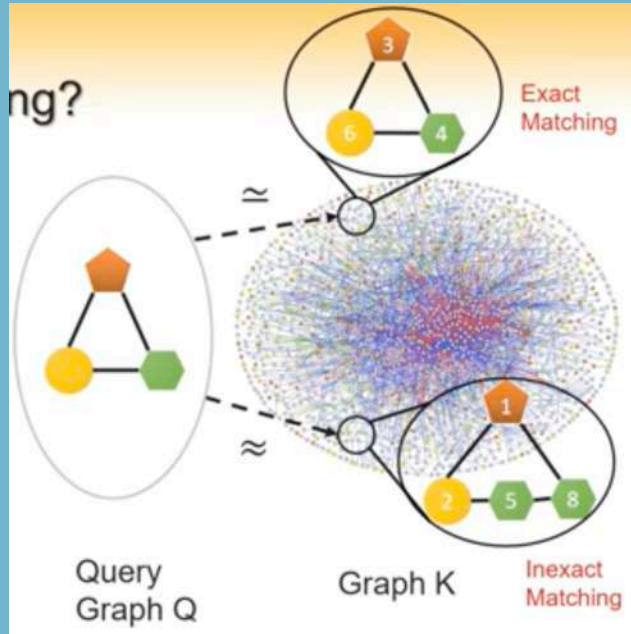
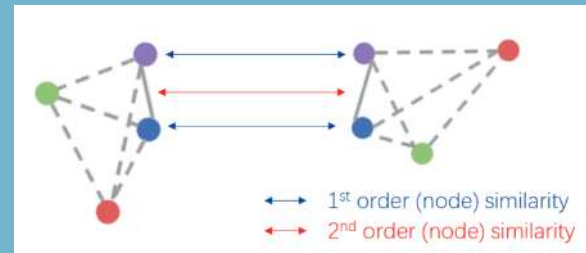


A Short Survey of Recent Advances in Graph and Subgraph Matching

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Learning Objectives



- **GM:** Construct *vertex corresponding*, which maximize *affinities*
 - Object Function \leftarrow Lawler's QAP
 - Optimization Problem \leftarrow Maximize Affinity Score
- **SubGM:** Find *all subgraphs* in the database graph
 - Making *Index* \leftarrow Dataset Preprocessing
 - Query processing \leftarrow GM
- **Current Hotspots:**
 - Multi-graph Matching
 - Incremental GM
 - Deep Learning based GM/SubGM
- **Applications:**
 - Effective and Efficient SubGM for bio networks
 - Online Incremental Learning

Background:

1. Subgraph Matching for (**large**) biological networks/graphs
2. Maximum Common Subgraphs (MCS)

Survey:

1. Most (*Inexact*) Graph Matching
2. Few *Subgraph Matching*

Graph Matching



Definitions

- Model **vertex corresponding** to maximize **object function** (e.g., affinity score, distance cost)
- Properties: **isometric** (等距), **isomorphisms** (同构), homeomorphisms (同胚)
- Two Steps:
 1. Build vertex corresponding (**Assignment Matrix**) and object function
 2. Optimize the Assignment Matrix to **maximize/minimize object function**

Measurements

- Which metrics we aim to optimize → **Assignment Matrix**
- How we define our object function → **Lawler's QAP** (Most commonly used affinity score)

Keywords

- Graph Matching, Subgraph Matching,
- Multi-graph Matching, Incremental Matching, Higher-order Graph Matching

Graphs/Subgraphs Matching to (Multiple/Large) Domain Database Graphs

- Subgraphs → (Large, $>10^3$ vertexes) domain Knowledge Graphs
- **Physical Science** (Chemistry, Fluid Dynamics, Astronomy, structural mechanics, and ecosystem modeling)
- **Life Science** (Biological Networks, protein-protein interaction networks, gene regulatory networks, metabolic networks, brain connectivity from alignment-free functional magnetic resonance imaging (fMRI) data)

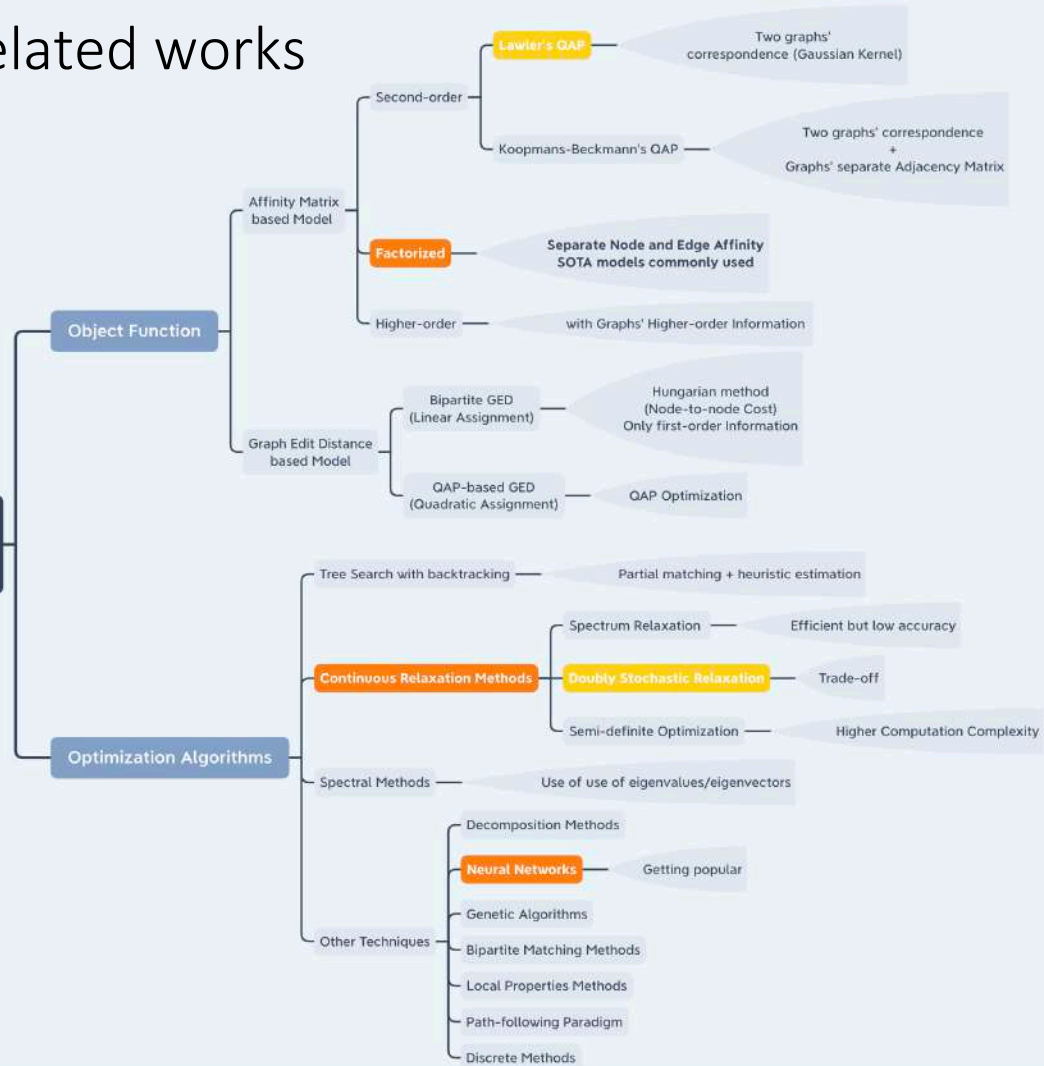
Computer Science Scenarios ← A lot of scenarios

- **Combinatorics** ← Quadratic Assignment Problem (QAP) ← Graph Matching
- **Pattern Recognition, Multimedia, Computer Vision**
- Image registration, understanding, extrapolation and recognition, object recognition and tracking, scene understanding and parsing, weak-perspective 3-D reconstruction, action recognition, robotics, video surveillance and person re-identification.

Current related works



Inexact Graph Matching



Inexact Matching

Tree Search

Tsai79[154], Ghahraman80[59], Shapiro81[136], Sanfeliu83[132], Tsai83[155], Eshera84[44, 45], Shapiro85[137], Wong90[172], Dumay92[40], Rocha94[128], Shasha94[138], Wang95[164], Cordella96[30], Allen97[2], Cordella97[31], Oflazer97 [113], Haris99[65], Serratos99[135], Berretti00[9,10], Serratos00[134], Berretti01[11], Lladós01[95], Valiente01[158], Gregory02[63] , Fernández01[48]

Continuous Optimization

Fisher73[51], Kittler89[80], Almohamad93[3], Christamas95[27], Pelillo95 [119], Pelillo95 [120], Gold96[61], Rangarajan96[127], Bomze97[12], Wilson97[167], Pelillo98 [121], Branca99[13], Huet99[71], Medasani99[105], Pelillo99[122, 123], Myers00[112], Luo01[98], Medasani01[104], Torsello01[151], Pelillo02[124], Van Wyk02 [159, 160]

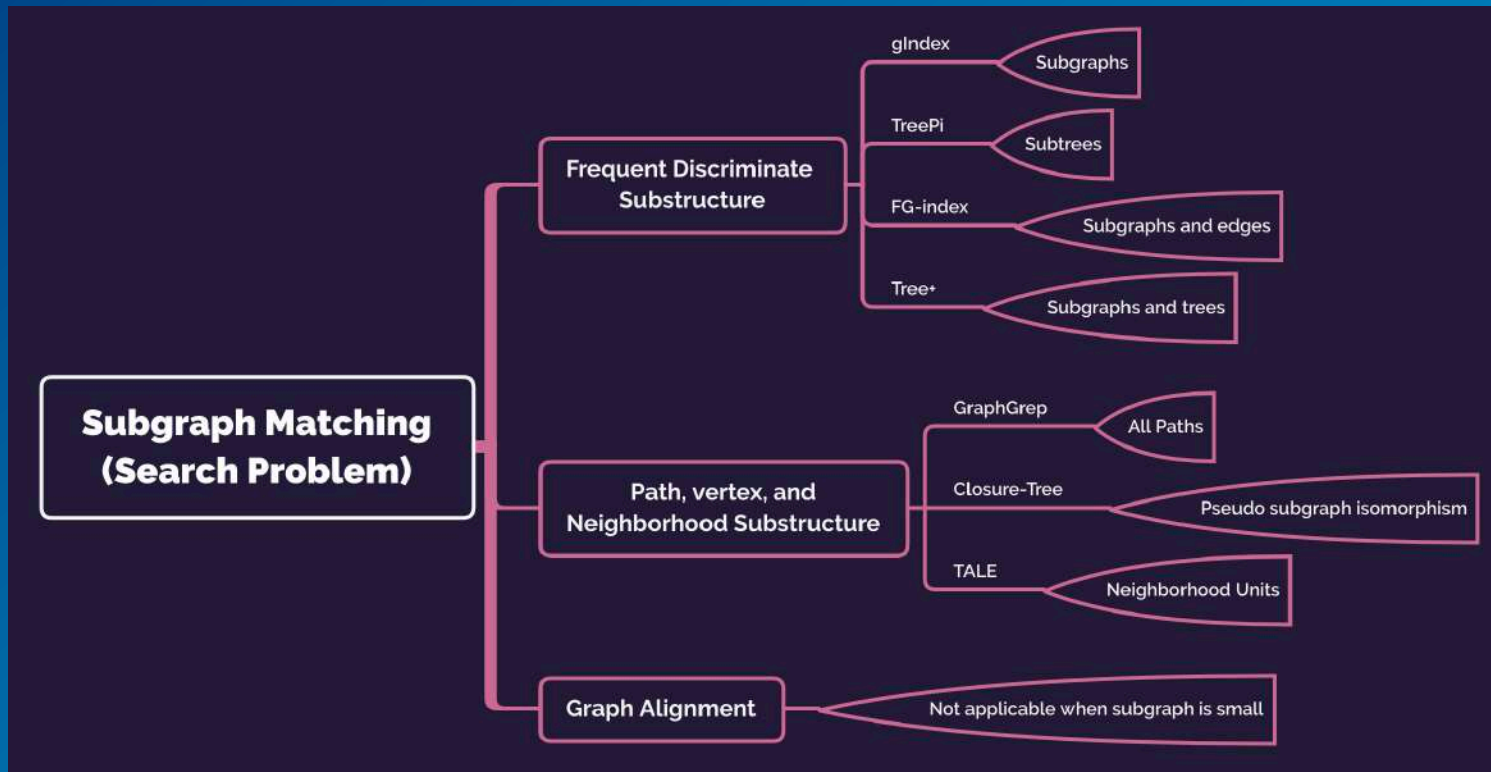
Spectral Methods

Umeyama88[157], Carcassoni01[21], Kosinov01[83], Xu01[173], Shokoufandeh01[144]

Other Techniques

Kitchen79[79], Gendreau93[58], Wang94[163], Liu95[93], Depiero96[37], Shoukry96[145], Wang97[166], El-Sonbaty98[42], Messmer98[108], Suganthan98[149], Fuchs99[57], Ozer99[115], Perchant99[125], Williams99[168], Baeza-Yates00[5], Fuchs00[56], Jagota00[74], Liu00[92], Suganthan00[146], De Mauro01[34], Khoo01[78], Hlaoui02[66]

Current related works



Summary



Year	Author	Institution	Title	Scenario	Metrics	Model	Result
2016	Junchi Yan (严骏驰)	上海交大	A Short Survey of Recent Advances in Graph Matching	Multiple	-	-	-
2018 2015	Junchi Yan (严骏驰)	上海交大	(中文期刊) 计算机视觉中图匹配研究进展: 从二图匹配到多图匹配 (博士论文) 图匹配问题的研究和算法设计	Multiple	-	-	-
2004	Donatello Conte, Pasquale Foggia, and et al.	萨勒诺大学	Thirty Years Of Graph Matching In Pattern Recognition	Multiple	-	-	-
2018	Andrei Zanfir and Cristian Sminchisescu	隆德大学	Deep Learning of Graph Matching	Multiple, Computer Vision in particular	PCK: Percentage of Correct Keypoints PCK@10 pixels, PCK@0.05, PCK@0.1	Neural Network (CNNs)	MPI-Sintel: PCK@10 pixels: 92.6% CUB: PCK@0.05: 0.86 PASCAL VOC keypoints: PCK@0.1 (class average): 40.6
2009	Shijie Zhang, Shirong Li, and Jiong Yang	凯斯西储大学	GADDI: Distance Index based Subgraph Matching in Biological Networks	Biological Networks	Accuracy, Precision, Recall, Query Time	Distance Index based method	-

To do




- Continue to survey *subgraph matching*, especially those methods for biological networks
- Try to reproduce “Deep Learning of Graph Matching” and apply the algorithm into biological networks (graph matching)
 - See whether the method is suitable for *subgraph matching*
- Get engaged with knowledge graph and corresponding tasks.

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Thanks and have a nice day!

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