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:
  April 5, 2021 (early-bird application)
  June 2, 2021 (regular application)

• 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>
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<td>14</td>
<td>6.3%</td>
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<tr>
<td>PhD abroad</td>
<td>35</td>
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<td>PostDoc abroad</td>
<td>10</td>
<td>4.5%</td>
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<td>9.0%</td>
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<tr>
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<td>147</td>
<td>30.6%</td>
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<td>4.1%</td>
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<tr>
<td>Unknown</td>
<td>37</td>
<td>7.7%</td>
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<tr>
<td>Unknown</td>
<td>37</td>
<td>7.7%</td>
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</tbody>
</table>

**Total:** 480 100.0%
## 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
- MiSOFT: 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>
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<tr>
<th>Position</th>
<th>Count</th>
<th>%</th>
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<tr>
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<tr>
<td>Faculty abroad</td>
<td>6</td>
<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 in abroad</td>
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<td>3.1%</td>
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In Turkey: 36 (52.9%)
Abroad: 32 (47.1%)
Total: 68 (100.0%)
## Graduates of PhD Program

### in Turkey

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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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<td>TED University</td>
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<td>Aselsan</td>
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<tr>
<td>Beykent University</td>
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<tr>
<td>Çukurova Üniversitesi</td>
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<tr>
<td>SAP</td>
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<td>TAI</td>
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<td>TCMB</td>
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<td>Turkcell</td>
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### Abroad

<table>
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<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>
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<tr>
<td>Lawrence Berkeley Lab</td>
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<tr>
<td>LIP ENS-LYON CNRS</td>
<td>1</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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<td>Georgia Tech</td>
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<td>Google</td>
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<td>Microsoft</td>
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<td>Oracle</td>
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<td>Salesforce</td>
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<td>Sandia National Labs.</td>
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<td>Stony Brook University</td>
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<td>U. of Central Florida</td>
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<td>Uber</td>
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### Faculty Members

<table>
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<tbody>
<tr>
<td>Georgia Institute of Technology</td>
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<tr>
<td>Konya Food &amp; Agriculture University</td>
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</table>
Faculty Members

• In alphabetic order

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

1. Contextual reasoning in AI
2. Social aspects of the Internet, esp. twitter
Contextual reasoning in AI

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

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

My grad course CS 578 (Natural Language Processing) examines contexts, as well as numerous other NLP topics.
Social aspects of the Internet, esp.

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

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

My grad course CS 513 (Implications of the Internet) treats such societal aspects of the Internet. I'm especially interested in twitter as a political medium.
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
Medical Image Analysis

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

- 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

Convolutional neural networks for region of interest classification

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
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

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

**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 consortia 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

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

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)

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

- We adapt algorithms to early childhood networks to understand the functional development.

A. Ercument Cicek

cicek@cs.bilkent.edu.tr
cs.bilkent.edu.tr/~cicek
Metabolic Networks to Understand Cancer

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

- De Novo Chip-Seq Analysis. Genome Biology 2015, 16:205.
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
Kinship Verification
Age Estimation through Facial Dynamics

00:01:52 << Duration
Slow Motion: 3x
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

The Pose Encoder is run twice.
Unsupervised 3D image synthesis

Image taken from: https://github.com/dariopavllo/convmesh/
Digital pathology: classification and segmentation in biopsy images

CT and MR image analysis for in vivo images

End-to-end segmentation in biopsy images

Gland/cell segmentation in colon tissues

High-level representation of histopathological images and colon cancer classification

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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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, fear, 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
Ibrahim Korpeoglu
Assoc. Professor
Dept of Computer Engineering
Bilkent University

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

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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

- **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

- **Bluetooth Scatternet Construction** and Bluetooth Applications
  *Sponsor*: TUBITAK

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

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

- Network Middleware for Environmental Monitoring and Control with **Wireless Ad hoc, Mesh and Sensor Networks**
  *Sponsor*: IBM Corporation
Wireless Mesh Networks
- Routing
- Channel assignment
- Interference mitigation

Testbeds

Cloud Computing
- Resource allocation
- VM placement
- Network virtualization

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 Publications


- 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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URL: http://www.cs.bilkent.edu.tr/~ozturk

- **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
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?
**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

- *An Auction-Based Serious Game for Bug Tracking*, Cagdas Usfekes, Eray Tuzun, Murat Yılmaz, Yagup Macit, Paul Clarke, IET 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)
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

- **1995** S. Brin meets L. Page
- **1998** Birth of Google
- **2000** First billion-URL index
  - The world’s largest!
  - $\approx$5000 PCs in clusters!
- **2004** Index grows to 4.2 billion pages
- **2008** Google counts 1 trillion unique URLs
- **2009** Tens of thousands of PCs
- **2009** TBs or PBs of data/index

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

Raw Video Database (File System)

Visual Query Interface

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

Feature Extraction
- MPEG-7 Features

Query Processor

XML-Native Feature Database (Tamino)

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

Salient video object extraction

segmentation
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.
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. İbrahım Körpeoğlu)