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# Chapter 1

# Graph Matching

In this chapter we review different forms and formulations of the graph matching problem (**GMP**) together with basic definitions and notations, used in this thesis. Due to large amount of literature in the field we used mainly the classification from Conte et al. [2004], but extended is with more recent works in the field.

## 1.1 Basic definitions and notation

A *undirected graph* $G = (V, E)$ is defined as a pair of disjoint sets $V$, $E$, where $E \subseteq \{\{u, v\} | u, v \in V\}$ Diestel [2000]. The elements of the set $V$ are called *vertices* or *nodes*[1] and the elements of $E$ are called *edges*. Where it is necessary, we will write $V(G), E(G)$ to refer node and edge sets to graph $G$ respectively.

The number of nodes in $V$ defines the *size* of a graph $G$. Two nodes $v_i, v_{i'} \in V$ are called *adjacent*, if there is an edge $e = \{v_i, v_{i'}\} \in E$. A graph, whose each pair of nodes is connected by an edge is called *complete*.

Each graph can be represented by its *adjacency matrix* $A{=}(a_{ij})_{n\times n}$, where

$$a_{ij} = \begin{cases} 1, & \text{if } \{v_i, v_{i'}\} \in E, \\ 0, & \text{otherwise.} \end{cases}$$

The adjacency matrix of undirected graphs is symmetric.

A graph $G' = (V', E')$ is called *subgraph* of the graph $G$, if $V' \subseteq V$ and $E' \subseteq E$. We use the notation $G' \subseteq G$. We also define graph cut $G \cap G' = (V \cap V', E \cap E')$ and union $G \cup G' = (V \cap V', E \cap E')$.

In case, when each node $v \in V$ of the graph $G$ has an associated attribute $d_i$, one speaks about attributed graph $G = (V, E, D)$.

Consider two undirected attributed graphs $G^I = (V^I, E^I, D^I)$ and $G^J = (V^J, E^J, D^J)$. We assume the situation, where $|V^I| = n_1$, $|V^J| = n_2$ and $n_1 \leq n_2$. A matching function between two graphs $G^I = (V^I, E^I, D^I)$ and $G^J = (V^J, E^J, D^J)$ is a total injective function $m : V^I \to V^J$.

*Graph matching problem* between $G^I$ and $G^J$ is a problem of finding a map $m : V^I \to V^J$, that maximizes the alignment score $F(G^I, G^J, m)$:

$$f = \underset{\hat{m}}{\operatorname{argmax}}\, F(G^I, G^J, \hat{m}) \tag{1.1}$$

[1] We use terms vertex and node as synonyms

## 1.2 Exact graph matching

## 1.3 Inexact graph matching

# Part I

# Appendix

# Appendix A

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Reinhard Diestel. *Graph Theory, 4th Edition*, volume 173 of *Graduate Texts in Mathematics*. Springer-Verlag New York, 2000.

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**Declaration of Authorship**

I confirm that this Master's thesis is my own work and I have documented all sources and material used. This thesis was not previously presented to another examination board and has not been published.

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