Bilkent University
Computer Engineering Department

MSc and PhD Programs

Prof. Dr. Ibrahim Korpeoglu
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, performance evaluation, scientific computing, virtual reality.
Applications

• Application Deadlines:
  November 1, 2021

• 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 to accommodate in dormitories or University housing
  – Health Insurance
  – Office (shared)
  – Meal Card (for Ph.D. students) support
Scholarship Options

• TÜBİTAK Scholarship or TÜBİTAK projects
  – Tuition waiver (100%)
  – Stipend (paid by TÜBİTAK)
  – Eligibility to accommodate in dormitories or University housing
  – Accommodation financial aid from University
  – Health Insurance
  – Office (shared)
  – Bilkent spending Card (for PhD students) support
  – Meal Card (for PhD Students) support
Scholarship Options

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

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

• MSc
  - 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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<tbody>
<tr>
<td>PhD in Turkey</td>
<td>20</td>
<td>9.0%</td>
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<tr>
<td>Faculty in Turkey</td>
<td>37</td>
<td>16.7%</td>
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<tr>
<td>Engineer in Turkey</td>
<td>151</td>
<td>68.0%</td>
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<tr>
<td>Co-founder in Turkey</td>
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<td>6.3%</td>
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<tr>
<td>PhD abroad</td>
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<tr>
<td>PostDoc abroad</td>
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<tr>
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<td>9.0%</td>
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<tr>
<td>Engineer abroad</td>
<td>147</td>
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<tr>
<td>Co-founder in abroad</td>
<td>9</td>
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<tr>
<td>Unknown</td>
<td>37</td>
<td>7.7%</td>
</tr>
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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>
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<tbody>
<tr>
<td>Bilkent Univ.</td>
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<td>ASELSAN</td>
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<td>TÜBİTAK</td>
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<td>TCMB</td>
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<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</th>
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<td>Microsoft</td>
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<tr>
<td>Google</td>
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<tr>
<td>Amazon</td>
<td>6</td>
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<td>Booking.com</td>
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<td>Case Western Reserve Univ.</td>
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<td>Facebook</td>
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<td>Univ. California</td>
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<td>SAP</td>
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<td>U. of Massachusetts Amherst</td>
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<td>UBER</td>
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<td>EPFL</td>
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<td>ETH</td>
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<td>Imperial College</td>
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<tr>
<td>Sandia National Labs.</td>
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<td>U. of Texas at San Antonio</td>
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<td>University of Florida</td>
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<tr>
<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>
<thead>
<tr>
<th>Position</th>
<th>Count</th>
<th>%</th>
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<tr>
<td>Faculty in Turkey</td>
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<tr>
<td>Engineer in Turkey</td>
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<tr>
<td>Co-founder in Turkey</td>
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<tr>
<td>PostDoc abroad</td>
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<tr>
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<td>17</td>
<td>53.1%</td>
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<tr>
<td>Co-founder in abroad</td>
<td>1</td>
<td>3.1%</td>
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</table>

| In Turkey | 36 | 52.9% |
| Abroad    | 32 | 47.1% |
| Total:    | 68 | 100.0% |
# Graduates of PhD Program

<table>
<thead>
<tr>
<th>in Turkey</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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<td>Akdeniz University</td>
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<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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<td>Aselsan</td>
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<td>Atılım University</td>
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<tr>
<td>Beykent University</td>
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<tr>
<td>Çukurova Üniversitesi</td>
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<td>SAP</td>
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<td>TAI</td>
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<tr>
<td>TCMB</td>
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<td>Turkcell</td>
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<table>
<thead>
<tr>
<th>Abroad</th>
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<tbody>
<tr>
<td>Amazon</td>
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<tr>
<td>Oregon Health and Sci. U.</td>
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<tr>
<td>Case Western R. U.</td>
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<td>Lawrence Berkeley Lab</td>
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<tr>
<td>LIP ENS-LYON CNRS</td>
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<td>ETH</td>
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<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>
<td>1</td>
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<tr>
<td>Oracle</td>
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<tr>
<td>Salesforce</td>
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</tr>
<tr>
<td>Sandia National Labs.</td>
<td>1</td>
</tr>
<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>
<thead>
<tr>
<th>Faculty Members</th>
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<tbody>
<tr>
<td>Georgia Institute of Technology</td>
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<tr>
<td>Oregon Health and Science University</td>
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<td>Stony Brook University</td>
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<td>Celal Bayar University</td>
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<td>Çukurova University</td>
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<td>Hacettepe University</td>
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<td>Konya Food &amp; Agriculture University</td>
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<td>METU</td>
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<td>Sabancı University</td>
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<tr>
<td>Selçuk University</td>
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<td>TED</td>
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</table>
Faculty Members

• In alphabetic order

(Please contact with 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
  - DPT, 2004-2005

Dr. Selim Aksoy
Segmentation and classification of cervical cells

Classification of prostate biopsies

Content-based search of medical archives

Dr. Selim Aksoy
Medical Image Analysis

Whole slide imaging
(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
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

Zero-shot learning for object recognition

Geospatial data mining

Attention model for multi-source fine-grained object recognition

Dr. Selim Aksoy
Mehmet Fatih Aktaş

• Newly joined to CS department
  – in September 2021.
• Office: EA521
• Phone: 2901218
Mehmet Fatih Aktaş

• Research Interests
  – Performance modeling and evaluation
  – Computer systems performance analysis
  – Distributed storage
  – Cloud computing
  – Computer networks
Sample publications

- Download time analysis for distributed storage codes with locality and availability, MF Aktaş, S Kadhe, E Soljanin, A Sprintson. IEEE Transactions on Communications.
- Straggler mitigation at scale, MF Aktaş, E Soljanin, IEEE/ACM Transactions on Networking 27 (6), 2266-2279.
- Modeling the edge: Peer-to-peer reincarnated. G Yadgar, O Kolosov, MF Aktas, E Soljanin. 2nd {USENIX} Workshop on Hot Topics in Edge Computing (HotEdge 19).
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

Reference Genome

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
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
- Ion Torrent PGM
- Ion Torrent Proton
- Illumina MiSeq
- 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**.


**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.
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)

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 Küçükyılmaz, 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.
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:

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

dibeklioglu@cs.bilkent.edu.tr | http://www.cs.bilkent.edu.tr/~dibeklioglu/
Kinship Verification
Facial Expression Recognition

- Angst: 65%
- Verrassing: 30%
- Walging: 5%
- Fear
- Surprise
- Disgust

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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/
**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
Computer Graphics
Uğur Güdükbay

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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 (row-wise order): neutral, happiness, surprise, fear, anger, sadness, disgust, happy, surprise, anger, surprise, disgust, surprise, happy, anger, anger, sadness, surprise, anger, sadness, disgust, anger, sadness, surprise, 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
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
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Research Areas:
- Computer Networks
- Computer Systems
- Distributed Systems
- Wireless Networks
- Cloud Computing
- Sensor Networks
- Internet of Things
- Big Data Systems
- P2P Networks

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

Testbeds

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

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


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.
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.
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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
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Research Areas
- Software Analytics
- Software Product Line Engineering
- Gamification / Serious Games
- Software Engineering Education
- Software Development Processes
- Empirical Software Engineering

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
Software Analytics & Software Productivity

"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

Programmers who changed this function also changed  
Don’t program on Fridays  
Which files are more likely to be buggy?
Serious Games & Gamification in Software Engineering

Gamification is the use of game mechanics to drive engagement in non-game business scenarios and to change behaviors in a target audience to achieve business outcomes.
Selected Publications

- **Catching up with Method and Process Practice: A new Baseline for Researchers**, HELENA Consortium, International Conference on Software Engineering in Practice, 2019
- **An Auction-Based Serious Game for Bug Tracking**, Cagdas Usfekes, Eray Tuzun, Murat Yilmaz, Yagup Macit, Paul Clarke, IET Software, 2019
- **Closing the gap between software engineering education and industrial needs**, Vahid Garousi, Görkem Giray, Eray Tüzün, Cagatay Catal, Michael Felderer, IEEE Software, 2019
- **Adopting Augmented Reality for the Purpose of Software Development Process Training and Improvement: An Exploration**, İpek Ohri, İrem Öge, Bora Orkun, Murat Yılmaz, Eray Tüzün, Paul Clarke, RV O’Connor, European Conference on Software Process Improvement, 195-206
- **Adopting the Essence Framework to Derive a Practice Library for the Development of IoT Systems**, Görkem Giray, Bedir Tekinerdogan, Eray Tüzün, Connected Environments for the Internet of Things, Challenges and Solutions, Springer International Publishing, 2018 (Book Chapter)
- **Are Computer Science and Engineering Graduates Ready for the Software Industry? Experiences from an Industrial Student Training Program**
  Eray Tuzun, Hakan Erdogmus and Izzet Gokhan Ozbilgin, International Conference in Software Engineering SEET 2018
Database Research
Özgür Ulusoy
http://www.cs.bilkent.edu.tr/~oulusoy/

- 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

Search Engines are the key to access Web Data

- First **billion-URL** index
  - The world’s largest!
  - ≈5000 PCs in clusters!

- S. Brin meets L. Page

- 2008
  - Google counts 1 trillion
    - unique URLs

- 2015
  - TBs or PBs of data/index
  - Tens of thousands of PCs

- 1995
  - First billion-URL index
  - The world’s largest!
  - ≈5000 PCs in clusters!

- 1998
  - Birth of Google

- 1995
  - ≈5000 PCs in clusters!

- 2004
  - Index grows to 4.2 billion pages

- 2009
  - Google counts 1 trillion
    - unique URLs

- 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

**Visual Query Interface**
- Users
- Web Client

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

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

**Feature Extraction**
- MPEG-7 Features

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

**Query Processor**

**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

**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.
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)