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, 2023 (early-bird deadline)
  May 31, 2023 (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, documents need 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 and Department)
  – Eligibility for accommodation in dormitories or University housing
  – Health Insurance
  – Office (shared)
  – Meal Card support (for Ph.D. students)
Scholarship Options

- **Project grants (other than TÜBİTAK projects)**
  - Tuition waiver (100%)
  - Stipend (paid from the project budget and Department)
  - Eligibility for accommodation in dormitories or University housing
  - Health Insurance
  - 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>
</tr>
</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>
</tr>
<tr>
<td>PhD abroad</td>
<td>35</td>
<td>15.8%</td>
</tr>
<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>
</tr>
<tr>
<td>Co-founder abroad</td>
<td>9</td>
<td>4.1%</td>
</tr>
<tr>
<td>Unknown abroad</td>
<td>37</td>
<td>7.7%</td>
</tr>
<tr>
<td>In Turkey</td>
<td>222</td>
<td>46.3%</td>
</tr>
<tr>
<td>Abroad</td>
<td>221</td>
<td>46.0%</td>
</tr>
<tr>
<td>Unknown</td>
<td>37</td>
<td>7.7%</td>
</tr>
<tr>
<td>Total</td>
<td>480</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Abroad
- PhD abroad, 35, 16%
- PostDoc abroad, 10, 5%
- Faculty abroad, 20, 9%

In Turkey
- Co-founder in Turkey, 14, 6%
- PhD in Turkey, 20, 9%
- Faculty in Turkey, 37, 17%
- Engineer in Turkey, 151, 68%
- Co-founder in Turkey, 14, 6%
- unknown, 37, 7.7%
# Graduates of MS Program

## in Turkey
- Bilkent Univ. 25
- ASELSAN 20
- HAVELSAN 16
- TÜBİTAK 13
- Hacettepe Univ. 6
- METU 6
- TSK 5
- STM 4
- TCMB 4
- Vestel 4
- Cybersoft 3
- Garanti Teknoloji 3
- MilSOFT 3
- OpsGenie 3
- Sabancı Univ. 3
- Akdeniz Univ. 2
- Oracle 2

## Abroad
- Microsoft 23
- Google 16
- Amazon 6
- Booking.com 4
- Case Western Reserve Univ. 4
- Facebook 4
- Univ. California 4
- SAP 3
- U. of Massachusetts Amherst 3
- UBER 3
- EPFL 2
- ETH 2
- Imperial College 2
- Sandia National Labs. 2
- U. of Texas at San Antonio 2
- University of Florida 2
- University of Waterloo 2
- U. of Illinois at Urbana-Champaign 1
- Washington U. in St. Louis 1
## Graduates of PhD Program

<table>
<thead>
<tr>
<th>Position</th>
<th>Count</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Faculty in Turkey</td>
<td>25</td>
<td>69.4%</td>
</tr>
<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>
<td>6</td>
<td>18.8%</td>
</tr>
<tr>
<td>Engineer abroad</td>
<td>17</td>
<td>53.1%</td>
</tr>
<tr>
<td>Co-founder abroad</td>
<td>1</td>
<td>3.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Position</th>
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<tr>
<td>Co-founder in Turkey</td>
<td>1</td>
<td>2.8%</td>
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<tr>
<td>Engineer abroad</td>
<td>17</td>
<td>53.1%</td>
</tr>
<tr>
<td>Co-founder abroad</td>
<td>1</td>
<td>3.1%</td>
</tr>
</tbody>
</table>

### In Turkey
- **Faculty in Turkey**: 25 (69.4%)
- **Engineer in Turkey**: 10 (27.8%)
- **Co-founder in Turkey**: 1 (2.8%)
- **PostDoc abroad**: 8 (25.0%)
- **Faculty abroad**: 6 (18.8%)
- **Engineer abroad**: 17 (53.1%)
- **Co-founder abroad**: 1 (3.1%)

### Abroad
- **Faculty in Turkey**: 25 (69.4%)
- **Engineer in Turkey**: 10 (27.8%)
- **Co-founder in Turkey**: 1 (2.8%)
- **PostDoc abroad**: 8 (25.0%)
- **Faculty abroad**: 6 (18.8%)
- **Engineer abroad**: 17 (53.1%)
- **Co-founder abroad**: 1 (3.1%)

**Total:** 68 (100.0%)
## Graduates of PhD Program

### in Turkey

<table>
<thead>
<tr>
<th>University</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>METU</td>
<td>4</td>
</tr>
<tr>
<td>Bilkent University</td>
<td>3</td>
</tr>
<tr>
<td>Hacettepe Univ.</td>
<td>3</td>
</tr>
<tr>
<td>Akdeniz University</td>
<td>2</td>
</tr>
<tr>
<td>Sabancı Univ.</td>
<td>3</td>
</tr>
<tr>
<td>TED University</td>
<td>2</td>
</tr>
<tr>
<td>Ankara University</td>
<td>1</td>
</tr>
<tr>
<td>Aselsan</td>
<td>1</td>
</tr>
<tr>
<td>Atılım University</td>
<td>1</td>
</tr>
<tr>
<td>Beykent University</td>
<td>1</td>
</tr>
<tr>
<td>Çukurova Üniversitesi</td>
<td>1</td>
</tr>
<tr>
<td>SAP</td>
<td>1</td>
</tr>
<tr>
<td>TAI</td>
<td>1</td>
</tr>
<tr>
<td>TCMB</td>
<td>1</td>
</tr>
<tr>
<td>Turkcell</td>
<td>1</td>
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</tbody>
</table>

### Abroad

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

### Faculty Members

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

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

Dr. Selim Aksoy
Medical Image Analysis

Graph convolutional networks and self-supervised learning

Simultaneous localization and classification

Content-based search of medical archives

Dr. Selim Aksoy
### Remote Sensing Image Analysis

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

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Landsat 5 (30 m) (1984)</td>
<td></td>
</tr>
<tr>
<td>(b) Spot 5 (5 m) (2002)</td>
<td></td>
</tr>
<tr>
<td>(c) WorldView-3 (0.31 m) (2014)</td>
<td></td>
</tr>
</tbody>
</table>

#### Hyperspectral image analysis

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) False color</td>
<td></td>
</tr>
<tr>
<td>(b) Buildings</td>
<td></td>
</tr>
<tr>
<td>(c) Roads</td>
<td></td>
</tr>
<tr>
<td>(d) Vegetation</td>
<td></td>
</tr>
</tbody>
</table>

#### Orchard segmentation and agricultural mapping

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Aerial</td>
<td></td>
</tr>
<tr>
<td>(b) Landsat</td>
<td></td>
</tr>
<tr>
<td>(c) DEM</td>
<td></td>
</tr>
<tr>
<td>(d) Ikonos</td>
<td></td>
</tr>
<tr>
<td>(e) Ikonos</td>
<td></td>
</tr>
</tbody>
</table>

#### 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

**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

**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

... 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

<table>
<thead>
<tr>
<th>Research Interests</th>
<th>Current Research Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Computer Vision</td>
<td>• Face Recognition</td>
</tr>
<tr>
<td>• Pattern Recognition</td>
<td>• Face Presentation Attack Detection</td>
</tr>
<tr>
<td>• Machine Learning</td>
<td>• Anomaly Detection</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.
• 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

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)

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: Petascale 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 Küçükylılmaz, 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
Soheil Abadifard
Sepehr Bakhshi
Pouya Ghahramanian
Sanaz Gheibuni
Oğuzhan Özçelik
Onur Yıldırım

UG Student(s)
Enes Bektaş

Some Prev. Members
Alican Büyükçakır
Sevil Çalışkan
Sanem Elbaşı
Ömer Gözüaçık
Berkay Gülcan
Çağdaş Öcalan

Other Contributors
Hamed R. Bonab, Umass
Dilek Küçük, TÜBİTAK
Çağrı Toraman, ASELSAN
Research Interests

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

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 to analyze biological data using machine learning. My work discovers biomarkers in particular for genetic diseases. Discovering an algorithm that is clear space for even a single variable machine learning is clearly space for even a basic algorithm is the lack of computational power in the "big data" era. Today, the bottleneck in the problem of vast amounts of information accumulation, the first 13 years from the biomedical network, even though it took $1b to sequence the genome, it takes a day to sequence.

Analyzing biological data using various biochemical networks resulted in vast amounts of "big data." The information flow from DNA -> RNA -> Protein -> Metabolite, 20k, 100k, 1m, and 3k layer respectively. The search for the right set of algorithms is the lack of computational power and the algorithm design. The data and algorithms that can introduce new discoveries in the field of molecular biology dictate the importance of the algorithm in making computational advances.
A. Ercument Cicek
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Gene Discovery for Autism Spectrum Disorder

- Broken interplay between 1000 genes lead to
  algorithmic networks along discovered ~50 of them, just
  understand 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 that affects the fetal period of human development. We design algorithms to model the interaction networks within the brain during this period to better understand the causes and effects of autism.

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Metabolic Networks to Understand Cancer

Metabolites are the small compounds in the body and have been found to be key biomarkers in the disease. We use certain algorithms to define network structures and analyze these metabolites to identify subtypes of the same cancer.

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Selected Publications:

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.
Assessment of Depression Severity

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Kinship Verification

- Kin 1
  - Input: Kin 1 (Father)
  - Decoding
  - Encoding
- Kin 2
  - Input: Kin 2 (Daughter)
  - Decoding
  - Encoding
- Others (No Kinship)
  - Expression Matching
  - Maximize Similarity
  - Minimize Similarity

Shared Weights

- Maximize Similarity
- Minimize Similarity

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Age Estimation through Facial Dynamics

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Facial Expression Recognition
Selected Publications


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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

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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
**Digital pathology: classification and segmentation in biopsy images**

End-to-end 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

Çiğdem Gündüz Demir
http://www.cs.bilkent.edu.tr/~gunduz
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

- 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

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Phone: 290 2599

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
- 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
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.

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

- Collaborative Filtering
- Graph Analytics
- PageRank
- Scientific Computing

- FPGAs
- GPUs
- Xeon Phi
- Parallel Systems
- Novel Architectures
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
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 Tüzün
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.
Overview of Data Science in SE

Data Science techniques

software engineering tasks helped by data mining

software engineering data

programming
defect detection
testing
debugging
maintenance

NLP
classification
association/patterns
Graph Mining
Deep Learning

code bases
change history
program states
structural entities
bug reports
"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?
...
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 Çetin, 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? Please contact us at eraytuzun@cs.bilkent.edu.tr

Bilkent University Software Engineering and Data Analytics Research Group (BILSEN)

https://bilsengroup.github.io

**Graduate Students**
- Barış Ardıç, MSc
- Utku Ünal, MSc (METU)
- Shirin Pirouzkah, MSc
- Khushbakht Ali, MSc
- Emre Sülün, MSc
- Elgun Jabrayilzade, MSc
- Erdem Tuna, MSc

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Data Science Research
Özgür Ulusoy
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- Text-to-SQL Systems
- Web Search Engines
- Multimedia Database Systems
- Social Network Analysis
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)
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
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
Web Search Engines

Diversification of Search Results

❖ Multidimensional result diversification
❖ Supervised learning methods for search result diversification
❖ Impact of index pruning on diversification performance
Web Search Engines

Efficiency and Scalability Issues

❖ Methods and algorithms for caching, indexing, and query processing in search engines
Multimedia Databases
(joint work with Prof. Uğur Güdükbay)

- 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**

- **Users**
  - Web Client

- **Visual Query Interface**

- **Raw Video Database** (File System)

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

- **XML-Native Feature Database** (Tamino)

- **Query Processor**

- **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*

- *putin*
- *bush*
- *dog*

**keywords:** trees, greenery, sky – *bush, putin, dog*
Multimedia Databases

Mobile Image Search Using Multi-View Object 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

a)

b)

QUERY

QUERY LIST

RESULT LIST

c)

QUERY LIST

RESULT LIST
Learning efficient visual similarity for image retrieval by revealing resemblances and differences between product images
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
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