<table>
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<th>Project Domain</th>
<th>Project Name</th>
<th>Company</th>
<th>Description/goal</th>
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<td>1.</td>
<td>Physics, Pattern Recognition.</td>
<td><strong>IMU navigation to support Prediction of a needle direction in the soft tissue.</strong></td>
<td>GE Healthcare Ultrasound</td>
<td>The goal of the project to investigate methods for displacement compensation and preserve calibration. Learn UMI behavior and implement UMI functionality in the uC.</td>
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<td>2.</td>
<td>Big Data, analytic, diagnostic, REST</td>
<td><strong>Big Data - Diagnostic package collector</strong></td>
<td>Amdocs</td>
<td>to collect diagnostic information from an Hadoop cluster</td>
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<td>3.</td>
<td>Man-Machine interface, Chat Bots, BI</td>
<td><strong>Slack and Amazon Alexa Expanding BI with Chat Bots</strong></td>
<td>Amdocs</td>
<td>Do a project related to chat and voice bots using the Slack and Alexa APIs</td>
</tr>
<tr>
<td>4.</td>
<td>Open Source, REST, MEF, NFV, Communication</td>
<td><strong>Automated service ordering between international service providers for hybrid and NFV services.</strong></td>
<td>Amdocs</td>
<td>The goal is to build an API solution on the ECOMP platform that can be verified as interoperable with solutions from other developer communities.</td>
</tr>
<tr>
<td>5.</td>
<td>Predictive analytics algorithms, Big Data</td>
<td><strong>From Information to Optimization by Predictive analytics algorithms</strong></td>
<td>Amdocs</td>
<td>The goal of this project is build a platform that allows running (existing) analytic tools on DWH (related to a product) that use data mining to find prediction trends, behavior patterns and anomalies preventing future potential issues.</td>
</tr>
<tr>
<td>6.</td>
<td>Network Security</td>
<td><strong>Monitoring security policies in organization networks</strong></td>
<td>Cisco</td>
<td>To develop a prototype which will interoperate with the network infrastructure to provide accurate information regarding the policies that are enforced by each router and switch in the network.</td>
</tr>
<tr>
<td>7.</td>
<td>Network Security</td>
<td><strong>Identify abnormal behavior (or threats) of users accessing organization’s network</strong></td>
<td>Cisco</td>
<td>To develop a prototype that will collect events from ISE in real time and use it to identify abnormal user behavior.</td>
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<td>8.</td>
<td>Adaptive bitrate video streaming,</td>
<td><strong>Live video crawler using the HLS or DASH</strong></td>
<td>IBM</td>
<td>To develop a live video crawler module, running in Node.JS, that connects to a live...</td>
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<td>No.</td>
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<td>Project Description</td>
<td>Company/Institution</td>
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<tr>
<td>9.</td>
<td>Cloud, PAAS, Docker, Video surveillance, Serverless computing (OpenWhisk)</td>
<td>Video surveillance service using OpenWhisk and Docker on IBM Bluemix cloud. To develop a basic video surveillance service on Bluemix using Docker and OpenWhisk, that involves both a client side that sends a video stream to a servers that deploy an existing motion detection open source software to the received stream.</td>
<td>IBM</td>
<td></td>
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<tr>
<td>10.</td>
<td>Cloud Infrastructure, Systems</td>
<td>Live Migration for Linux Containers. The goal of the project is to enhance CRIU container migration by streaming container snapshot over the network without storing it in files.</td>
<td>IBM</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Image Processing, Physics Engines, VR</td>
<td>Physics – Based Virtual Camera. The goal is to enable camera movement in a virtual environment in a way that is both intuitive and pleasing to experience by applying physical qualities to the virtual camera.</td>
<td>Intel</td>
<td></td>
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<tr>
<td>12.</td>
<td>Machine Learning, Data Mining</td>
<td>A Tool for Data Quality Management in Machine Learning. To develop a tool for dramatically facilitating the control of data quality in the context of machine learning applications. In particular, the tool will focus on the management of large volumes of training data.</td>
<td>LogicBox</td>
<td></td>
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<tr>
<td>13.</td>
<td>Machine Learning, Databases</td>
<td>A Declarative System for Engineering Deep Learning. The goal of this project is to drastically reduce the amount of engineering and the level of expertise required for building DL applications.</td>
<td>LogiBox</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Network Processing</td>
<td>Record-breaking multi-threaded TCP performance. The goal of this project is to allow high TCP throughput from a single system (250Gb/s TCP for a single CPU and 500Gb/s TCP for a dual CPU. This will be done by exploring Intel’s CPU Cluster-On-Die configuration and learn how it may be used for solving shared resources issues.</td>
<td>Mellanox</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Operating Systems, Internet of</td>
<td>Concurrent Operating Systems - Linux and Zephyr. The students are requested to develop a hybrid Operating System configuration in which 3 of the CPU cores are running</td>
<td>Qualcomm</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Category</td>
<td>Description</td>
<td>Platform/Software</td>
<td>Developer</td>
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<tr>
<td>16.</td>
<td>Operating Systems, Internet of Things (IoT), Computer Communications</td>
<td>Operating Systems, Internet of Things (IoT) - Drone Flight Manager Software on Linux</td>
<td>Qualcomm</td>
<td>The students will develop a connected drone controller SW that runs on DragonBoard 410c with Linux Debian.</td>
</tr>
<tr>
<td>17.</td>
<td>CPS – Cyber-Physical systems, Navigation, Real-time programming, Kernels</td>
<td>Raspberry-Pi based high precision navigation system</td>
<td>Rafael</td>
<td>The project goal is to provide a high-accuracy navigation system based on low-cost computing environment, such as RPI, and high industry grade multi-axis inertial sensors connected over high-speed serial lines.</td>
</tr>
<tr>
<td>18.</td>
<td>Computer Vision</td>
<td>Look at this!</td>
<td>Rafael</td>
<td>The goal is to develop a smartphone application that will be the base for a “visualized social network”</td>
</tr>
<tr>
<td>19.</td>
<td>Data mining</td>
<td>Face recognition evaluation framework</td>
<td>Shutterfly</td>
<td>To develop a framework that allows to simulate face recognition process on a user's account and to compare different scenarios and algorithms.</td>
</tr>
<tr>
<td>20.</td>
<td>User interaction simulation, data mining</td>
<td>Testing framework simulating user account</td>
<td>Shutterfly</td>
<td>The goal of this project is to create a framework that allows simulating a large variety of user behaviors and recreating the sequence of events that caused an error.</td>
</tr>
<tr>
<td>21.</td>
<td>Data collection</td>
<td>Smart collection of mobile behavior info for experience personalization</td>
<td>Shutterfly</td>
<td>In this project the goal is to collect and A/B test browsing paths of users in mobile application.</td>
</tr>
<tr>
<td>22.</td>
<td>Mobile/Web programming</td>
<td>Social media to photo product</td>
<td>Shutterfly</td>
<td>To connect to user's accounts in SM and suggest Shutterfly photo products based on images shared in specific event or a series of events.</td>
</tr>
<tr>
<td>23.</td>
<td>User experience, Mobile App, Data Analysis</td>
<td>Tinder for your photos</td>
<td>Shutterfly</td>
<td>The Goal is implement a Tinder-like interface for fast like/dislike selection of single images or image collages.</td>
</tr>
<tr>
<td>24.</td>
<td>Deep learning, machine</td>
<td>Detection of ulcers and erosions in the gastrointestinal tract</td>
<td>Medtronic (former)</td>
<td>The purpose of the project is to develop a deep learning system that will automatically detect abnormalities in...</td>
</tr>
<tr>
<td>Learning, pattern classification, computer vision</td>
<td>From capsule endoscopy data using deep learning</td>
<td>GivenImaging</td>
<td>PillCam Crohn’s data</td>
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<tr>
<td>25. Image processing, deep learning, machine learning</td>
<td>Detection of ulcers and erosions in the gastrointestinal tract from capsule</td>
<td>Medtronic (former GivenImaging)</td>
<td>The purpose of the project is to develop a deep learning system that will automatically perform demosaicing on compressed images of Bayer image sensor.</td>
<td></td>
</tr>
<tr>
<td>26. Computer vision, machine learning</td>
<td>Identification and segmentation of the Colon Lumen in Wireless Capsule Endoscopy images</td>
<td>Medtronic (former GivenImaging)</td>
<td>The project will be composed of two main parts – identifying images (in PillCam Crohn’s data) that show the lumen, and in those images – correctly segmenting the lumen.</td>
<td></td>
</tr>
</tbody>
</table>
PROJECT 1

Company: GE Healthcare Ultrasound

Project name: IMU navigation to support Prediction of a needle direction in the soft tissue.

Supervisors: Alex Rozin, Tal Kenig

Project field: Physics, Pattern Recognition

Project description: People who suffer from either acute or chronic pain might have a nerve block injection to achieve temporary pain relief. Imaging guidance, such as fluoroscopy or computed tomography (CT or "CAT" scan), may be used to help the doctor place the needle in exactly the right location so that the patient can receive maximum benefit from the injection. But a problem that above mentioned methods relating to invasive methods and accompanying with exposer to significant x-ray.

In current products GEHC resolved a navigation problem by using ultrasound for a needle navigation visualization and direction prediction methods. Although visualization is an intuitive feature, prediction is rater extremely challenging. Actually, the prediction methods allow overlay drawing of the possible direction before actual needle invasion in to a human tissue.

The method based on calculation of position of the needle tip in a magnetic field. The process includes calibration stage where the system that implemented on the hardware board calculates environmental MF. Once needle that includes magnet enter to the environment close to HW board, the system calculates needle position and tracking displacement.

The system works properly as long as the HW board remains in fixed position in real world the board which is a part of ultrasound transducer all the time displaces and as a result lose a calibration.

In order to compensate displacement and remove recalibration demand we implemented IMU device.
The goal of the project is to investigate methods for displacement compensation and preserve calibration. Learn IMU behavior and implement UMI functionality in the uC. Implement Windows library for compensation calculations.

**Required course pre-requisites:** Preferable: 236315/236323

**Programming languages and development platforms:** C/C++, Matlab/Phyton, VS2015.

### PROJECT 2

**Company:** Amdocs

**Project title:** Big Data - Diagnostic package collector

**Category:** Big Data, analytic, diagnostic, REST

**Supervisors:** Idan Raphael, Menachem Kaplan

**Project Description:** Big data analytics (BDA) is an Amdocs framework for providing data centric applications. It is based mainly on Hadoop and its standards ecosystems tools.

The aim of the project is to provide a diagnostic package collector in order to create a utility that enable to collect diagnostic information from the Hadoop cluster and pack it in an archive, for two purposes:

- Offline analysis of failures
- Analysis of performance bottlenecks

The tool should receive a timeframe to work on, and a diagnostic level (verbose / trace / error)

Then it should connect to the Hadoop cluster and other components (Elastic search cluster for example), and pull the diagnostic information from it using various protocols (mostly REST and java clients, but may be others, such as SSH / SFTP, etc.)

After pulling the data additional processing might be required (in error level, for example, error messages should be extracted from the logs)

Then the diagnostic information need to be stored in a hierarchical structure and packed in an archive
The tool should also be extendable with custom collectors, for future use, so, if for example data need to be collected form a new system, the user can inject new collector that the tool will use in order to collect data from the new system

Implementation should be done with Java or Groovy

Technical Expertise required: Java and / or Groovy

PROJECT 3

Company: Amdocs

Project title: Slack and Amazon Alexa Expanding BI with Chat Bots

Category: Man-Machine interface, Chat Bots, BI

Supervisor: Evgeni Berenstein

Project Description: Exploring existing BI set of reports via Chat Bot.

Chatbots are an exciting new trend in the technology ecosystem and they are starting to become relevant in the enterprise. Chatbots can be considered the apps of voice interfaces. In the near future, we should expect enterprises to adopt chatbot platforms in the same way they are currently embracing mobile and IoT platforms.

Understanding and interpreting natural language commands using either text or voice is an extremely difficult endeavor. Semantically, the same command can be expressed using different sentences, synonymous, etc. Providing a rich natural language interface is essential to provide a strong user experience with chatbots.

In the enterprise, chatbots can be used as a lighter model to access data or perform actions in line of business systems. To streamline those operations, enterprise chatbot platforms should provide a simple way for chatbot developers to integrate with existing business systems and translate the data into voice or simple text interfaces.

In this project the students will build a working code that will expose existing BI dashboards data as text and voice bot interfaces to be implemented via Slack and Amazon Alexa APIs.

During the project the students will:

1. Understand the business needs answered by the existing BI implementation.
2. Define the business questions and required data that will be implemented in the project
3. Deal with chat and voice bots usability challenges
4. Create a front end application that will allow user to configure the data exposed by the bot
5. Create a code generation engine to implement the configuration in Slack and Alexa APIs
6. Deploy the project into Slack and Amazon Alexa environments
7. Create a backend server that will extract the required data from a database
8. Present a working solution

Implementation should be done with JavaScript

**Technical Expertise required:** JavaScript, NodeJS, BI/SQL, Slack and Alexa APIs, Rest

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## PROJECT 4

**Company:** Amdocs

**Project title:** Automated service ordering between international service providers for hybrid and NFV services

**Project Domain:** Open Source, REST, MEF, NFV, Communication

**Supervisor:** Mark Gibson

**Project Description:** The project aim is to allow network service providers to support services across the globe by leasing connection from peers in other countries. The project seeks to make this process fully automatic and reduce the time from days and weeks using email to a series of simple API calls.

**Background:** The project will build upon the work of two international bodies (TMF and MEF [www.mef.net](http://www.mef.net)). MEF defines a framework for ordering and managing network services. MEF has now decided to follow an open source approach to building its interfaces and the first project will focus on the way one service provider orders a connection from another. This is the most important automation use case that service providers want to support today. Solving this
will transform the business and move from 100s of manual operations to 1000s of automated operations per month. The services that are ordered will include traditional network equipment and NFV components.

The foundation for the API is provided by the TMF (www.tmforum.org/open-apis/) in their open api projects.

The project will involve linking these to the industry leading Open Source ECOMP project lead by Amdocs and will produce libraries that will eventually be used in live operational systems.

There are two sub-projects.
- Matching the customer location in the peer service provider to ensure they can support them.
- Ordering the service from the buyer service provider gateway to the customer location.

**Goal:** The aim is to provide a contribution that leads the global industry forwards by delivering an open and interoperable solution. The aim is to build an API solution on the ECOMP platform that can be verified as interoperable with solutions from other developer communities. This will include an interface profile spec.

Your mission is to provide open source contributions that can be used in scheduled hackathons at MEF meetings to confirm that we have a conformant interface profile spec and a working solution for the ECOMP platform. You will help test these against other implementations and find ways to glue the backend together to emulate a fully-designed provisioning system.

**Recommended background but not a must:** Open Source stores/processes

**PROJECT 5**

**Company Name:** Amdocs

**Project title:** From Information to Optimization by Predictive analytics algorithms

**Supervisor:** Yuval Balak

**Project Categories:** Predictive analytics algorithms, Big Data

**Project Description:** From Information to Optimization by Predictive analytics algorithms
In this project we will define a set of rules to check and predict main Program pillars and optimize them – for better planning and ongoing execution, allowing early detection and mitigations for future issues

“Analytics becomes a key competitive weapon- Leaders are addressing the diversity of data and unlocking the value of data via algorithms tuned to anticipate and deliver customer value” (Forrster)

Background: Today we are capturing in the Program management DWH various data segments from the different Amdocs system of the development life cycle from the pre sales through going live to production up to stabilizing the systems to customer satisfaction and support in customer premises.

- We would like to use the existing information systems to solve problems in the software development lifecycle
- Predictive analytics algorithms that can allow finding patterns in data that can make increasingly accurate predictions about the future of the business based on the relevant data so we will be able to (e.g.)
  - Early risks detection
  - Better Planning & budget optimization
    - Resource optimization
    - Pipeline optimization
    - Activities predicted effort and final cost
    - Project potential delays for contractual MSs
  - Execution
    - Identify code areas with high risk for defects
    - Defects closure models
  - And Other

Goal: The goal of this project is to be able to run an analytic tool that will be able to do data mining on the DWH and will be able to find prediction trends, behavior patterns and anomalies preventing future potential issues.
Recommended background

- Knowledge in data structures, and SQL
- Predictive modeling
- Machine learning
- Data Mining

PROJECT 6

Company: Cisco

Project name: Monitoring security policies in organization networks

Project field: Network Security

Supervisors: Amit Tropper and Yaniv Azoulay

Short description: Cisco TrustSec solution enables deployment of security policies into organization's network. The policies are enforced by the network infrastructure such as routers and switches. The policies define the type of traffic that is allowed in the network and whether traffic of some employee in an organization is allowed to reach various resources in the network (for example policy can define that in the network of the university a student can access only the servers in the computer science faculty lab and cannot access any other computers in the university).

The network security policies are dynamic and obligated for changes. As result the network infrastructure which enforces the policies maintains different policies at a given time.

Your role as a student in this project is to develop a prototype which will interoperate with the network infrastructure and will be able to provide accurate information which policies are enforced by each router and switch in the network. The customers of this prototype (network security administrators in organizations) will be able to get an updated and accurate view of the policies in each network element and identify any issues that may cause network connectivity or security bridges that need to be mitigated.

Programming languages and development platforms: OS: Linux

Possible programming languages: Python, C++, Java (will be finalized with the students)
PROJECT 7

Company: Cisco

Project title: Identify abnormal behavior (or threats) of users accessing organization’s network

Project domain: Network Security

Supervisors: Amit Tropper and Yaniv Azoulay

Project Description: Cisco Identity Service Engine (ISE) is responsible to authenticate and authorize users that login into an organization networks such as in universities for example (only students and/or staff can login the network with different privileges). Once some user access the network ISE collects various information about the user such as whether the user accesses the network from wireless connection or wired. The location of the user, the user IP address, the user MAC address, the OS type the user uses (iOS, Android, Windows etc.) etc.

As a student your role will be to develop a prototype that will collect events from ISE in real time, normalize the information received in the events, classify them by different vectors and run algorithm which will identify abnormal behavior for all users. For example, in case of a global organization with many offices around the globe, some user usually accesses the organization network from Tel-Aviv office. If the same user has been identified accessing the network from San Francisco offices, it is a potential threat that should be detected

Programming languages and development platforms:

- OS: Linux
- Possible programming languages: Python, C++, Java (will be finalized with the students)
**PROJECT 8**

**Company:** IBM Research – Haifa Lab

**Project title:** Live video crawler using the HLS or DASH adaptive bitrate video streaming Standards

**Project field:** Adaptive bitrate video streaming, HLS, DASH

**Supervisors:** Ophir Azulai and Udi Barzelay

**Project description:** Adaptive bitrate video streaming is a method of video streaming over HTTP where the source content is encoded at multiple bit rates, then each of the different bit rate streams are segmented into small multi-second parts. The streaming client is made aware of the available streams at differing bit rates, and segments of the streams by a manifest file. When starting, the client requests the segments from the lowest bit rate stream.

HLS and DASH are adaptive bitrate video streaming standards which are used today in the industry. The hls.js is a java script open source for HLS player and dash.js is a java script open source for DASH player.

FFmpeg is an open-source software project that produces libraries and programs for handling multimedia data.

In this project we will develop a live video crawler module, running in Node.JS, that connects to a live video source using the hls.js / dash.js open source, receives the video segments, decode it using FFmpeg and detect text in the images using a text extraction service from IBM. The module will support multiple sessions in parallel.

**Required course pre-requisites:** Software Engineering Methods (234321) or Object Oriented Programming (236703)

**Programming languages and development platforms:** Golang, Node.js, Java script
Company: IBM Research – Haifa Lab

Project name: Video surveillance service using OpenWhisk and Docker on IBM Bluemix cloud

Project field: Cloud, PAAS, Docker, Video surveillance, Serverless computing (OpenWhisk)

Supervisors: Ophir Azulai, Yevgeni Burshtein, Udi Barzelay

Short description: Bluemix is an implementation of IBM’s Open Cloud Architecture based on Cloud Foundry, an open source Platform as a Service (PaaS). Bluemix delivers enterprise-level services that can easily integrate with your cloud applications without you needing to know how to install or configure them. Bluemix provides access to a wide variety of services that can be incorporated into an application.

OpenWhisk is the IBM offering for serverless computing platform, also known as Function as a Service (FaaS). It is a cloud computing code execution model in which the cloud provider fully manages starting and stopping of function's container PaaS as necessary to serve requests, and requests are billed by an abstract measure of the resources required to satisfy the request, rather than per virtual machine, per hour.

Docker containers wrap up a piece of software in a complete filesystem that contains everything it needs to run: code, runtime, system tools, and system libraries – anything you can install on a server. This guarantees that it will always run the same, regardless of the environment it is running in.

In this project, we will develop a basic video surveillance service on Bluemix using Docker and OpenWhisk. In the client side we will have a gateway which will get the video stream from the camera, divide it to short segments and upload it to the cloud. The server side will receive the video and detect motion in it using an existing algorithm from the Open Computer Vision (OpenCV) open source. When a motion is detected, an event will be sent to a test web application.

The motion detection algorithm will run in a Docker container in OpenWhisk.
Required course pre-requisites: Software Engineering Methods (234321) or Object Oriented Programming (236703)

Programming languages and development platforms: Golang, C++, OpenCV, Linux

PROJECT 10

Company: IBM

Project title: Live Migration for Linux Containers

Project domain: Cloud Infrastructure, Systems

Supervisor: Mike Rapoport

Background: Linux containers allow developers to package and isolate applications with their entire runtime environment but without the whole OS, like it is done in VM technology. Containerized applications are easy to deploy and to move between environments (dev, test, production, etc.) while retaining full functionality. Container technology is a necessary building block for modern software development processes, such as DevOps and CI/CD (continuous integration and continuous deployment).

Live migration of containers is a process of moving application between different physical machines without disconnecting the client. It involves transferring all the system resources of the running container (memory, file system, and network connectivity) without incurring noticeable application downtime.

Open source project CRIU provides core migration technology to many prominent container engines, e.g. to Docker and LXC/LXD. Today, CRIU implements checkpoint-copy-restore type of migration where container snapshot is created and saved as a collection of files on the origin host; the files are then transferred to the destination host and are used to restore the container at destination.

Project Description: The purpose of the project is to enhance CRIU container migration by streaming container snapshot over the network without storing it in files. Eliminating intermediate step has a potential to streamline and speed up the migration process further facilitating its applicability and usage.
The project involves learning Linux container technology and CRIU project, followed by designing and implementing an abstraction layer for snapshot transport and a network protocol to be used for the communications between the source and the destination hosts.

The project provides an opportunity to contribute to an influential open source project under supervision of an experienced contributor. Requirements: working knowledge of Linux OS, programming skills in C and Python.

**PROJECT 11**

**Company:** Intel Corporation

**Project title:** Physics – Based Virtual Camera

**Project domain:** Image Processing, Physics Engines, VR

**Supervisor:** Gilad Bauman

**Short description:** Many virtual reality and computer graphics applications require the use of one or more virtual cameras which define the point of view from which we observe the virtual world. There are many methods for controlling that camera: from keyboards, mice and gamepads to full head tracking in virtual reality. What these methods have in common is that they attempt to bridge the gap between the human and the virtual world. However, due to the complexity of human perception and the way humans interact with the real world, it is difficult to fully model camera movement in a virtual environment in a way that is both intuitive and pleasing to experience. Our goal is to enable exactly such an experience for viewing 3D virtual worlds by applying physical qualities to the virtual camera. This will allow us to express our requirements as natural movements with the Newtonian physics laws of motion. In this project we will model a physics-based virtual camera which will be controlled by dynamic forces and kinematic constraints.

**Required course pre-requisites:** 236816,

**Programming languages and development platforms:** C/C++/C#/...
Company: LogicBlox


Project field: Machine Learning, Data Mining

Supervisor: Dr. Nikolaos Vasiloglou

Short description: The abundance of Big Data resources opens up unprecedented opportunities for Machine Learning (ML) applications, towards a variety of tasks such as automation of processes (Artificial Intelligence) and predictive analysis (e.g., demand forecasting and disease prediction). However, such data comes with significant challenges to ML libraries. One of the greatest challenges is that of controlling the quality of data. Low data quality has several basic reasons in the context of Big Data. Repositories are often collected from sources with limited content control, and they undergo nontrivial automated processing before being served to the ML library at hand. For example, data may be integrated from resources that disagree on formats, or contain overlapping information. Data may be generated via imprecise methods such as signal analysis, image recognition, and natural language processing. And data may undergo transformations that fail on certain values or character encodings.

While low data quality is an old problem, the high volumes processed nowadays often make it impossible to detect and correct errors. In fact, one typically observes the errors only when the ML library mal-behaves. The easy case is when exceptions are thrown. The hard case is when the learned prediction model behaves in an unintuitive manner (e.g., reducing the price of a product leads to reduction of sales). In this project, you will develop a tool for dramatically facilitating the control of data quality in the context of machine learning applications. In particular, the tool will focus on the management of large volumes of training data, and will serve two main functionalities.
1. The tool will gather and visualize statistics on columns, such as histograms, curve fitting, outlier detection, correlation among columns (e.g., one column is generally monotonic in the other), and integrity rule mining.

2. The tool will allow the ML developer to phrase expected behavior patterns (e.g., sales go up when price goes down), and consequently, to detect unexpected behavior in the resulting ML model, and to evaluate the compatibility of different ML models with the developer’s expected behavior.

The project will be co-supervised by a professor at Technion CS (Prof. Benny Kimelfeld), and a researcher at LogicBlox, Atlanta (Dr. Nikolaos Vasiloglou). The tool will be developed within one or more specific deployments of active customers of LogicBlox.

**Useful background/courses (not a formal requirement):** Machine Learning, Statistics, Databases, Logic, Artificial Intelligence, Web Design.

**Programming languages and development platforms:** c++ / python . Web UI design

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**PROJECT 13**

**Company:** LogicBlox

**Project title:** A Declarative System for Engineering Deep Learning

**Project field:** Machine Learning, Databases

**Supervisor:** Dr. Nikolaos Vasiloglou

Short description: Deep Learning (DL) is among the topics that arouse the most excitement in the computer-science community nowadays. The major benefit of DL is the ability to learn complex functions from a highly rich space of computations (neural networks). Consequently, DL is able to operate over basic, low-level details of information (raw features), and allows to avoid the tedious (and domain-specific) challenge of feature engineering. DL has been so far successful in a handful of domains, such as image recognition and natural language processing, where labeled data is abundant due to modern social and technological trends. Moreover,
modern hardware design, such as the GPU family, allow to conduct the heavy computation that DL training entails.

Engineering a task-specific solution using DL technologies requires expertise in neural networks, mastery of specialized libraries for linear algebra such as Signa and TensorFlow, and the transformation of data from the semantic database (e.g., people, reviews, words) into the algebraic representations of the libraries. The goal of this project is to drastically reduce the amount of engineering and the level of expertise required for building DL applications. In particular, in the project you will build the language and translation component for constructing neural networks over a logic-based database, namely LogicBlox (www.logicblox.com). As a result, developers will be presented with a uniform language for representing the database, query the data for raw features, building the network, and using the trained model for prediction. We will focus on some specific forms of DL (e.g., feed-forward networks for multi-classification), and some specific tasks from actual client engagements of LogicBlox.

**Required background:** Machine Learning

**Programming languages and development platforms:** c++ / python

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**PROJECT 14**

**Company:** Mellanox  
**Project title:** Record-breaking multi-threaded TCP performance  
**Project domain:** Network Processing  
**Supervisor:** Tal Gilboa

The purpose of this project is to set a new standard of expected TCP throughput from a single system.

**Goal 1:** Get 250Gb/s TCP throughput over a single CPU node.

**Goal 2:** Get 500Gb/s TCP throughput over dual CPU nodes.

In order to do so we would explore Intel’s CPU Cluster-On-Die configuration and learn how it may be used for solving shared resources issues. The project would also require deep learning of
Linux systems and the Linux kernel, networking drivers, chipset structure and networking devices.

**Project Description**: Processing TCP traffic involves heavy CPU processing and a lot of memory consumption. PCI devices in general and network devices in particular, interact with the system (CPU and memory) during the process of sending and receiving TCP traffic. Current tendency is to achieve highest performance over the physical CPU and memory structure, as exposed to the operating system. The physical CPU structure usually consists of cores clustered together in 1 or more clusters. Different levels of memory caches are shared between the cores, where higher cache levels are shared by more cores than lower cache levels.

**Programming Languages and Development Platform**:
- C as the basic programming language
- Linux kernel and user space

**Mostly suited for**: students with computer structure orientation and interest in networking.

**Required/Recommended knowledge**: Basic networking, basic computer structure, Linux systems, C language.

* The project won’t involve heavy coding, but would require deep dive into existing code and modifying it to support COD configuration.

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**PROJECT 15**

**Company**: Qualcomm

**Project title**: Concurrent Operating Systems - Linux and Zephyr

**Project domain**: Operating Systems, Internet of Things (IoT)

**Supervisor**: Constantine Elster

The DragonBoard™ 410c is a development board based on a Qualcomm® Snapdragon™ 400 series processor. It features advanced processing power, Wi-Fi, Bluetooth connectivity, and GPS, all packed into a board the size of a credit card. Based on the 4 core 64-bit capable Snapdragon 410E processor, the DragonBoard 410c is designed to support rapid software
development, education and prototyping, and is compliant with the 96Boards Consumer Edition specification. All this makes it ideal for enabling embedded computing and Internet of Things (IoT) products, including the next generation of robotics, cameras, medical devices, vending machines, smart buildings, digital signage, casino gaming consoles, and much more. DragonBoard 410c can run different Operating Systems, such as Android, Linux Debian, Linux OpenEmbedded, Ubuntu Snappy and Windows IoT.

In this particular project the students are requested to develop a hybrid Operating System configuration in which 3 of the CPU cores are running Linux OS and one of the cores is designated for Zephyr Operating System.

The requested goals

1. Bring up the SW development environment for DragonBoard 410c.
2. Implement core restriction so that Linux runs on 3 cores instead of 4.
3. Enable Zephyr Operating System on the 4th core.
4. Create a nice demo showing the concurrent execution of both Operating Systems.
5. Contribute the developed work to the open source community and DragonBoard 410c forums.

Additional Information:

- DragonBoard 410c - http://www.96boards.org/product/dragonboard410c/
- Zephyr Operating System - https://www.zephyrproject.org/

Development platform: Linux (Debian or OpenEmbedded) on DragonBoard 410c
Programming language: C/C++
Required background: Operating Systems, Linux User space and kernel programming

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**PROJECT 16**

**Company: Qualcomm**

**Project title: Internet of Things (IoT) - Drone Flight Manager Software on Linux**

**Project Domain:** Operating Systems, Internet of Things (IoT), Computer Communications

Page 21 of 30
Supervisor: Constantine Elster

Internet of Things is a new concept that defines that all human surroundings can be controlled and monitored through Internet Protocol. Few examples of IoT are always connected automobiles, wearable health monitors, autonomous vehicles and drones, autonomous and connected surveillance systems, baby monitors, connected to Internet homes with connected autonomous air conditioning, connected refrigerators and many more.

For such IoT use cases, the industry and academies are developing small low cost computers that can be embodied within such connected devices as their controllers, connectivity mechanisms and computation engines. One such example is DragonBoard 410c, a board with Qualcomm 4-core 410 processor, WiFi, Bluetooth, GPS, USB and other functionalities. DragonBoard 410c board runs Linux Ubuntu and Android OSes.

In this particular project, the students will develop a connected drone controller SW that runs on DragonBoard 410c with Linux Debian.

The requested goals:

1. Develop or port an existing open source SW for controlling drones to Linux Debian on DB410c.
2. UnitTest the flight Control SW.
3. Develop a communication protocol and smartphone application to monitor and control the drone from smartphone.
4. Demo the flight control mechanism.
5. Contribute the development to the open source community.

Additional (bonus) goals

1) Identify additional needed hardware to show case the development on a real drone.
2) Demo a real drone with DB410c and developed/ported SW.

Available information

1) Open Source flight control SW project ArduPilot (https://github.com/diydrones/ardupilot). Usually runs on Real Time OS NuttX.
2) DragonBoard 410c - https://www.96boards.org/products/ce/dragonboard410c/.
https://www.96boards.org/forum/products/dragonboard410c/

Development platform: Linux Debian on DB410c
Programming language: C/C++, Java

Required background: Operating Systems, Linux User space and kernel programming, Communication Protocols

PROJECT 17

Company: Rafael

Project title: Raspberry-Pi based high precision navigation system

Project domain: CPS – Cyber-Physical systems, Navigation, Real-time programming, Kernels

Supervisor: Tomer Hertz

Short description: The project is aimed to provide a high-accuracy navigation system based on low-cost computing environment, such as RPi, and high industry grade multi-axis inertial sensors connected over high-speed serial lines.

The students will have to evaluate, and modify if necessary, the RPi operating system kernel to meet the specific real-time requirements, allow for minimal latency communication with the sensors over standard communication channels and implement basic navigation algorithm based on data received from the sensors.

Required course:
- Operating Systems
- Concurrent and Distributed Programming

Programming languages and development platforms:
- Raspberry Pi
- Linux – Preemptive (RT-Patch)
- C / C++
PROJECT 18

_look at this!

משה הפרויקט:تطצל על זה!

עולמו של נח: יוהונתן גולדמן

(Prof. Yehonatan Goldman)

הAIMS: הנהיג ב_reserve אתreds חכמים לחם ל"רשת חברתית חזותית", ותתמודד עם

בפרוייקט נפתח אפליקציה לפלאפונים חכמים שתחיונית את הצפייה של "ראיה_KHRשית" ותחזה עוד

NSIndexPath תוכן

ראיה ממוחשבת

מנחה: יוהונתן גולדמן (Yehonatan Goldman)

Looking at this!

The project title: "Look at this!"

The team: Yehonatan Goldman

The aims: To develop an application for smart phones that will be the first step in creating a "content-based social network", and will address this need.

The application will allow users to send pictures, direct them to where to look, and mark them on their own camera image of the object that they choose to show them.

Requirements:

- Image processing and OCR

- Android background programming - Advantage

- High ability to use open-source software packages, such as OpenCV.

- Creativity, interest in computer vision and high ability to learn new topics.

- Background in computer vision, especially feature detector, descriptors, multiple view geometry - Advantage (086761, 046746, 086761).

Languages and platforms:

- Operating system android
- Code in C++
- And open source platforms.

For more information, please contact the lead developer:

Yehonatan Goldman (046200, 236327) – Home.

Rachel Ben-Arie – Team Lead.

The application will be tested on Android platforms using OpenCV and C++ libraries.

The project is developed by a team of computer vision experts and will be tested on a number of different platforms.

For more information, please contact the lead developer:

Yehonatan Goldman (046200, 236327) – Home.

Rachel Ben-Arie – Team Lead.

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For more information, please contact the lead developer:

Yehonatan Goldman (046200, 236327) – Home.

Rachel Ben-Arie – Team Lead.
**PROJECT 19**

**Company:** Shutterfly  
**Project title:** Face recognition evaluation framework  
**Project Domain:** Data mining  
**Supervisor:** Omer Geiger  

**Project Description:** Shutterfly provides its users with tools to simplify photo management experience. One of them is face recognition for all user photos. A customer may store hundreds of thousands of his photos in Shutterfly account. One way to simplify finding the right photo is automatic face recognition across the account. Developing such ability requires a framework which is a challenge by itself.

The outcome of this project is a framework that allows to simulate face recognition process on a user's account and to compare different scenarios and algorithms. Using this framework, several experiments will be conducted by the students to compare the performance of different algorithms and parameter configurations in terms of precision and recall.

**Programming Languages and Development Platform:**  
- Web technology, Php/python, AWS.  
- Face recognition algorithms

**Required experience:** Course in AI is an advantage

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**PROJECT 20**

**Company:** Shutterfly  
**Project title:** Testing framework simulating user account  
**Project Domain:** User interaction simulation, data mining  
**Supervisor:** Itzik Shabtay  

**Project Description:** Shutterfly suggests its customers a wide range of types of personalized photo products. Testing those products is a nontrivial task since most of the flow is user...
specific. One of the hardest challenges in testing customer experience is recreation the very specific concurrence of customer steps and backend processes that cause wrong system behavior. The goal of this project is to create a framework that allows simulating a large variety of user behaviors and recreating the sequence of events that caused an error. Specifically, it will create a wide range of photo collections from a photo set, create user accounts varying user answers during account creation, simulate different scenarios of photo upload, and simulate different user behavior as a response to events on the site. The goal of the tool will be also to narrow down the parameters that result in undesirable program behavior (not necessarily a crash).

**Programming Languages and Development Platform:** Web development.

**Required experience:** Course in AI is an advantage

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**PROJECT 21**

**Company:** Shutterfly

**Project name:** *Smart collection of mobile behavior info for experience personalization*

**Project Domain:** Data collection

**Supervisor:** Roman Sandler

**Project Description:** Every customer browses the site/application of retailer before purchasing. Some retailers use the history of such browsing to push additional products that seem to interest the customer. In physical world some retailers even make the customer pass those products before finding the product the customer is really looking for, hoping for impulse purchase.

In this project we intend to collect and A/B test browsing paths of users in mobile application. The goal is to summarize the browsing info into short, comparable string of items, train machine learning algorithm on it and optimize user experience. The resulting browsing path should be shorter than today, but let the user to consider all purchases he wants.

**Programming Languages and Development Platform:**
- Any method convenient to the students to proceed and summarize large amounts of data.
- Mobile development.

**PROJECT 22**

**Company:** Shutterfly  
**Project title:** Social media to photo product  
**Project Domain:** Mobile/Web programming  
**Supervisors:** Yohan Sabbah, Yoni Mor  
**Project Description:** Social media is very convenient for fast sharing of photos with friends and family, but not for creating the photo products (e.g. photobooks, greeting cards, etc.) from them. The task of this project is to connect to user's accounts in SM and suggest Shutterfly photo products based on images shared in specific event or a series of events. The main aspects of the projects are programming using SM and realizing the context of the share to choose the relevant products.

**Programming Languages and Development Platform:** Mobile or web development.

**PROJECT 23**

**Company:** Shutterfly  
**Project title:** Tinder for your photos  
**Project Domain:** User experience, Mobile App, Data Analysis  
**Supervisor:** Yoni Mor  
**Project Description:** Tinder app is famous for its "swipe" feature, allowing for fast filtering of photo series. In this project students will implement a Tinder-like interface for fast like/dislike selection of single images or image collages.

A possible extension of this project may be learning user's taste in photos and photo products; which is important for Shutterfly to simplify and enrich the photo product creation process. The desired result is learning the "liked" photos parameters, and generates collages adjusted to the learned user preferences.
Programming Languages and Development Platform: Mobile development

**PRIOJECT 24**

**Company name:** Medtronic (former GivenImaging)  
**Project name:** Detection of ulcers and erosions in the gastrointestinal tract from capsule endoscopy data using deep learning  
**Project field:** deep learning, machine learning, pattern classification, computer vision  
**Supervisor:** Dorit Baras  
**Short description:** PillCam Crohn’s is a disposable capsule that uses a miniaturized camera to visualize the small bowel. The data obtained from this procedure (capsule endoscopy) is widely used by doctors to detect and monitor abnormalities such as lesions, bleeding and ulcers. The purpose of the project is to develop a deep learning system that will automatically detect such abnormalities. This system should be able to identify suspicious images, classify the type of anomaly and localize or segment the anomaly area.

**Required course:** Introduction to machine learning (236756) OR computer vision (236873) OR equivalent courses (e.g., machine learning (046195))  
**Programming languages and development platforms:** python, tensorFlow, matlab

**PRIOJECT 25**

**Company name:** Medtronic (former GivenImaging)  
**Project name:** Deep learning for demosaicing of compressed capsule endoscopy images  
**Project field:** image processing, deep learning, machine learning  
**Supervisors:** Ofra Zinaty and Dorit Baras
Short description: PillCam colon is a disposable capsule that uses a miniaturized camera to visualize the colon. The data obtained from this procedure (capsule endoscopy) is widely used by doctors to detect and monitor abnormalities such as polyps, lesions, bleeding and ulcers.

The purpose of the project is to develop a deep learning system that will automatically perform demosaicing on compressed images of Bayer image sensor. Overall performance will also be evaluated with respect to known image quality measures.

Required course: Introduction to machine learning (236756), and preferably also Signal and image processing by Computer (236327) OR equivalent courses (e.g., Image processing and analysis (046200), machine learning (046195))

Programming languages and development platforms: python, tensorflow, matlab

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**PROJECT 26**

Company name: Medtronic

Project name: Identification and segmentation of the Colon Lumen in Wireless Capsule Endoscopy images

Project field: Computer vision, machine learning

Supervisor: Eyal Dekel

Project description: The Medtronic endoscopic capsule is swallowed by the patient and passes through the entire digestive tract, all the while capturing images and wirelessly transmitting them to a portable data recorder. Following the procedure a physician reviews the images, trying to detect various pathologies. One of the most prominent features in the Colon, the last part of the digestive tract, is its lumen – the open space within the intestine tube. Identification and segmentation of the Colon lumen in capsule endoscopy images have several potential benefits to the physician reviewing the procedure. First and foremost, it may assist in the detection of abnormal protrusions (polyps) from the Colon wall into the lumen, abnormalities that may become cancerous and need to be detected and removed. It may also...
give crucial information regarding the location of the capsule along the Colon, since different parts of the Colon have different lumen shapes. Finally, it may give information regarding the progress of the capsule along the Colon and its tissue coverage during the procedure. The project will be composed of two main parts – identifying images that show the lumen, and in those images – correctly segmenting the lumen. The students will be encouraged to explore state of the art machine learning, computer vision, classification and segmentation methods, ranging from “classical” machine learning methods to deep learning and convolutional neural networks.

**Required course pre-requisites:**

Introduction to machine learning (236756) OR computer vision (236873) OR equivalent courses (e.g., machine learning (046195))

**Programming languages and development platforms**

Python, TensorFlow, Matlab