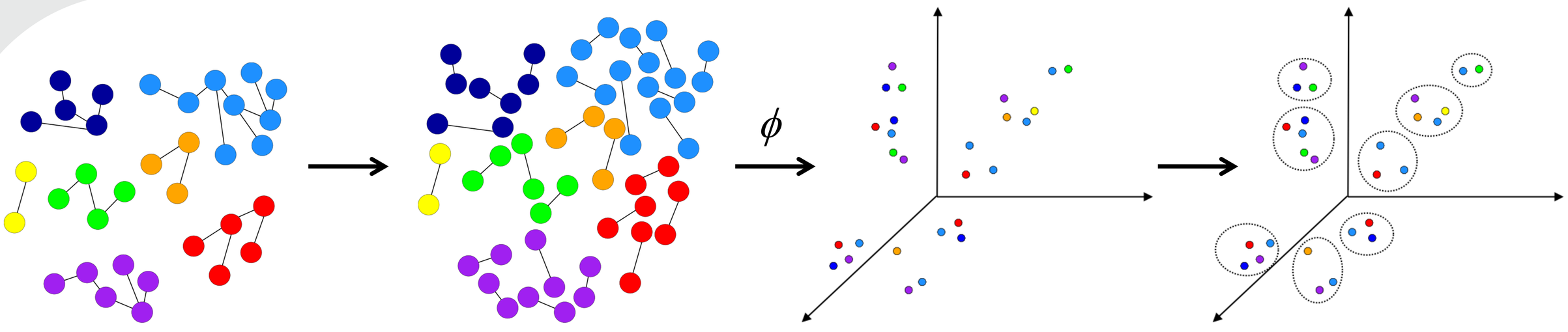
Graph level information	→	Graph order Graph size
Structural level information	→	Node degree Homogeneity of subgraphs in graph
Elementary level information	→	Node attributes Edge attributes

- Numeric feature vector encodes information by employing:
  - fuzzy histogram of numeric information
  - crisp histogram of symbolic information

- Muhammad Muzzamil Luqman, Josep Llados, Jean-Yves Ramel and Thierry Brouard, A Fuzzy-Interval Based Approach For Explicit Graph Embedding. Lecture Notes in Computer Science, Volume 6388, Recognizing Patterns in Signals, Speech, Images, and Videos, 2010, p. 93-98.

SUBGRAPH SPOTTING



1 - a collection of graphs

2 – two-node subgraphs extracted from graphs

3 – subgraphs mapped to n-dimensional feature vector space

4 - feature vectors clustered in groups

- $$score = \sum_{z=0}^{2} (z \times \frac{|z|}{w})$$

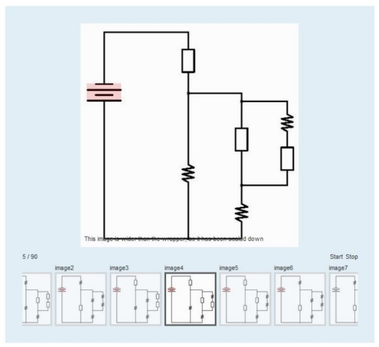
where,

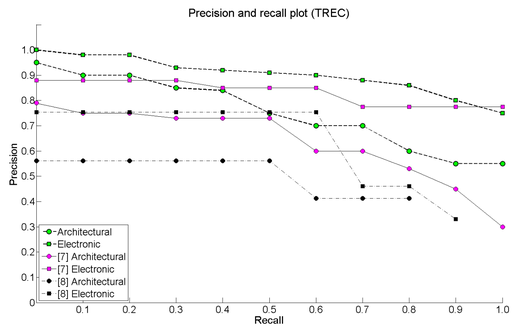
z *is a value in adjacency matrix* (*either* 0,1 *or* 2)

$|z|$ *is number of times the value* z *occurs in neighborhood*

w *is number of connected neighbors that are looked up*

- Application to content based information retrieval from graphic document image repositories.





- Muhammad Muzzamil Luqman, Jean-Yves Ramel, Josep Llados and Thierry Brouard, Subgraph Spotting through Explicit Graph Embedding: An Application to Content Spotting in Graphic Document Images. International Conference on Document Analysis and Recognition, Volume 11, 2011.