Bilkent University
Computer Engineering Department

MS and PhD Programs

Prof. Dr. Selim Aksoy
Research Areas

• Algorithms
• Artificial intelligence
• Big data
• Bioinformatics
• Cloud computing
• Computational biology
• Computational geometry
• Computer architecture
• Computer graphics
• Computer networks
• Computer vision
• Cryptography
• Data mining
• Data science
• Data security
• Database systems
• Graph visualization
• High performance computing
• Image analysis
• Information retrieval
• Machine learning
• Mobile systems
• Parallel and distributed systems
• Pattern recognition
• Robotics
• Scientific computing
• Software engineering
• Virtual reality
Applications

• **Application Deadlines:**
  March 31, 2022 (early-bird deadline)
  May 31, 2022 (regular deadline)

• **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 applying PhD).
Interview

• **Date:** we will inform applicants about interview dates

• If not uploaded during online application, 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

• Grad committee approval
• At least one faculty member willing to work with the applicant towards thesis
• Passing the interview and department approval
• Graduate School of Engineering and Science approval
Scholarship Options

• Department scholarship
  – Tuition waiver (100%)
  – Stipend (paid by Department)
  – Eligibility for accommodation in dormitories or University housing
  – Health Insurance
  – Office (shared)
  – Meal Card support (for Ph.D. students)
Scholarship Options

- **TÜBİTAK scholarship or TÜBİTAK projects**
  - Tuition waiver (100%)
  - Stipend (paid by TÜBİTAK)
  - Eligibility for accommodation in dormitories or University housing
  - Accommodation financial aid from University
  - Health Insurance
  - Office (shared)
  - Bilkent Spending Card support (for Ph.D. students)
  - Meal Card support (for Ph.D. students)
Scholarship Options

• **Project grants (other than TÜBİTAK projects)**
  – Tuition waiver (100%)
  – Stipend (paid from the project budget)
  – Eligibility for accommodation in dormitories or University housing
  – Health Insurance (paid from the project budget)
  – Office (shared)
  – Meal Card support (for Ph.D. students)

• **Graduate School scholarship**
  – Tuition waiver (between 80% - 100%)
Degree Requirements

• MS
  ▪ 7 technical elective courses + Seminar + MS Thesis + Research Methods and Academic Publication Ethics course

• PhD
  ▪ 7 technical elective courses + Seminar + Qual Exam + PhD Thesis + Journal Publication + Research Methods and Academic Publication Ethics course
# Graduates of MS Program

<table>
<thead>
<tr>
<th>Position</th>
<th>Count</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>PhD in Turkey</td>
<td>20</td>
<td>9.0%</td>
</tr>
<tr>
<td>Faculty in Turkey</td>
<td>37</td>
<td>16.7%</td>
</tr>
<tr>
<td>Engineer in Turkey</td>
<td>151</td>
<td>68.0%</td>
</tr>
<tr>
<td>Co-founder in Turkey</td>
<td>14</td>
<td>6.3%</td>
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<tr>
<td>PhD abroad</td>
<td>35</td>
<td>15.8%</td>
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<tr>
<td>PostDoc abroad</td>
<td>10</td>
<td>4.5%</td>
</tr>
<tr>
<td>Faculty abroad</td>
<td>20</td>
<td>9.0%</td>
</tr>
<tr>
<td>Engineer abroad</td>
<td>147</td>
<td>30.6%</td>
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<tr>
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<td>9</td>
<td>4.1%</td>
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<tr>
<td>Unknown abroad</td>
<td>37</td>
<td>7.7%</td>
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<table>
<thead>
<tr>
<th>Position</th>
<th>Count</th>
<th>%</th>
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</thead>
<tbody>
<tr>
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<td>20</td>
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<tr>
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</tr>
<tr>
<td>Engineer in Turkey</td>
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<tr>
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<td>Faculty abroad</td>
<td>20</td>
<td>9.0%</td>
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<td>Co-founder abroad</td>
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<td>4.1%</td>
</tr>
<tr>
<td>Unknown abroad</td>
<td>37</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

In Turkey: 222, 46.3%
Abroad: 221, 46.0%
Unknown: 37, 7.7%
Total: 480, 100.0%
# Graduates of MS Program

## in Turkey

<table>
<thead>
<tr>
<th>University</th>
<th>Count</th>
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<tbody>
<tr>
<td>Bilkent Univ.</td>
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<tr>
<td>ASELSAN</td>
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<tr>
<td>HAVELSAN</td>
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<tr>
<td>TÜBİTAK</td>
<td>13</td>
</tr>
<tr>
<td>Hacettepe Univ.</td>
<td>6</td>
</tr>
<tr>
<td>METU</td>
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<tr>
<td>TSK</td>
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<tr>
<td>STM</td>
<td>4</td>
</tr>
<tr>
<td>TCMB</td>
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<tr>
<td>Vestel</td>
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<tr>
<td>Cybersoft</td>
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<tr>
<td>Garanti Teknoloji</td>
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<td>MilSOFT</td>
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<td>OpsGenie</td>
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<tr>
<td>Sabancı Univ.</td>
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<tr>
<td>Akdeniz Univ.</td>
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<tr>
<td>Oracle</td>
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## Abroad

<table>
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<tr>
<th>Company/University</th>
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<td>Microsoft</td>
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<tr>
<td>Google</td>
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<td>Amazon</td>
<td>6</td>
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<tr>
<td>Booking.com</td>
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<tr>
<td>Case Western Reserve Univ.</td>
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<tr>
<td>Facebook</td>
<td>4</td>
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<tr>
<td>Univ. California</td>
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<tr>
<td>SAP</td>
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<tr>
<td>U. of Massachusetts Amherst</td>
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<tr>
<td>UBER</td>
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<tr>
<td>EPFL</td>
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<tr>
<td>ETH</td>
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<tr>
<td>Imperial College</td>
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<tr>
<td>Sandia National Labs.</td>
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<tr>
<td>U. of Texas at San Antonio</td>
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<td>University of Florida</td>
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<td>University of Waterloo</td>
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<tr>
<td>U. of Illinois at Urbana-Champaign</td>
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<tr>
<td>Washington U. in St. Louis</td>
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Graduates of PhD Program

<table>
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<tr>
<th>Position</th>
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<td>Faculty in Turkey</td>
<td>25</td>
<td>69.4%</td>
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<tr>
<td>Engineer in Turkey</td>
<td>10</td>
<td>27.8%</td>
</tr>
<tr>
<td>Co-founder in Turkey</td>
<td>1</td>
<td>2.8%</td>
</tr>
<tr>
<td>PostDoc abroad</td>
<td>8</td>
<td>25.0%</td>
</tr>
<tr>
<td>Faculty abroad</td>
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<td>18.8%</td>
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<tr>
<td>Engineer abroad</td>
<td>17</td>
<td>53.1%</td>
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<tr>
<td>Co-founder abroad</td>
<td>1</td>
<td>3.1%</td>
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<table>
<thead>
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<tbody>
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<td>Faculty in Turkey</td>
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<tr>
<td>Engineer in Turkey</td>
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<tr>
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<tr>
<td>Faculty abroad</td>
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<tr>
<td>Engineer abroad</td>
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<tr>
<td>Co-founder abroad</td>
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</table>

| Total:                 | 68    | 100.0%|
# Graduates of PhD Program

## in Turkey

<table>
<thead>
<tr>
<th>University</th>
<th>Count</th>
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<tbody>
<tr>
<td>METU</td>
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<tr>
<td>Bilkent University</td>
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<tr>
<td>Hacettepe Univ.</td>
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</tr>
<tr>
<td>Akdeniz University</td>
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</tr>
<tr>
<td>Sabancı Univ.</td>
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<tr>
<td>TED University</td>
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<tr>
<td>Ankara University</td>
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<tr>
<td>Aselsan</td>
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<tr>
<td>Atılım University</td>
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</tr>
<tr>
<td>Beykent University</td>
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<tr>
<td>Çukurova Üniversitesi</td>
<td>1</td>
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<tr>
<td>SAP</td>
<td>1</td>
</tr>
<tr>
<td>TAI</td>
<td>1</td>
</tr>
<tr>
<td>TCMB</td>
<td>1</td>
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<tr>
<td>Turkcell</td>
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## Abroad

<table>
<thead>
<tr>
<th>Institution</th>
<th>Count</th>
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<tbody>
<tr>
<td>Amazon</td>
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<tr>
<td>Oregon Health and Sci. U.</td>
<td>3</td>
</tr>
<tr>
<td>Case Western R. U.</td>
<td>2</td>
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<tr>
<td>Lawrence Berkeley Lab</td>
<td>1</td>
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<tr>
<td>LIP ENS-LYON CNRS</td>
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<tr>
<td>ETH</td>
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<tr>
<td>Facebook</td>
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<td>Fraunhofer</td>
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<tr>
<td>Georgia Tech</td>
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<tr>
<td>Google</td>
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<tr>
<td>Microsoft</td>
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<tr>
<td>Oracle</td>
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<tr>
<td>Salesforce</td>
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<tr>
<td>Sandia National Labs.</td>
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<tr>
<td>Stony Brook University</td>
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<tr>
<td>U. of Central Florida</td>
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<tr>
<td>Uber</td>
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</table>

## Faculty Members

<table>
<thead>
<tr>
<th>Institution</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georgia Institute of Technology</td>
<td></td>
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<tr>
<td>Oregon Health and Science University</td>
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<tr>
<td>Stony Brook University</td>
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<tr>
<td>University of Calgary</td>
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<tr>
<td>Bilkent University</td>
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<tr>
<td>Akdeniz University</td>
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<td>Ankara University</td>
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<td>Atatürk University</td>
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<tr>
<td>Atılım University</td>
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<tr>
<td>Beykent University</td>
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<tr>
<td>Celal Bayar University</td>
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<tr>
<td>Çukurova University</td>
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<tr>
<td>Hacettepe University</td>
<td></td>
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<tr>
<td>Konya Food &amp; Agriculture University</td>
<td></td>
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<tr>
<td>METU</td>
<td></td>
</tr>
<tr>
<td>Sabancı University</td>
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<tr>
<td>Selçuk University</td>
<td></td>
</tr>
<tr>
<td>TED</td>
<td></td>
</tr>
</tbody>
</table>
Faculty Members

• In alphabetical order

(Please contact them in person for details.)
Selim Aksoy
saksoy@cs.bilkent.edu.tr
http://www.cs.bilkent.edu.tr/~saksoy
Office: EA 422 (4th floor)

Research interests:
➢ Computer vision
➢ Pattern recognition
➢ Machine learning

Current topics:
➢ Medical image analysis
➢ Remote sensing image analysis
➢ Image classification
➢ Object recognition
➢ Content-based image retrieval
Sponsored Research Projects

➢ Medical image analysis
  ➢ TÜBİTAK 1001, 2018-2021
  ➢ TÜBİTAK 1001, 2014-2017
  ➢ TÜBİTAK CAREER Grant, 2005-2010

➢ Remote sensing image analysis
  ➢ TÜBİTAK 1001, 2010-2012
  ➢ European Commission, Joint Research Centre, 2008-2009
  ➢ TÜBİTAK CAREER Grant, 2005-2010
  ➢ FP6 Marie Curie Grant, 2005-2007

➢ Image and video mining
  ➢ TÜBİTAK and COST 292 Action, 2004-2008
  ➢ DPT, 2004-2005
Medical Image Analysis

Whole slide image analysis
(100,000 x 100,000 pixels, 30 GB/image)

Deep networks for region of interest detection

Different weakly supervised learning scenarios

- Non-proliferative changes only
- Proliferative changes
- Atypical ductal hyperplasia
- Ductal carcinoma in situ
- Invasive carcinoma

(a) Input to a learning algorithm

(b) Traditional supervised learning scenario

(c) Multi-instance learning (MIL) scenario

(d) Multi-label learning (MLL) scenario

(e) Multi-instance multi-label learning (MIMLL) scenario

Dr. Selim Aksoy
Medical Image Analysis

Deep feature representations

Conditional random fields for weakly supervised learning

Convolutional neural networks for region of interest classification

Computer aided diagnosis of breast biopsies

(a) WSI  (b) Predicted labels
Medical Image Analysis

Simultaneous localization and classification

Graph convolutional networks and self-supervised learning

Content-based search of medical archives

Dr. Selim Aksoy
Remote Sensing Image Analysis

Increasing spatial resolution (300m $\Rightarrow$ 1-2cm)

Hyperspectral image analysis

Orchard segmentation and agricultural mapping

Multi-source fusion and missing data analysis

Dr. Selim Aksoy
Remote Sensing Image Analysis

Geospatial data mining

Zero-shot learning for object recognition

Attention model for multi-source fine-grained object recognition

Dr. Selim Aksoy
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

Resequencing

De novo sequencing

Contigs/Scaffolds

Read mapping and variation analysis

Assembly
Types of genomic variants

**SNP**: Single nucleotide polymorphism (substitutions)
**Indel**: Insertions and deletions of sequence of length 1 to 50 basepairs

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

**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
- Ion Torrent PGM
- Ion Torrent Proton
- Illumina MiSeq
- Oxford Nanopore MinION
- Oxford Nanopore GridION

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


Recipient of the 2010 AAAS Newcomb Cleveland Prize.


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.
Shervin Rahimzadeh Arashloo

s.rahimzadeh@cs.bilkent.edu.tr
www.cs.bilkent.edu.tr/~s.rahimzadeh
Office: EA 429

Research Interests

• Computer Vision
• Pattern Recognition
• Machine Learning

Current Research Topics

• Face Recognition
• Face Presentation Attack Detection
• Anomaly Detection
Unconstrained Face Recognition
Face Presentation Attack Detection

Securing face recognition systems against security threats made by fake biometric traits

Sample data from the MSU dataset. (a) Genuine faces; (b)-(d) Spoof faces.
Anomaly Detection

Developing novel methodologies along with applications to:

Surveillance
Novelty detection
Healthcare
etc.
Bilkent University
High Performance Computing (HPC)

- Recent research interest and expertise
  - Combinatorial scientific computing
  - Iterative solvers: novel partitioning models, algorithms and software utilities for development of parallel iterative methods for linear-system solutions
  - Optimizing latency-centric communication metrics for petascaling sparse solvers
  - Partitioning irregular domains for large-scale parallel processing
  - Locality aware scheduling of irregular applications on Many Core architectures
  - Partitioning models for scaling 1D-, 2D- and 3D-parallel sparse matrix-matrix multiply
  - Partitioning large scale social networks and graph databases
  - Parallel graph analytics kernels for big data applications

- HPC for Machine Learning and ML for HPC
  - Partitioning methods for scalable sparse Tensor decomposition
  - Scaling parallel stochastic gradient descent algorithms for ML
  - Fast and efficient model parallelism for Deep CNNs
  - Task leader in FP7 / Horizon2020 PRACE projects: 1IP, 2IP, 3IP, 4IP, 5IP

Contact Address:
Prof. Cevdet Aykanat
aykanat@cs.bilkent.edu.tr

Speedup curves of Conjugate Gradient solver for different methods on a Cray and BlueGene/Q machine
(kkt-power matrix: 2 million rows, 12 million nonzeros)
Recent Publications (2018-2021)

- True Load Balancing for Matricized Tensor Times Khatri-Rao Product, 
  Nabil Abubaker, Seher Acer, Cevdet Aykanat, 

- Fast Shared-Memory Streaming Multilevel Graph Partitioning 
  Oguz Selvitopi, Nazanin Jafari, and Cevder Aykanat, 

- Partitioning Models for General Medium-Grain Parallel Sparse Tensor Decomposition 
  M. Ozan Karsavuran, Seher Acer and Cevder Aykanat, 

- Cartesian Partitioning Models for 2D and 3D Parallel SpGEMM Algorithms, 
  Gunduz V. Demirci and Cevdet Aykanat, 

- Reordering Sparse Matrices into Block-Diagonal Column-Overlapped Form, 
  Seher Acer and Cevder Aykanat, 

- Reduce Operations: Send Volume Balancing While Minimizing Latency, 
  M. Ozan Karsavuran, Seher Acer, and Cevder Aykanat, 

- The Effect of Various Sparsity Stuctures on Parallelism and Algorithms to Reveal Those Structures, 
  Oguz Selvitopi, Seher Acer, Murat Manguoglu and Cevdet Aykanat, 

- Regularizing irregularly sparse point-to-point communications, 
  Oguz Selvitopi and Cevdet Aykanat 
  Proceedings of the International Conference for High Performance Computing, 

- A Hypergraph Partitioning Model for Profile Minimization, 
  Seher Acer, Enver Kayaaslan, Cevdet Aykanat, 

- Locality-aware and load-balanced static task scheduling for MapReduce, 
  Oguz Selvitopi, Gunduz V. Demirci, Ata Turk, Cevdet Aykanat, 

- Scaling Sparse Matrix-Matrix Multiplication in the Accumulo Database, 

- Spatiotemporal Graph and Hypergraph Partitioning Models for Sparse Matrix-Vector Multiplication on Many-Core Architectures, 
  Nabil Abubaker, Kadir Akbudak, Cevder Aykanat, 

- A novel partitioning method for accelerating the block cimmino algorithm, 
  Sukru Torun, Murat Manguoglu, Cevdet Aykanat, SIAM Journal on Scientific Computing, 

- Cascade-aware partitioning of large graph databases, 
  Gunduz V. Demirci, Hakan Ferhatosmanoglu, Cevdet Aykanat, 

- Optimizing nonzero-based sparse matrix partitioning models via reducing latency, 
  Seher Acer, Oguz Selvitopi, Cevdet Aykanat, 

- Improving medium-grain partitioning for scalable sparse tensor decomposition, 
  Seher Acer, Tugba Torun, Cevdet Aykanat, 

- 1.5 D parallel sparse matrix-vector multiply, 
  Enver Kayaaslan, Cevdet Aykanat, Bora Ucar, 

- Partitioning models for scaling parallel sparse matrix-matrix multiplication, 
  Kadir Akbudak, Oguz Selvitopi, Cevdet Aykanat, 
Recent Funded Projects

Contact Address:
Prof. Cevdet Aykanat
aykanat@cs.bilkent.edu.tr
http://www.cs.bilkent.edu.tr/~aykanat/

- **TUBITAK/COST Projects**
  - 119E035: Parallel Stochastic Gradient Descent Algorithms for Large-Scale Recommendation Systems, 15/09/2019 - 15/02/2022
  - 116E043: High Performance Tensor Decomposition Methods for Distributed and Shared Memory Parallel Systems, 01/05/2017 – 1/11/2019
  - 115E212/COST-CA15109: Improving Sparse Matrix Based Graph Analytics Kernels for Big Data Applications, 01/09/2015 - 01/03/2018
  - 114E545/COST-IC1406: Petascaling Sparse Iterative Solvers via Optimizing Multiple Communication Metrics, 01/04/2015 - 01/10/2017
  - 112E120: Partitioning, Replication and Query Processing in Social Networks, 01/09/2012 - 01/09/2014

- **FP7/HORIZON-2020 Projects**
  - PRACE 6IP 01/05/2019 – 01/05/2021
    - Task 7.4: Evaluation of Benchmark Performance
  - PRACE 5IP 01/01/2017 – 01/05/2019
    - Task 7.2: Preparing for PRACE Exascale Systems
  - PRACE 4IP 01/02/2015 - 01/05/2017
    - Task 7.2: Preparing for Future PRACE Exascale Systems
  - PRACE 3IP 01/08/2012 - 01/08/2014
    - D7.2.1 HPC Tools and Techniques
  - PRACE 2IP 01/07/2011 - 01/07/2014
    - D12.5 Summary of Novel Programming Techniques Results (Taskleader)
  - PRACE 1IP-Extension 01/07/2013 - 01/07/2014
    - D7.1.3 Application Enabling for Capability Science in the MICArchitecture
  - PRACE 1IP 01/07/2010 - 01/07/2013
    - D7.5 HPC Programming Techniques (Task leader)
Current Positions of Some Former PhD. Students

• Dr. Ozan Karsavuran, 2020. Bilkent University, Postdoctoral Researcher
• Dr. G. Vehbi Demirci, 2019. University of Warwick, Postdoctoral Researcher
• Dr. Seher Acer, 2017. Oak Ridge National Lab., Research Scientist
• Dr. Oguz Selvitopi, 2017. Lawrence Berkeley Nat. Lab., Research Scientist
• Dr. Şükrü Torun, 2017. Yıldırım Beyazıt University, Assistant Professor
• Dr. Kadir Akbudak, 2015. University of Tennessee, Research Scientist
• Dr. Enver Kayaaslan, 2013. Google Switzerland, Researcher
• Dr. Ertuğrul Tabak, 2013. Aurea Software, Software engineering manager
• Dr. Eray Özkural, 2013. Celestial Intellect Cybernetics, Software engineer
• Dr. Tayfun Küçükyılmc, 2012. TED University, Assistant Professor
• Dr. Ata Türk, 2010. Boston University, Research Scientist,
• Dr. Engin Demir, 2009. Hacettepe University, Assistant Professor
• Dr. Barla Cambazoğlu, 2006. RMIT University, Senior Research Fellow
• Dr. Bora Uçar, 2005. LIP ENS-lyon, CNRS researcher.
• Dr. Ümit Çatalyürek, 1999. Georgia Institute of Technology, Professor
• Dr. Tahsin Kurc, 1997. Stony Brook University, Associate Professor
Bilkent Information Retrieval Group

Faculty
Fazlı Can
Seyit Koçberber

Graduate Students
Sepehr Bakhshi
Alican Büyükçakır
Sevil Çalışkan
Sanem Elbaşi
Pouya Ghahramanian
Ömer Gözüaçık
Aykut Güven

UG Student(s)
Taha Aksu

Some Prev. Members
Cem Aksoy
Ahmet Buğdaycı
Hayrettin Erdem
Cem Karbeyaz
Süleyman Kardaş
Cihan Kaynak
H. Çağdaş Öcalan
Anıl Türel
İbrahim Uysal

Other Contributors
Hamed R. Bonab, UMass
Dilek Küçük, TÜBİTAK
Çağrı Toraman, UCF
Research Interests

Information Retrieval (IR)
- Information Filtering
- News Aggregation and Categorization
- Turkish Text Mining

• Data Stream Mining
  - Ensemble Models for Stream Classification
  - Multi-label Classification
  - Concept Drift Detection
  - Multi-stream Processing
  - Stance Detection
You are the right person for our group

- If you are good at four core practices of computer science
  - 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.
A. Ercument Cicék

cicek@cs.bilkent.edu.tr
cs.bilkent.edu.tr/~cicek

- Gene Discovery for Autism Spectrum Disorder
  - Broken interplay between 1000 genes lead to algorithms networks along with "50 of them, understanding needed to discover new genetic architecture.

- So far we have only discovered ~50 genes lead to autism.
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.
A. Ercument Cicek  
cicek@cs.bilkent.edu.tr  
cs.bilkent.edu.tr/~cicek

Metabolic Networks to Understand Cancer  

Metabolites are small compounds in the body. We have defined certain compounds as biomarkers that can be used to diagnose and analyze metabolic networks. We use these biomarkers to identify subtypes of cancer and analyze the differences within the same cancer.
Selected Publications:

- De Novo Chip-Seq Analysis. Genome Biology 2015, 16:205.
I work in the fields of Affective Computing, Computer Vision, and Pattern Recognition.

My current research mainly focuses on multimodal analysis of non-verbal human behavior (e.g. face analysis, gesture recognition, etc.) and deep learning of temporal representations.
Kinship Verification
Age Estimation through Facial Dynamics

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Facial Expression Recognition

<table>
<thead>
<tr>
<th>Expression</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angst</td>
<td>65%</td>
</tr>
<tr>
<td>Fear</td>
<td>30%</td>
</tr>
<tr>
<td>Verrassing</td>
<td></td>
</tr>
<tr>
<td>Surprise</td>
<td></td>
</tr>
<tr>
<td>Walging</td>
<td>5%</td>
</tr>
<tr>
<td>Disgust</td>
<td></td>
</tr>
</tbody>
</table>

dibeklioglu@cs.bilkent.edu.tr   |    http://www.cs.bilkent.edu.tr/~dibeklioglu/
Selected Publications


i-Vis @ Bilkent
Information Visualization Research Lab
at Bilkent University

Big data visualization & analytics, Pathway visualization & informatics, Graph drawing & layout, Graph database querying algorithms

Ugur Dogrusoz

Click here for live/animated/full presentation
Image Synthesis with Deep Neural Networks

Image inpainting

Texture synthesis

Image synthesis

Image to image translation
Unsupervised feature learning with Deep Neural Networks
Unsupervised 3D image synthesis

Image taken from: https://github.com/dariopavllo/convmesh/
Computer Graphics

Uğur Gündükbay

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

Modeling and Visualization Research Group

http://www.cs.bilkent.edu.tr/~modvis/
Computer Graphics

Computer Graphics Research Group at the Department of Computer Engineering at Bilkent University conducts research on different aspects of computer graphics.

**Human Modeling and Animation**
- Motion control, Realistic rendering, Facial animation, Hair simulation, Motion capture
- Augmented Reality
- Crowd simulation
- Agent Personality and Emotion Modeling
- Learning Personality and Emotions

**Three-Dimensional (3D) Modeling**
- Tetrahedralization of Large Models
- Terrain and Urban Scenes

**Rendering**
- Tetrahedralization-based Acceleration Structures for Raytracing
- Direct Volume Visualization Using Tetrahedralization-based structures
Çiğdem Gündüz Demir
http://www.cs.bilkent.edu.tr/~gunduz
gunduz@cs.bilkent.edu.tr

Digital pathology: classification and segmentation in biopsy images

End-to-end segmentation in biopsy images

Gland/cell segmentation in colon tissues

High-level representation of histopathological images and colon cancer classification

CT and MR image analysis for in vivo images

Subcutaneous tumor segmentation

Cartilage endplate segmentation

High content screening: cell segmentation in microscopic images

Cell segmentation in phase contrast microscopy

Cell segmentation in fluorescence microscopy

Cell segmentation in peripheral blood and bone marrow images
Deep Learning for Medical Image Analysis

Digital Pathology

Unsupervised feature extraction via deep neural networks for histopathological image representation and classification

End-to-end gland and tissue segmentation using fully convolutional networks
Deep Learning for Medical Image Analysis

Cell Segmentation

Multi-task models for cell detection in live cell microscopy

Two-stage convolutional neural networks for cell nucleus segmentation in tissue images
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
http://www.cs.bilkent.edu.tr/~korpe/nsrg/

Faculty Member
Ibrahim Korpeoglu
Professor
Dept of Computer Engineering
Bilkent University

Research Areas:
- Computer Networks
- Wireless Networks
- Sensor Networks
- P2P Networks
- Computer Systems
- Distributed Systems
- Cloud Computing
- Internet of Things
- Big Data Systems

Working on Problems and Projects related with Computer Networks and Computer Systems
Wireless Mesh Networks
- Routing
- Channel assignment
- Interference modeling
- Interference mitigation

Testbeds

Cloud Computing
- Resource allocation
- VM placement
- Network virtualization
- Network embedding
- Mobile Edge Computing

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

Internet of Things
- Data and Application Placement
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*


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, 26(10), pages 2439-2452, 2014.

More information at the group website: http://www.cs.bilkent.edu.tr/~korpe/nsrg/
Özgür S. Öğüz

- Recently joined the CS department in January 2022.
- Office: EA529
- Phone: 2903398
High-Performance and Energy Efficient Computing

Algorithms, Systems, and Applications
Active projects:

• Energy efficient FPGA accelerators for big data applications (*supported by European Commission, in collaboration with Intel, Oregon*)
• Parallelizing Collaborative Filtering algorithms for recommender systems
• Parallel and vectorized scientific computing algorithms
• Optimizing memory architecture for graph analytics applications for large datasets.

I am interested in graduate student candidates who have one or more of the following:

• Strong algorithmic background and analytical skills
• Interest in solving programming puzzles
• C++ programming skills
• Experience with multi-core, GPU, and/or FPGA programming

For more information, see [www.bilkent.edu.tr/~mustafa.ozdal](http://www.bilkent.edu.tr/~mustafa.ozdal). You can send an email to mustafa.ozdal@cs.bilkent.edu.tr to set up an appointment.
Özcan Öztürk

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- **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*
Eray Tüzün
Bilkent University Software Engineering and Data Analytics Research Group
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Research Areas
- Software Analytics / Intelligence
- Machine Learning & Data Science for Software Engineering
- Software Product Line Engineering
- Gamification / Serious Games

Interested in being part of our research group? Please contact us at eraytuzun@cs.bilkent.edu.tr
Mining Software Engineering data

Analyzing Developer Contributions using Artifact Traceability Graphs

H. Alperen Çetin, Eray Tuzun
Bilkent University
Ankara, Turkey

Abstract
Software artifacts are the by-products of the development process. Throughout the life cycle of a project, developers produce different artifacts such as source files and bug reports. To analyze developer contributions, we construct artifact traceability graphs with these artifacts and their relations using the data from software development and collaboration tools.

Identifying Key Developers using Artifact Traceability Graphs

H. Alperen Çetin
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Eray Tuzun
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ABSTRACT
Developers are the most important resource to build and maintain software projects. Due to various reasons, some developers take more responsibility, and this type of developers are more valuable and indispensable for the project. Without them, the success of the project would be at risk. We use the term key developers for

1 INTRODUCTION
Software development mainly depends on human effort. In a project, some developers take more responsibility, and the success rate of the project heavily depends on these developers. Thus, they are valuable and essential to develop and maintain the project, in other words, they are the key developers of the project.
Overview of Data Science in SE

- programming
- defect detection
- testing
- debugging
- maintenance

software engineering tasks helped by data mining

- NLP
- classification
- association/patterns
- Graph Mining
- Deep Learning

Data Science techniques

- code bases
- change history
- program states
- structural entities
- bug reports

software engineering data
"practice offering software practitioners (not just developer) up-to-date and pertinent information to support their daily decision-making processes and Software Intelligence should support decision-making processes throughout the lifetime of a software system”

Ahmed E. Hassan and Tao Xie

Guess the location of undetected bugs
Who should fix this bug?
Who should review this pull request?
Which files are more likely to be buggy?
...

Software Analytics & Software Productivity
Recent Publications

- **Ground Truth Deficiencies in Software Engineering: When codifying the past is counterproductive.** Eray Tüzün, Hakan Erdoğmuş, Maria Teresa Baldassare, Michael Felderer, Robert Feldt, Burak Turhan. IEEE Software, 2021


- **RSTrace+: Reviewer Suggestion using Software Artifact Traceability Graphs.** Emre Sülün, Uğur Doğrusöz, Eray Tüzün. Information and Software Technology, 2021

- **Bus Factor In Practice.** E Jabrayilzade, M Evtikhiev, E Tüzün, V Kovalenko, 44th International Conference on Software Engineering, 2022

- **Bug Tracking Process Smells in Practice.** Erdem Tuna, Vladimir Kovalenko, Eray Tüzün, 44th International Conference on Software Engineering, 2022


- **Closing the gap between software engineering education and industrial needs.** Vahid Garousi, Görkem Giray, Eray Tüzün, Cagatay Catal, Michael Felderer, IEEE Software, 2020

- **Identifying Key Developers using Artifact Traceability Graphs.** Alperen Cetin, Eray Tüzün. PROMISE, 2020

- **Towards a taxonomy of code review smells.** Emre Dogan, Eray Tüzün, Information Software and Technology, 2021
Interested in being part of our research group?
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Bilkent University Software Engineering and Data Analytics Research Group (BILSEN)

https://bilsengroup.github.io

Graduate Students
• Barış Ardıç, MSc
• Utku Ünal, MSc (METU)
• Shirin Pirouzkhah, MSc
• Khushbakht Ali, MSc
• Emre Sülün, MSc
• Elgun Jabrayılzade, MSc
• Erdem Tuna, MSc

Interested in being part of our research group?
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Database Research
Özgür Ulusoy
http://www.cs.bilkent.edu.tr/~oulusoy/

- Web Search Engines
- Natural Language Interface to Databases
- Multimedia Databases
- Big Data and Social Network Analysis
- Genomic Data Privacy
Web Search Engines

- Diversification of Search Results
- Educational Web Search
- Efficiency and scalability issues for Web-IR

http://www.cs.bilkent.edu.tr/~bilweb
Natural Language Interface to Databases (NLIDB)

- Make relational databases accessible to casual users
- Translate query to SQL
- No need to be familiar with SQL syntax
- No need-to-know schema
- Broadly categorized into 2 approaches
  - Conventional pipeline-based systems
  - End-to-end neural network based solutions
Keyword Mapping in NLIDB

Challenges

Semantic variation

Detect non/relevant keywords

Multi-word entities
DBTagger - Neural Network Architecture
Explainable NLIDB

- Open-up black-box deep learning models
- Explain output to the user
Query Recommendation in Databases

- Witness-Based Query Recommendation
- Utilize Local Database Embeddings
Multimedia Databases
(joint work with Prof. Üğur Güdükbay)

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

http://www.cs.bilkent.edu.tr/~bilmdg
BilVideo-7: An MPEG-7 Compatible Video Retrieval System

Powerful querying capability for video data
- keyword and content-based queries
- spatio-temporal object queries

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

Example query formulation

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

Video Processing
- SBD, Segmentation
- Object Extraction
- Annotation
- etc.

XML-Native Feature Database
(Tamino)

Feature Extraction
- MPEG-7 Features

Query Processor

Raw Video Database
(File System)

Visual Query Interface

Web Client
Mobile Image Search Using Multi-Image Queries

Workflow of the Search System

- Early and Late fusion methods

- Multi-View Dataset and Queries

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

- Dataset Images

- Query Images
Learning Visual Similarity for Image Retrieval with Convolutional Neural Networks

- Finding matching images across large and unstructured dataset plays a key role in many computer vision applications.
- An image retrieval system enables searching and retrieving images from a large dataset of images.
- The aim is learning efficient visual similarity for image retrieval task by revealing resemblances and differences between product images using triplet networks empowered with global descriptors, revised capsule networks, spatial group-wise enhance, and self-attention layer in an end-to-end manner.

Image retrieval process

Triplet loss
Big Data and Social Network Analysis

- Social Network Data Analysis on Big Data Processing Platforms
  (joint work with Prof. İbrahim Körpeoğlu)

- Misinformation Propagation in Social Networks
Misinformation Propagation in Social Networks

Game Theoretic and Reinforcement Learning Approaches

Misinformation as a Cooperation Game

Random Regular Networks

Facebook Network

Network structure affects the outcome.

Truth is at disadvantage!

Misinformation under Reinforcement Learning

Agent 1 (Spread Fake)

Agent 2 (Spread Truth)

RL Agents keep up with the state of the art!