Bilkent University
Computer Engineering Department
MSc and PhD Programs

Prof. Dr. H. Altay Güvenir
Graduate Programs

• **MSc**
  – 8 courses + Seminar + Thesis

• **PhD**
  – With MSc degree (approx. 4 years)
    • 8 courses + Seminar + Thesis
  – With BSc degree (approx. 5 years)
    • 16 courses + 2 Seminars + Thesis
Applications

• Application Deadline: 30 May 2016
• Online Application:  
  https://stars.bilkent.edu.tr/gradapp/
• Requirements for application:
  – CGPA ≥ 2.80 / 4.00
  – ALES (Turkish citizens) or GRE (Foreign applicants)
    • ALES: Quantitative ≥ 55 (for MS), 80 (for PhD w/o BS)
    • GRE: Quantitative ≥ 153 (MS), 157 (PhD)
  – English Proficiency: TOEFL (IBT) ≥ 87 or
    IELTS avg ≥ 6.5 (and min 5.5 in each section)
  – And YDS ≥ 55 (for Turkish citizen PhD).
Interview

• **Date:** 6-7 June 2016
• **Hard copy documents to be submitted during interview:**
  – Transcript
  – ALES or GRE score report
  – Proof of English Proficiency (TOFLE, IELTS or YDS report)
Acceptance requirements

• At least one faculty member willing to work with the applicant towards thesis
• Department approval
• Graduate School of Engineering and Science approval
Scholarship Options

• **Department scholarship**
  – Tuition waiver
  – Stipend
  – Accommodation support
  – Health Insurance
  – Additional Scholarship for Teaching Assistantship
  – Office (shared)

• **TÜBİTAK Scholarship or TÜBİTAK projects**
  – Tuition waiver
  – Accommodation
  – Health Insurance
  – Office (shared)
Scholarship Options

• Project grants (except TÜBİTAK projects)
  – Tuition waiver
  – Stipend (paid from the project budget)
  – Accommodation
  – Health Insurance (paid from the project budget)
  – Additional Scholarship for Teaching Assistantship
  – Office (shared)

• Graduate School scholarship
  – Tuition waiver
  – Additional Scholarship for Teaching Assistantship
Faculty Members

• In alphabetic order

(Please contact with them in person for details)
My current research is two pronged:

i.  contextual reasoning in AI
ii.  public implications of the Internet

- http://www.cs.bilkent.edu.tr/~akman
- email: akman@bilkent.edu.tr
Contextual reasoning in AI

Problems originating from natural language processing and understanding, especially those caused by the lack of explicit context:

When we say a particular thing, we do so in a context. Thus, there are embedded background assumptions available only through the context. We are also good at shifting between contexts. Can context be formalized in a formal framework? This would lead to improved software not only in Natural Language Understanding but also in knowledge-based systems, robotics, search engines, and personal assistants like Siri, Cortana, OK Google.

My grad courses CS 563 and CS 661 examine contexts, as well as other AI topics.
Public implications of the Internet

Problems caused by tensions between local versus global, individual versus corporate, and democratic versus authoritarian in the framework of the Internet. More specifically:

Basic concepts and history of the Internet as a socio-political medium. Free access to information in the networked world. The Internet as a trusted communications medium in light of security and privacy issues. Censorship and politics of the Internet vis-à-vis interventions by oppressive governments. Social movements in the 21st century marked by rapid broadcast of ideas and images.

My grad course CS 513 treats such societal aspects of the Internet.
Selim Aksoy
saksoy@cs.bilkent.edu.tr
http://www.cs.bilkent.edu.tr/~saksoy
Office: EA 423 (4th floor)

Research interests:
- Computer vision
- Pattern recognition
- Machine learning
- Data mining

Current topics:
- Remote sensing image analysis
- Image and video mining
- Medical image analysis

RETINA Vision and Learning Group
http://retina.cs.bilkent.edu.tr
Sponsored Research Projects

- Remote sensing image analysis
  - TÜBİTAK CAREER Grant, 158,000 YTL, 2005-2010
  - EC Joint Research Centre, 35,000 Euro, 2008
  - FP6 Marie Curie Grant, 80,000 Euro, 2005-2007
  - U.S. Army, $850,000, 2003-2005
  - NASA Goddard Space Flight Center, $430,000, 2001-2004

- Image and video mining
  - TÜBİTAK and COST 292 Action, 102,060 YTL, 2004-2008
  - DPT, 2004-2005

- Medical image analysis
  - TÜBİTAK CAREER Grant, 158,000 YTL, 2005-2010
  - U.S. National Library of Medicine, $750,000, 2001-2004
Remote Sensing Image Analysis

- Increasing resolution in space and time (NASA receives 3 TB/day)
- Object recognition, classification and retrieval (Have you tried Google Earth?)
- Urban planning / monitoring
- Effects of natural disasters
- Environmental monitoring

Dr. Selim Aksoy
Image and Video Mining

- Huge amounts of multimedia data (personal, commercial, free, ...)
- Semantic classification and retrieval (Have you tried Google Video?)

- Object recognition
- Scene classification
- Combining image/audio/motion/text
Medical Image Analysis

- Microscopic image classification
- Cancer detection / grading
- Content-based searching of past cases
- Automatic report generation
Combinatorial algorithms to analyze high throughput sequence data to discover, genotype, and phase genomic variants, assemble genomes and transcriptomes.

Test genome

Random shearing and Size-selection

Paired-end sequencing

Reference Genome

Resequencing
Read mapping and variation analysis

De novo sequencing
Assembly

Contigs/Scaffolds
Types of genomic variants

**SNP**: Single nucleotide polymorphism (substitutions)

**Indel**: Insertions and deletions of sequence of length 1 to 50 basepairs

**Reference**: C A C A G T G C G C - T

**Sample**: C A C C G T G - G C A T

**SNP**  deletion  insertion

**Short tandem repeats**: microsatellites, minisatellites, alpha & beta satellites, etc.

**Reference**: C A G C A G C A G C A G C A G

**Sample**: C A G C A G C A G C A G C A G C A G

**Structural variation**: Genomic alterations > 50 bp

Deletions, insertions, mobile elements, duplications, inversions and translocations
Genome sequencers

Roche/454
AB SOLiD
Illumina HiSeq2000
Pacific Biosciences RS
Illumina MiSeq
Ion Torrent PGM
Ion Torrent Proton
Oxford Nanopore MinION
Oxford Nanopore GridION
Complete Genomics

... and more! All produce data with different properties.
Selected publications


**Combinatorial algorithms for structural variation detection in high throughput sequenced genomes.** Genome Research, Jul, 19(7):1270-8, 2009.


**A draft sequence of the Neandertal genome** Science, 7 May, 328 (5979):710-722, 2010.

Recipient of the [2010 AAAS Newcomb Cleveland Prize](http://www.naaas.org/).


**Limitations of next-generation genome sequence assembly.** Nature Methods, 8(1):61-65, 2011.


Projects

- Discovery and characterization of genomic variation
  - Funded by EU Marie Curie Actions Career Integration Grant
- Algorithms and hardware designs for ultra-fast mapping of HTS reads to reference genome assemblies
  - Funded by US National Institutes of Health
- De novo and hybrid (multi-platform) sequence assembly.
- Genomic repeat discovery, classification and annotation.
- Distributed algorithms for genome assembly.

Positions available. Contact if you have B.Sc. or M.Sc. degree in computer science, computer engineering, electrical engineering, or mathematics, and if you are interested in combinatorial optimization, approximation algorithms, and graph theory. Strong programming skills in C/C++ are highly desired.

Successful applicants will also have a chance to contribute to many international consortiums such as the 1000 Genomes Project and the Genome 10K, and will involve in other international collaborations with researchers in Vancouver, Seattle, Barcelona, Bari, Pittsburgh, and more.

Basic understanding of biology/genetics/genomics is a plus, but not required.
Volume rendering of a combustion chamber: pressure and velocity fields.

Screen assignments for 24 processors: jagged and hypergraph partitionings.
Projects funded by TUBITAK, Intel and European Union

- EU-funded FP6 SEE-GRID2 project (2006-2009)
- Parallel Text Retrieval & Query Processing (TÜBİTAK, 2006-2008)
- EU-funded FP6 EUMedGrid project (2006-2008)
- EU-funded FP6 SEE-GRID project (SE4SEE application) (2004-2006)
- Task scheduling for PC clusters (TÜBİTAK, 1999-2002)
- Unstructured domain mapping (EU ITDC, 1995-1998)
- Parallel direct volume rendering (TÜBİTAK EEAG, 1995-1997)
Paralel and Grid Computing Group

- Paralel computing architectures
  - Intel iPSC/2 hypercube (32 nodes)
  - Parsytec CC24 (24 nodes)
  - PC cluster (Borg) (32 nodes)
  - PC cluster (Skynet) (48 nodes)
  - Grid cluster (16 nodes)
Paralel and Grid Computing Group
Current research topics

- Algorithm design for parallel and distributed computing applications
- Parallel text retrieval, query processing
- Parallel and distributed Web crawling
- High-performance geographical information systems
- Parallel scientific computing
- Inverted index compression
- Parallel and distributed data mining
- Task allocation and scheduling for Grid systems
- Grid-enabled Web search
- Parallel direct volume rendering


Paralel and Grid Computing Group

- Contact information
  - Cevdet Aykanat
  - Phone: 312 290 1625
  - Email: aykanat@.cs.bilkent.edu.tr
  - Homepage: http://www.cs.bilkent.edu/~aykanat
Bilkent Information Retrieval Group

Faculty
Fazlı Can
Seyit Koçberber

Graduate Students
Cem Aksoy
Ceyhun Karbeyaz
Çağrı Toraman
Anıl Türel
Ahmet Yeniçağ

Undergraduate Students
Turgut Işık
Oğuz Kaya
Harun Özden
Abdullah Şahin

Volunteers
Aykut Bal
Akif Buğday
Bilge Köroğlu
Hasan Can Tuncay

Some Prev. Members
Erman Balçık
Ahmet Buğdaycı
Tunay Gür
Cihan Kaynak
Levent Koç
İbrahim Uysal

Other Contributors
Cevdet Aykanat
Pınar Duygulu
Özgür Ulusoy
İsmail Şengör Altingövde
Özgür Bağlıoğlu
Ethem F. Can
Gonenç Ercan
Süleyman Kardaş
H. Çağdas Öcalan
Erkan Uyar
Research Interests

- New Event Detection and Tracking
- Novelty Detection
- Information Retrieval
- Information Filtering
- News Categorization
- Text Mining & Processing
Bilkent Haber Portalı

SON HABERLER

- Küçük Tamil askerler sınıflarına dönüyor...
  Sri Lanka'da 30 yıllık çatışmaların ardından hükümet tarafından eski topraklarına döndürülen ülkenin doğu ve kuzey [Devam...]

- Kütahya'da göcük nevdana gelen maden...
  Kütahya'nın Tavşanlı ilçesinde, göcük nevdana gelen maden ocağı hakkında Valilikçe yaklaşık 2.5 ay önce eksikleri [Devam...]

- Kuruvesin azı karar, çoğlu zarar...
  İlk teaminde dünya ticincisi oclusunuz kuruvesin, ögülu miktarında alınan sağlıklı yaşamda katkı sağlayacağı bildirildi.
  [Devam...]

- Vali Güler: Deyletin verdiği görevin...

EN ÇÖK OKUNANLAR

[List of articles with the highest views is visible but not transcribed due to the format of the image.]
You are the right person for our group

- If you are good at four core practices of CS
  - programming,
  - systems thinking,
  - modeling, and
  - innovation.

- If you
  - "can dream,"
  - "can do," and
  - "can write."
My research focuses on building algorithms for analyzing biological data using various biochemical networks. Even though it took 13 years and ~$1b to sequence the first genome, right now, it takes a day and ~$1k. This has resulted in accumulation of vast amounts of information. Consequently, biosciences have faced the problem of “big data”. Today, the bottleneck in the bio-research is the lack of computational power and algorithms that can efficiently analyze the data and make discoveries. Central dogma in molecular biology dictates the information flow from DNA --> RNA --> Protein --> Metabolite. Each layer introduces 20k, 100k, 1m, and 3k variables respectively. The search space for even a basic pattern discovery is clearly intractable. I design machine learning algorithms that use biological networks to prune the search space and discover biomarkers in particular for genetic Diseases.
Gene Discovery for Autism Spectrum Disorder
-Broken interplay between 1000 genes lead to autism.
-So far we have only discovered ~50 of them, Biological networks along with intelligent search algorithms needed to discover new genes to understand the genetic architecture.
Using Dynamic Network Algorithms to Model Neurodevelopment.

- Autism is a neurodevelopmental disorder and affects evolving the gene interaction networks of the fetal period to early childhood.
- We design algorithms that analyze the dynamic networks to understand the functionality autism affects.
Metabolic Networks to Understand Cancer

Metabolites are the small compounds in the body and have been found to be key biomarkers to define certain tumors. We use network algorithms and build online systems that analyze metabolic signatures in tumors and understand the differences within the subtypes of the same cancer.
Selected Publications:

- **De Novo Chip-Seq Analysis. Genome Biology** 2015, 16:205.
- Insights into autism spectrum disorder genomic architecture and biology from 71 risk loci **NEURON** 2015, 87(6):1215–33.
David Davenport
david@cs.bilkent.edu.tr

Self-motivated, creative, committed

Graduate Students
Interested in…

• Unraveling mysteries of cognition
  (Center for Mind language & Culture)
• Information Quality – (ColSys group)
• Computer use in Education
• Ethical concerns raised by Internet

Contact: David  david@cs.bilkent.edu.tr
Performance modeling and analysis

Scientific computing (especially numerical linear algebra for stochastic matrices)

Bioinformatics

Computer networks

requires solid background:
1) in computer engineering
2) specifically in probability theory, linear algebra, numerical analysis, and high-level programming,

which one must either have or be willing to develop

Visit: www.cs.bilkent.edu.tr/~tugrul/tugrul.html for further information
For us, research is practical solutions to real problems using strong theory!

**Topics:** Graph visualization, bioinformatics & graph algorithms

**Projects:**
- **PATIKA & Visibio** [Pathway Modeling, Analysis & Visualization Tools]
- **Chisio** [Graph Visualization Tool]

Our projects have been supported by TÜBİTAK and Tom Sawyer Software (CA, USA)
Social Network of Drug Traffickers
The PATIKA Project
www.patika.org

Sample PATIKA Tool: PATIKAweb

Lost in the jungle of cellular processes...?

PATIKAweb can show you the PATHway
Interested in being part of this kind of research & development? Then join us! Please contact me at ugur@cs.bilkent.edu.tr
Data Management and Mining
Hakan Ferhatosmanoglu

• We investigate data management and data mining methods for emerging applications:
  – Data streams (telecom data warehouses, financial markets)
  – Social Media (Twitter text and social network)
  – Bioinformatics (proteins, genes)

• We aim to build scalable systems for online exploration of text, image, time-series

• Funded by USA Dept of Energy, NSF, NASA, Pfizer, IBM
Data Management and Mining
Hakan Ferhatosmanoglu

• Looking for students with theoretical interest and systems building skills (basically math and programming..)

Please contact me for more information:

hakan@cs.bilkent.edu.tr
We are conducting research in data-intensive distributed systems, looking at issues such as parallelization, load balancing, load shedding, placement optimization, fault-tolerance, etc.

Particular topics of interest include:

- Distributed data stream processing systems
- Big Data technologies, such as distributed key-value stores, map/reduce systems, bulk-synchronous parallel processing frameworks, etc.
- Large-scale distributed graph management and mining
- Peer-to-peer, mobile, and sensor data management
Data Stream Processing Systems

Stock market
- Impact of weather on securities prices
- Analyze market data at ultra-low latencies

Law Enforcement, Defense & Cyber Security
- Real-time multimodal surveillance
- Situational awareness
- Cyber security detection

Fraud prevention
- Detecting multi-party fraud
- Real time fraud prevention

Transportation
- Intelligent traffic management

Manufacturing
- Process control for microchip fabrication

Health & Life Sciences
- Neonatal ICU monitoring
- Epidemic early warning system
- Remote healthcare monitoring

Telephony
- CDR processing
- Social analysis
- Churn prediction
- Geomapping

Natural Systems
- Wildfire management
- Water management

e-Science
- Space weather prediction
- Detection of transient events
- Synchrotron atomic research

Other
- Smart Grid
- Text Analysis
- Who’s Talking to Whom?
- ERP for Commodities
- FPGA Acceleration
Automatic Parallelization

- Transparent parallelization: Locate parallel regions in streaming applications without user intervention
- Safe parallelization: Generate parallel alternatives that produce the exact same results as the sequential version
- Elastic parallelization: Dynamically adjust profitability decisions w.r.t. parallelization based on run-time dynamics
Looking for students

We are seeking highly motivated and skilled students for graduate level research in data intensive distributed systems. Both Ph.D. and Masters level students are welcome. Students with strong interest in systems and implementation as well as a good understanding of fundamental theory are encouraged to apply.

Contact: www.bugragedik.com
Selected Publications


Main research interests:

- Medical image analysis for automatic cancer diagnosis, grading, and prognosis
- Machine learning for intelligent medical systems
Current projects:

- Diagnosis and grading of colon cancer
  - Construction of new biocomputational methods
  - Colon cancer diagnosis
  - Colon cancer grading
  - Tissue image segmentation
  - Colon gland segmentation

- Designing medical diagnostic systems
  - Cost-sensitive classification
  - Qualitative decision theory
  - Dynamic model selection and combination
Computer Graphics
Uğur Güdükbay

http://www.cs.bilkent.edu.tr/~gudukbay
gudukbay@cs.bilkent.edu.tr

Research Topics:
1. Augmented and Virtual Reality
2. Terrain and Urban Modeling and Visualization
3. Human Modeling and Animation
Augmented and Virtual Reality

- Crowd Simulation
- Realistic Lighting
- Camera Registration and Tracking
- Augmented Reality on Mobile Devices
Terrain and Urban Modeling and Visualization

- Level-of-detail management
- View-dependent refinement
- Stereoscopic visualization
- GPU-based tessellation
- Crowd simulation in urban environments
Human Modeling and Animation

Figure 2: Different facial expressions and expression combinations: from left-to-right and top-to-bottom (rowwise order): neutral, happiness, surprise, fear, anger, sadness, disgust, happy, surprise, anger, disgust, surprise, happy, anger, fear, anger, sadness, surprise, anger, sadness, disgust.

Real-time Virtual Garment Fitting Using Depth Sensor Data

Realistic Rendering of Joint Regions Using Bone Splitting

A Model Wearing a Sundress with Different Postures

A Model Wearing a Vest and Jeans with Different Postures
Machine Learning and Data Mining

Current research topics include Learning to

- rank instances
- model risk factors
- estimate risks
- suggest to increase success

Application areas: Medical, Social Networks
Networks and Systems Research Group

Bilkent University – Department of Computer Engineering

Faculty Member
Ibrahim Korpeoglu
Assoc. Professor
Dept of Computer Engineering
Bilkent University

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Working on Problems and Projects related with Computer Networks and Computer Systems

Research Areas:
- Computer Networks
- Computer Systems
- Network and Distributed Algorithms
- Wireless Networks
- Distributed Systems
- Cloud Computing
- P2P Networks
- Sensor Networks
- Internet of Things
- WiFi and Bluetooth
- Big Data Systems
Networks and Systems Research Group

Sample Funded Projects

- Efficient Resource Allocation in Heterogeneous Cloud Infrastructures
  Sponsor: TUBITAK

- Supporting Real-time Traffic in Wireless Ad Hoc and Sensor Networks
  Sponsor: TUBITAK

- Bluetooth Scatternet Construction and Bluetooth Applications
  Sponsor: TUBITAK

- Network Middleware for Environmental Monitoring and Control with Wireless Ad hoc, Mesh and Sensor Networks
  Sponsor: IBM Corporation

- Intel WCNC, Wireless Networking Curriculum Enhancement Project
  Sponsor: Intel Corporation

- FIRESENSE Fire Detection and Management through a Multi-Sensor Network for the Protection of Cultural Heritage Areas from the Risk of Fire and Extreme Weather Conditions
  Sponsor: European Commission FP7 Programme, ENV

- Network of Excellence in Wireless Communications (NEWCOM and NEWCOM++)
  Sponsor: European Commission FP7 Programme, ICT
Networks and Systems Research Group

Sample Current Work

- **Wireless Mesh Networks**
  - Routing
  - Channel assignment
  - Interference modeling
  - Interference mitigation

- **Sensor Networks**
  - Energy efficient routing
  - Activity scheduling
  - Channel access scheduling
  - ZigBee wireless technology
  - ZigBee routing

- **P2P Networks**
  - Query forwarding
  - Free riding
  - File sharing and lookup

- **Delay tolerant networks**
  - Routing and Scheduling

- **Testbeds**

- **Cloud Computing**
  - Resource allocation
  - VM placement
  - Network virtualization
  - Network embedding
Hidayet Aksu, Mustafa Canim, Yuan-chi Chang, Ibrahim Korpeoglu, Ozgur Ulusoy, *Distributed k-Core View Materialization and Maintenance for Large Dynamic Graphs*, IEEE Transactions on Knowledge and Data Engineering, 2014.


- Computer architecture - memory scheduling, memory hierarchy design, metrics to consider energy, performance, reliability....
- Multicore/Manycore architecture - design of multicore systems, application mapping, data mapping, communication
- Heterogeneous computing - heterogeneous multicore design, core and cache selection, application execution
- Parallel programming/systems/applications - OpenMP, MPI, GPGPU, application characterization, automatic parallelization, scheduling
- Cloud computing - at the system level and architectural optimizations, heterogeneity aware scheduling
- Embedded computing - energy, performance, ...
- Compiler optimizations - code modifications and optimizations to generate better applications
Current Projects

- Heterogeneous Multicore Design
  *Funding: EC FP7*

- Parallelization for Heterogeneous Multicore Architectures
  *Funding: IBM*

- Utilizing Accelerator Technologies in the Cloud
  *Funding: Türk Telekom*

- Parallelizing Data Mining applications using GPUs
  *Funding: Nvidia*

- Accelerator Design for Graph Parallel Applications
  *Funding: Intel*
Our research interest is in developing computational methods and tools, which aim at providing novel insights into biological mechanisms of the diseases and phenotypes. The techniques we employ base themselves on statistical machine learning and advanced algorithms that are guided by insights from a systems biology perspective.
Significant progress has been made in our ability to measure DNA, RNA and protein sequences, structures and expression quantities. In addition to the part list of molecules, substantial amount of knowledge has been accumulated on the interactions of these molecules and their role in the cellular machinery.
It is critical to translate this vast amount of data into biological findings, clinical research and eventually into clinical practice. As the data is vast, heterogenous, multi-dimensional and noisy, unleashing the full power of the accrued data will be only possible through development of rigorous computational techniques. We employ statistical machine learning approaches to gain insight into biological mechanisms.
Database Research
Özgür Ulusoy
http://www.cs.bilkent.edu.tr/~oulousey/

- Web Databases and Search Engines
- Multimedia Databases
- Big Data and Social Network Analysis
Web Databases and Search Engines

- Social Web search and personalization
- Domain-specific search engines
- Efficiency and scalability issues for Web Search Engines (caching, index pruning)
- Web information extraction
- Modeling and querying of Web resources
- XML querying & searching

http://www.cs.bilkent.edu.tr/~bilweb
Search Engines are the key to access Web Data

- **1995**: Birth of Google
- **1998**: S. Brin meets L. Page
- **2000**: First billion-URL index
  - The world’s largest!
  - ≈5000 PCs in clusters!
- **2004**: Index grows to 4.2 billion pages
- **2008**: Google counts 1 trillion unique URLs
- **2009**: TBs or PBs of data/index
  - Tens of thousands of PCs
- **2015**: Efficient and scalable strategies are of vital importance!
Multimedia Databases
(joint work with Prof. Uğur Güdükbay)

- Video Retrieval Systems
- Mobile Visual Search
- Ottoman Archive Content-Based Retrieval System

http://www.cs.bilkent.edu.tr/~bilmdg
**BilVideo**: Integrated video DBMS supporting low-level, spatio-temporal, motion and semantic querying of videos

**SPATIO-TEMPORAL QUERY GUI**

**SEMANTIC QUERY GUI**

**TRAJECTORY QUERY GUI**

**SYSTEM ARCHITECTURE**
BilVideo-7: An MPEG-7 Compatible Video Retrieval System

- **Web Client**: Visual Query Interface
- **Query Processor**: Video Processing
  - SBD, Segmentation
  - Object Extraction
  - Annotation
  - etc.
- **XML-Native Feature Database (Tamino)**
- **Feature Extraction**: MPEG-7 Features

**Automatic processing**: segmentation, tracking, feature extraction, annotation, indexing

**Powerful querying capability for video data**
- Keyword and content-based queries
- Spatio-temporal object queries

**Example query formulation**
- Keywords: trees, greenery, sky – bush, putin, dog

**Segmentation**

**Salient video object extraction**
Mobile Image Search Using Multi-Image Queries

Workflow of the Search System

Early and Late fusion methods

Single (a) and multi-view queries and corresponding result lists using early (b) and late (c) fusion methods.
Big Data and Social Network Analysis

- **Social Network Data Analysis on Big Data Processing Platforms**
  - Development, implementation and evaluation of algorithms/methods to process/analyze social network data for various social network problems.
  - (joint work with Prof. İbrahim Körpeoğlu)

- **Decentralized Social Networks**
  - Development, implementation and evaluation of algorithms/methods for peer-to-peer social networks.
  - (joint work with Prof. Hakan Ferhatosmanoğlu)