



Data Science Research

Özgür Ulusoy

<http://www.cs.bilkent.edu.tr/~oulusoy/>

- **Text-to-SQL Systems**
- **Web Search Engines**
- **Multimedia Database Systems**
- **Social Network Analysis**
- **Resource Optimization in WSNs**



Text-to-SQL Systems

- **Keyword Mapping**
- **Explainable Text-to-SQL**
- **Query Recommendation**

Text-to-SQL Systems

Keyword Mapping - mapping between tokens in the query and relational database elements

- ❖ Keyword mapping formulated as sequence tagging problem in NLP
- ❖ An end-to-end keyword mapper (DBTagger)

- A. Usta, A. Karakayalı, Ö. Ulusoy, 'DBTagger: Multi-Task Learning for Keyword Mapping in NLIDBs Using Bi-Directional Recurrent Neural Networks', **Very Large Databases (VLDB) Conference**, 2021.

Text-to-SQL Systems

Explainable Text-to-SQL - based on Explainable AI

- ❖ Explaining the decisions made by the keyword mapping system using LIME
- ❖ A novel wrapper around LIME
- ❖ Using a schema graph to explain join-path inference

➤ A. Usta, A. Karakayalı, Ö. Ulusoy, 'xDBTagger: explainable natural language interface to databases using keyword mappings and schema graph', **VLDB Journal**, 2024.



Text-to-SQL Systems

Query Recommendation

- ❖ A ranking method to create a list of suggested queries
- ❖ Distributed representations for database tuples, trained on a relational database
- ❖ Graph convolutional networks (GCNs) to learn distributed representations



Web Search Engines

- **Learning to Rank for Educational Web Search**
- **Diversification of Search Results**
- **Efficiency and Scalability Issues for Web-IR**

<http://www.cs.bilkent.edu.tr/~bilweb>



Web Search Engines

Learning to Rank for Educational Web Search - machine-learned ranking models

- ❖ A rich set of features employed in educational search
- ❖ Domain knowledge utilized to build query-dependent ranking models

➤ A. Usta, R. Ozcan, I. S. Altingovde, Ö. Ulusoy, '*Learning to Rank for Educational Search Engines*', **IEEE Transactions on Learning Technologies**, 2021.



Web Search Engines

Diversification of Search Results

- ❖ Multidimensional result diversification
- ❖ Supervised learning methods for search result diversification
- ❖ Impact of index pruning on diversification performance

- S. Yigit-Sert, I.S. Altingovde, C. Macdonald, I. Ounis, Ö. Ulusoy, '*Explicit diversification of search results across multiple dimensions for educational search*', **Journal of the Association for Information Science and Technology (JASIST)**, 2021.
- S. Yigit-Sert, I.S. Altingovde, C. Macdonald, I. Ounis, Ö. Ulusoy, '*Supervised approaches for explicit search result diversification*', **Information Processing & Management**, 2020.

Web Search Engines

Efficiency and Scalability Issues

- ❖ Methods and algorithms for caching, indexing, and query processing in search engines
- E. Sarıgil, I. S. Altingovde, R. Blanco, B. Cambazoglu, R. Ozcan, Ö. Ulusoy, '*Characterizing, predicting, and handling web search queries that match very few or no results*', **Journal of the Association for Information Science and Technology (JASIST)**, 2018.
- E. Sarıgil, O. Yılmaz, I. S. Altingovde, R. Ozcan, Ö. Ulusoy, '*A "Suggested" Picture of Web Search in Turkish*', **ACM Transactions on on Asian and Low-Resource Language Information Processing**, 2016.
- R. Ozcan, I. S. Altingovde, B. B. Cambazoglu, Ö. Ulusoy, '*Second Chance: A Hybrid Approach for Dynamic Result Caching and Prefetching in Search Engines*', **ACM Transactions on the Web**, 2014.



Multimedia Databases

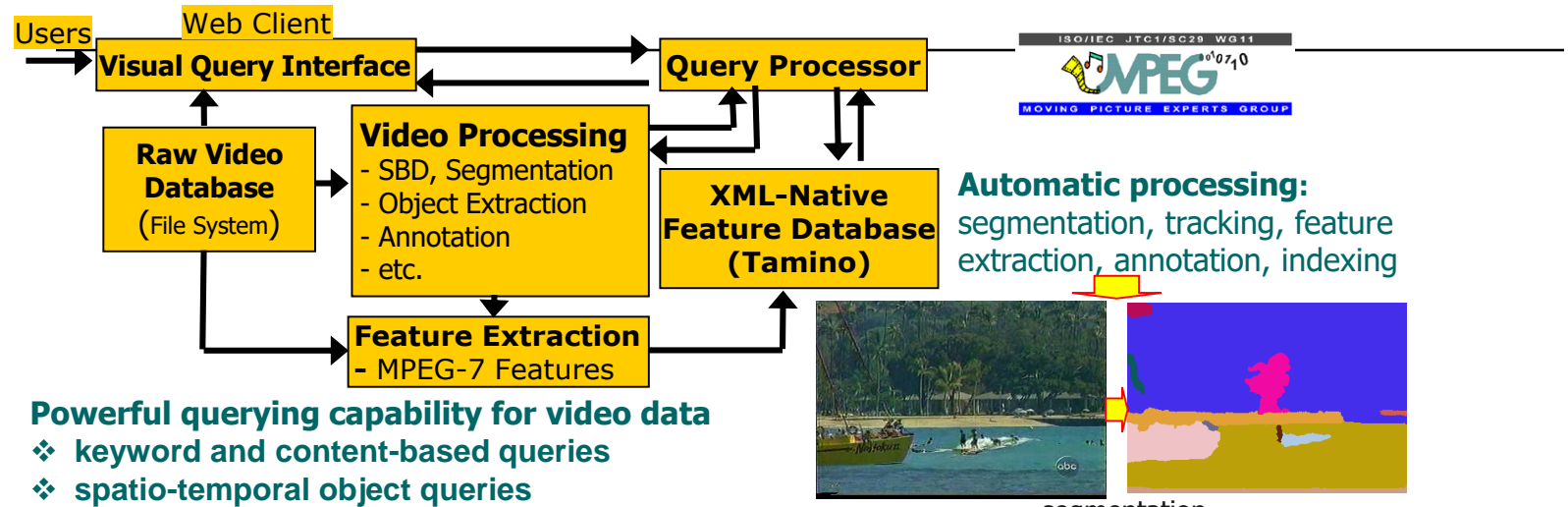
(joint work with Prof. Uğur Gündükbay)

- **Video Retrieval Systems**
- **Mobile Visual Search**
- **Learning Visual Similarity for Image Retrieval**

<http://www.cs.bilkent.edu.tr/~bilmdg>

Multimedia Databases

BilVideo-7: An MPEG-7 Compatible Video Retrieval System

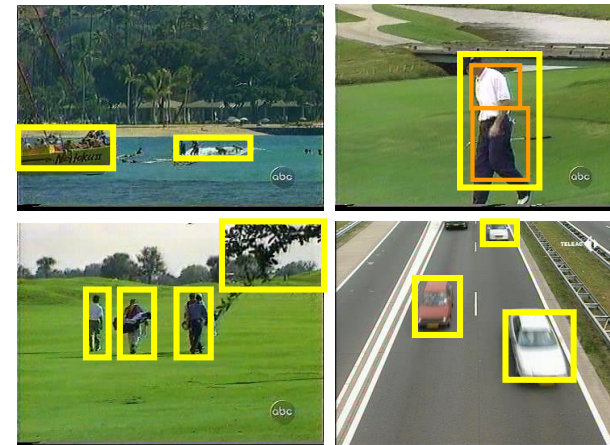


segmentation



keywords: trees, greenery, sky – bush, putin, dog

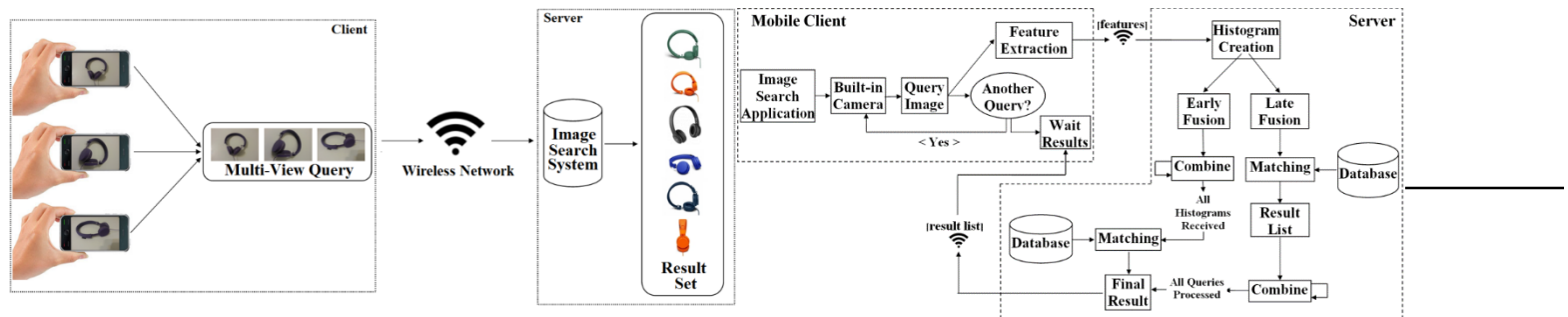
Example query formulation



Salient video object extraction

Multimedia Databases

Mobile Image Search Using Multi-View Object Image Queries

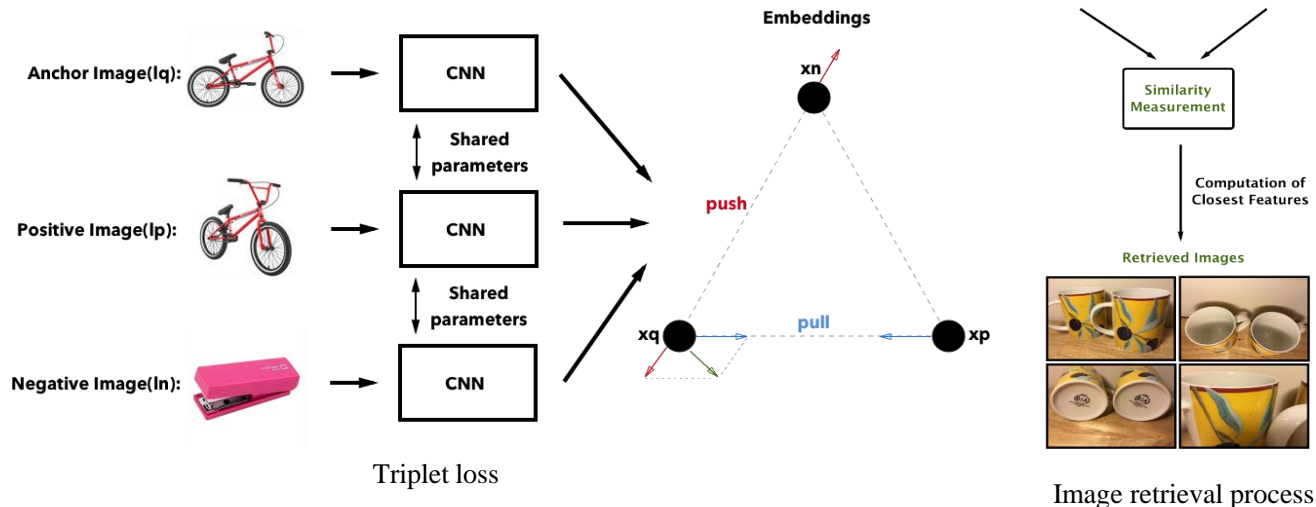


- F. Calisir, M. Bastan, Ö. Ulusoy, U. Güdükbay, 'Mobile Multi-View Object Image Search', **Multimedia Tools and Applications**, 2017.

Multimedia Databases

Learning Visual Similarity for Image Retrieval with CNNs

- ❖ Learning efficient visual similarity for image retrieval by revealing resemblances and differences between product images



- D. Durmus, U. Gdkbay, . Ulusoy, 'Learning visual similarity for image retrieval with global descriptors and capsule networks', **Multimedia Tools and Applications**, 2024.



Social Network Analysis

- **Misinformation Propagation in Social Networks**
- **Social Network Data Analysis on Big Data Processing Platforms**



Social Network Analysis

Misinformation Propagation in Social Networks

- ❖ Misinformation problem modelled as a game based on the notion of cooperative games
- ❖ Agents defined to maximize the total reward
- ❖ A blockchain - machine learning hybrid approach for addressing misinformation in a crowdsourced environment

➤ T. Yilmaz, Ö. Ulusoy, 'Misinformation Propagation in Online Social Networks: Game Theoretic and Reinforcement Learning Approaches', **IEEE Transactions on Computational Social Systems**, 2023.

Social Network Analysis

Social Network Data Analysis on Big Data Processing Platforms

(joint work with Prof. İbrahim Körpeoğlu)

- ❖ Community detection formulated as a multi-k-core problem
- ❖ Distributed multi-k-core construction and maintenance algorithms running on a big data platform

- H. Aksu, I. Körpeoğlu, Ö. Ulusoy, 'An Analysis of Social Networks based on Tera-scale Telecommunication Datasets', **IEEE Transactions on Emerging Topics in Computing**, 2019.
- H. Aksu, M. Canim, Y. C. Chang, I. Körpeoğlu, Ö. Ulusoy, 'Distributed k-Core View Materialization and Maintenance for Large Dynamic Graphs', **IEEE Transactions on Knowledge and Data Engineering**, 2014.

Resource Optimization in Wireless Sensor Networks

(joint work with Prof. İbrahim Körpeoğlu)

- Application placement with shared monitoring points in WSNs
- Application scheduling with multiplexed sensing of monitoring points in WSNs

- M. C. Cavdar, I. Körpeoğlu, Ö. Ulusoy, 'Application Scheduling with Multiplexed Sensing of Monitoring Points in Multi-purpose IoT Wireless Sensor Networks', **IEEE Transactions on Network and Service Management**, 2024.
- M. C. Cavdar, I. Körpeoğlu, Ö. Ulusoy, 'Application placement with shared monitoring points in multi-purpose IoT wireless sensor networks', **Computer Networks**, 2022.