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PROJECT 1

Company: IBM – Research

Project title: Collective Emotion Tracking

Project field: Machine learning on images

Supervisors: Lior Limonad and Valentin Dashinsky

Project description: This project is aimed to develop a prototype for the tracking of Crowd Emotions. This will consist of the assembly of the physical IoT instrumentation consisting of a webcam and a Raspberry Pi, and integrating these components with corresponding visual data analysis for real time data processing. Overall the work will include preliminary image processing for face recognition / extraction, followed by the development of emotional classification models. To enable such instruments, the work in the project will cater the following activities:

- Exploration of existing solutions models
- Formulation of requirements
- Prototyping and setup of the physical instrumentation setup (Raspberry Pi, webcam)
- Installation of relevant video processing runtime (Python/OpenCV/dlib)
- Development of an emotion classifier utilizing freely available data sources
- Deployment on the Raspberry Pi
- Integration with backend for data gathering and reporting

Solution testing and demonstration

Value to student: Gaining knowledge and hands-on experience with combining image processing and ML via realistic application development and the area of human emotions.

Value to the company: An opportunity to collaborate with talented CS students in an innovative field to test the viability of the proposed idea

Prerequisites:

- 236501 Introduction to A
- 236756 Introduction to ML (optional)

Programming languages: Python
Company: IBM

Project title: Control Protocols for Cloud Networks

Project field: Software Defined Network (SDN) for Cloud

Supervisors: Liran Schour, Katherine Barabash

Project description: In this project, students will explore the tradeoff between the declarative and the imperative network control protocols. The challenge is to quantify the pros and the cons of the two approaches and to identify the optimal design point for a specific use case. The work will be based on a widely used imperative open source network control system (OVN/OVS, details below). First, the students will modify the existing system to support a more declarative control plane protocol. Then, the students will use the existing simulation environment to perform a comparative evaluation between the two protocols. Guided by an experienced developer and open source contributor, students will create publishable results and contribute code to open source (stretch goal).

More details: Modern Cloud Networking relies on two important paradigms – Software Defined Network (SDN) and virtualization overlays. One of the major challenges is identifying the right level of abstraction for the network control protocol. On the one hand, with imperative control plane protocols, the SDN controller computes low level packet processing rules and dispatches these rules to every virtual switch (host/hypervisor). On the other hand, in declarative control plane protocols, the SDN controller communicates high level intentions to the virtual switches which generate their packet processing pipelines and populate them with packet processing rules. There are pros and cons to both approaches and the design space is not yet fully explored.

The project goal is comparing these two approaches, based on state-of-the-art Open Source SDN virtualization technology – OVN/OVS. OVS is a virtual programmable switch, while OVN is an overlay controller for OVS, both are part of the same open source project. OVN employs an imperative control plane protocol. OVN/OVS project also provides a simulation environment for testing and evaluating the solution in realistic cloud settings.

Value to the company: IBM cloud networking solution is based on SDN overlay networks. IBM Research team at Haifa is interested in continuous exploration of design alternatives. This project will yield thorough evaluation of important trade-offs, to be published and to inform control plane design decisions in the future.
Value to students: Exposure to leading cloud networking technologies; hands on experience with OVS and OVN; opportunity to contribute to a highly respected open source community; opportunity to create a publishable result to be included in developer conference talk (e.g. ovscon).

Prerequisites:

- Introduction to Systems
- Programming, Operating Systems
- Introduction to Computer Networks

Development platform and tools: Linux, git, OVS, OVN, Linux containers.

Programming languages: C and Python.
**PROJECT 3**

**Company:** IBM Research – Haifa Lab

**Project title:** Real time 3D scanning using mobile devices (iPhone / Android)

**Project field:** Computer Vision, Augmented Reality

**Supervisor:** Yochay Tzur

**Project description:** Recent advances in mobile devices open a wide range of applications which were considered impossible not long ago. Specifically, ARKit (iOS, Apple) and ARCore (Android, Google) are new SDKs that provide accurate estimation of the device’s motion in space, based on the fusion of video (SLAM) and motion sensors (VIO). Using the live motion estimation, Augmented Reality applications show virtual content that seems to be naturally embedded into the physical world.

Additional valuable data, which is currently not provided by these SDKs, is a dense, colorful 3D model of the environment. Such model can be used for gaming, Virtual Reality, content creation for AR and 3D printing. Therefore, a real-time generation of such model is very important.

In this project the students will define and implement an algorithm for real-time reconstruction of 3D model from video. The algorithm will be developed and tested on PC, and will be deployed to one of the mobile platforms.
**Value for students:** The students will gain experience in the field of 3D computer vision, which is highly requested by companies working on robotics, autonomous driving and drones. And - they will end up with a cool 3D-scanning app that can be demonstrated on their personal mobile devices!

**Value for the company:** The algorithm will be incorporated into IBM offering of AR for Enterprises, for generating 3D models of assets in a simple way.

**Required course pre-requisites:** Image Processing, 3D knowledge (Computer Vision/graphics)

**Programming languages and development platforms:** C++
**PROJECT 4**

**Company:** Intel

**Project title:** CPU power tracing through memory architecture

**Project field:** CPU power tracing

**Supervisors:** Arik Gihon (אריק גיחון), Eylon Toledano (אילון טולדנו)

**Project description:** CPU tracing has major importance when deciding on architectural changes, it is a real challenge to decide how and what should be traced and architect’s input mostly consist CPU traces. Our department- CPU power architecture has major responsibility and influence on Intel’s product and therefore CPU tracing is very valued.

The project’s goal is to plan and implement a way to trace power components and transitions of the CPU to a hidden memory segment. Implementation should contain windows OS driver that connects to the CPU’s internal interface and enables high speed data flow to a hidden memory segment.

After the goal is reached, it will be used as a new tracing solution in Intel and provide new functionality to Intel's tracing solutions and finally contribute to architectural decisions all around the world.

**Value for the company:** New and useful tracing solution to CPU power architecture.

**Value for student:** Large scale traces solution planning, windows OS driver writing, CPU power architecture learning.

**Required course pre-requisites:**
- 234123 Operating Systems
- 236267 Computer Architecture (Advantage)

**Programming languages and development platforms:** C/C++
Visual Studio 2012
Company: Intel

Project title: Autonomous wheel chair

Project field: Networking, Navigation, Image processing, machine learning

Supervisor: Haim Rochberger

Project description: The purpose of this project is to help wheelchair disabled people with additional limited hands movement to operate the wheelchair to point-of-interests (POI) within defined indoor locations (like airport, shopping mall, etc.). Upon entry to such building (exp. Airport), the system shall automatically download a DB with a list of POIs and routes within that facility.

The solution should allow the user to view on a tablet screen the list of POIs, and select one.

Once selected, the wheelchair autonomously and safely navigates to that POI (user can stop it at any time – similar to cruise control).

Note that the solution must consider dynamic obstacles and wheelchair heading angles

High level architecture of a solution (for indoor and outdoor):

Value to the company: For the company it provides help to needed in the society, and promote use of Realsense camera and Intel indoor location solution.

Value to students: For the student it provides learning on realtime system and develops applications for Windows/Linux + Android/IOS

Required course pre-requisites:

- Programing languages
- System programing
- Algorithms
- Internet networking
- SW design
- Robotics

**Programming languages and development platforms:**
- C#/Java
- Android or IOS
- Arduino
- ROS
Company: Qualcomm Israel

Project title: Aligning depth information with image sensor

Project field: Signal/image processing, computer vision

Supervisor: Tomer Livneh

Project Description: Depth sensing/measurement is an enabler of advanced Digital photography applications and VR\AR\XR applications. Having a high quality depth estimation of a scene is a key to generating high quality solutions. More and more smartphones use a dedicated depth sensor to “generate a 3D model” of the scene.

One of the problems is how to align the depth information coming from one sensor with the image coming from another.

In this project you will need to understand the underlying (ideal) geometric model of digital cameras and depth sensors, the limitations it has and its errors compared to real life and to come up with a solution that projects depth information to the camera.

You’ll work with state of the art sensors and design a solution that may find its way to premium smartphones.

Value to the company: Support a new feature that is required by our clients.

Value to student: Learn and experience with digital imaging, image processing and computer vision.

Required course pre-requisites:

- 236860 Digital Image Processing
- 236861 Geometric Computer Vision or 236873 Computer Vision

Programming languages and development platforms: Open but probably one or more of the following: Python, MATLAB, C++
Company: J.P. Morgan

Project title: K8Proxy for Algo-trading Data Framework

Project field: Cloud computing

Supervisor: Tamer Ghattas

Project description: Our trading data framework allows building efficient event-driven applications for algorithmic trading, simulations, backtesting, signal generation, calibration, and the like. At the core of this framework is a propagating graph, where nodes are tasks acquiring trading data from various market feeds. Each node receives multiple time series as input and multiplexes the data to its multi subscribes. K8Proxy will add on a Kubernetes service layer that manages these nodes in a scalable manner.

Value to the company: Utilizing cloud based technology to improve scalability and performance of an existing system. This system currently provides ubiquitous access to financial market data

Value to students: Implement scalable Kubernetes service with real time financial market data.

Prerequisites: Data structures, Operating systems

Programming languages and development platforms: Linux, Python
Company: PTC

Project title: 3D map evolution

Project field: Computer Vision/Computer Graphics.

Supervisors: Eldad Finkelstein, Mordecai Sayag

Project description: with the changes, there’s a need to update the 3D model. In large scale scenes rescanning of the entire scene can be expensive and time consuming. In this project we want to make the process more efficient, by scanning the evolved portions only and fuse them to base the 3D model. Extra goals: filling holes, expanding the model. In the research we will use recognition and positioning techniques to align the 3D models as well as 3D reconstruction and mesh processing techniques for merging the models.

Value to the company: PTC is a leader in 3D modeling of products and their digital twins. 3D space digitization would be an attractive expansion to be used in design stage or design review stage (VR).

Value to student: The project will be based on state-of-the-art techniques in the field of 3D objects recognition and mesh processing and supervised by a computer vision Technion MSc student.

Required course pre-requisites: Computer Vision 236873

Programming languages and development platforms: C++, OpenCV/PCL.
**Company:** PTC

**Project title:** Cross platform visual positioning service

**Project field:** Computer Vision.

**Supervisors:** Eldad Finkelstein, Mordecai Sayag

**Project description:** Location based services provide varying ranges of accuracy and confidence level of that accuracy depending on the technology. Using integrated/attached omnidirectional cameras (360 cameras) on variety of mobile platforms we wish to create a visual localization service. The first part is creating the mapping capability (**SLAM**) by capturing the scene using an omnidirectional camera and exporting the map to a point cloud with descriptors for each point. The student will extract real-time feature points from a video stream to reconstruct the map.

The second part is using the map for localization using supported devices by matching visual references of the SLAM and current view, by extracting feature points and locating a strong reference in the feature map.

![Omnidirectional camera](https://resources.samsungdevelopers.com/Gear_VR_and_Gear_360/Gear_360)

**Value to the company:** PTC is a leader in IoT and AR in manufacturing space and interested in adding location awareness capabilities to support some of the AR use-cases.

**Value to student:** The project will be based on state-of-the-art techniques in the field of SLAM and supervised by a computer vision Technion MSc student.

**Required course pre-requisites:** Computer Vision 236873

**Programming languages and development platforms:** Android, C++, OpenCV/PCL.

[https://resources.samsungdevelopers.com/Gear_VR_and_Gear_360/Gear_360](https://resources.samsungdevelopers.com/Gear_VR_and_Gear_360/Gear_360)
Company: Rafael

Project title: Cyber-Trainer

Project field: Cyber, Web

Supervisors: Roei Goldblat, Moshe Pinto

Project description:

In the framework of the project, the students will develop a tool designed to train developers in developing secure applications (Secure Application) that do not contain cyber vulnerabilities.

The tool will enable developers to perform checks and deal with vulnerabilities in the code. In each test, a piece of code with a different type of vulnerability will be presented, and the developer will need to find the line(s) containing the vulnerability and choose the correct way to deal with it from the options presented.

During the project, the students will build a repository of at least 50 vulnerabilities and their solutions. The tool will allow adding and removing pieces of code and extend the test with additional vulnerabilities.

The repository will be divided into categories of technologies (C++, Java, etc.) and difficulty levels. The tool will be developed in the Web technology and run in a browser including a server to record the test results in a log.

Programming languages and development platforms: Web & C++
**PROJECT 11**

**Company:** TSG IT Advanced Systems Ltd.

**Project title:** Technion Disaster Response Services Platform

**Project field:** Disaster Resilience, distributed systems, Cloud platforms

**Supervisors:** Eran Reuveni, Gilad Sharoni

**Project description:** The Students project goal is to design The Technion Disaster Response Services Platform that can manage information flow and basic transactions between all stakeholders: rescue forces, municipal agents, private sector & community members during disaster response. The platform will be designed to support the following common disaster response activities such as:

- Disaster allocation & expected spreading area mapping service
- Transportation network damage allocation service
- Disaster area population assessment service
- Smart Planner Disaster Evacuation planning service
- Evacuation execution service

The platform will be designed to be integrated with Technion Smart Backbone, existing digital environment, as to enable all required data exchange.

**Value to the company:** TSG develops smart city, Smart transportation, and Disaster response & Emergency events management systems. The design of this Very Large Scale Interconnected Complex Systems is most challenging engineering discipline that is going to be part of the next decade development of municipal systems & emergency managements systems & public services solutions.

**Value to students:** Students will have a unique opportunity to confront the challenge of the design of large-scale distributed systems. More specifically, the students will investigate several architectural schemes and recommend on "optimal architecture" based on existing cloud processing tools: Cluster Resource Management (Apache: YARN, Mesos, Kubernetes) Distributed File System (Cassandra, Apache: HDFS, Hbase, Accumulo), Distributed Processing Engines (Hadoop: Map/Reduce, Spark, Storm, Solr, Flink), Serverless Computing (FaaS– Apache OpenWhisk, PyWren ) Distributed Message Broker (Pub/Sub) or Message Queue (ZeroMQ, Netty, Apache: Kafka, ActiveMQ, RPC/RMI – REST, WS, gRPC), Protocol Buffers (Apache: Thrift, Avro) Meta-data and Synchronization (Apache ZooKeeper, etc

**Prerequisites:** 236351 קורס מערכות מבוזרות
**Company:** TSG IT Advanced Systems Ltd.

**Project title:** Technion Transportation Mobility Cloud Service Platform

**Project field:** MaaS: Mobility as a Service, distributed systems, Cloud platforms

**Supervisors:** Eran Reuveni, Gilad Sharoni

**Project Description:**

MaaS - Mobility as a Service platforms let users plan and book door-to-door trips using a single app, answering the question of how best to get individual users where they’re going based on real-time conditions throughout the network, taking account of all the possible options and each user’s own preferences (for example, time and convenience versus cost).

The student task is to design & demonstrate Technion Transportation Mobility Cloud Platform that will support various mobility services consumed by Technion academic personnel, students, employees, & visitors. The platform will be designed as MaaS- Mobility as a Service cloud-based platform that supports multi-modal transportation services: personal cars, public transit, ridesharing, bikesharing, bicycles, pedestrians, mass transit systems and city infrastructure, including parking. The platform will be integrated with Technion Smart Backbone, existing digital environment, as to enable all required mobility data exchange.

Also, the students will design, basic Technion Users Mobility Services web-based Application that will be integrated with Technion Transportation Mobility Cloud platform

**Value to the company:** TSG develops smart city, Smart transportation large scale integrated systems solutions. The design of Smart Mobility service platform is complex challenge as the MaaS platform needs to be integrated with other municipal systems & emergency managements systems & others.

**Value to students:** Students will have a unique opportunity to confront the challenge of the design of large-scale distributed systems. More specifically, the students will investigate several architectural schemes and recommend on "optimal architecture" based on existing cloud processing tools: Cluster Resource Management (Apache: YARN, Mesos, Kubernetes) Distributed File System (Cassandra, Apache: HDFS, Hbase, Accumulo), Distributed Processing Engines (Hadoop: Map/Reduce, Spark, Storm, Solr, Flink), Serverless Computing (FaaS— Apache OpenWhisk, PyWren ) Distributed Message Broker (Pub/Sub) or Message Queue (ZeroMQ, Netty, Apache: Kafka, ActiveMQ, RPC/RMI – REST, WS, gRPC), Protocol Buffers (Apache: Thrift, Avro) Meta-data and Synchronization (Apache ZooKeeper, etc.)

**Prerequisites:** 236351
Company: Yotpo

Project title: Detecting Reviews in Social Media

Project field: NLP, Machine Learning, Big Data

Supervisors: Yoni Yedidia, Jonathan Yaniv

Yotpo provides online stores (e.g., Steve Madden) with solutions for commerce marketing. One of the most important sources of marketing for stores are customer reviews, since reviews play a significant role when customers purchase online, and are also a valuable source of feedback for the store.

Currently, stores collect reviews through Yotpo by contacting their shoppers via email and asking them to submit a review for products they've purchased. However, many posts on social media (facebook, twitter, instagram) also qualify as store reviews. In order to extract reviews from social media, one must distinguish between the posts that classify as reviews, and those who do not.

In this project, you will develop a system that detects whether a social media post qualifies as a review or not. The project will consist of two major parts:

1. Build and train a model that classifies social media posts as being review or non-review, using modern NLP and deep learning techniques.
2. Write a process that extracts posts from social media networks (for example, tweets using the Twitter API) given a hashtag identifier of a store (e.g., #SteveMadden), and applies the model to detect posts that classify as reviews for the store.

Value to the company: Yotpo will be able to provide online stores with an additional stream of customer reviews that currently are not offered by competitors. In addition, these reviews could be analyzed using our Yotpo Insights engine to extract customer opinions from social media.

Value to the student: the students will conduct research in the field of Natural Language Processing (NLP) on a problem that can make a significant impact to Yotpo’s core business. In addition, the students will gain experience in developing machine learning solutions that are designed for production environments.

Recommended background:

- Intro. to Machine Learning (236756) or Intro. to AI (236501) - Required
• Intro. to NLP (236299) or Advanced topics in Deep Learning (236606) - Big advantage
• Object Oriented Programming (236703) - Advantage

**Programming languages and development platforms:** Python (Keras/Pytorch, Tensorflow/Theano, NLTK, Gensim, Spacy), Spark (specifically, pyspark)
Company: Yotpo
Project title: MetorikkuWeb - A Web Application for Creating Big Data Flows
Project field: Web development, Big Data Development
Supervisors: Ofir Ventura, Jonathan Yaniv

Project description: Nowadays, nearly every part of an organization relies on data. Software developers, product managers, analysts - even marketing teams - must develop data processes to support their workflows. Yet, there is a non-trivial learning curve for working with big data technologies, such as writing distributed processing jobs or managing computing clusters to execute these jobs.

To that end, we developed Metorikku - an open-source library that simplifies the creation and execution of big data flows (ETLs) on top of Apache Spark. Through Metorikku, any user can define data flows by writing a few YAML files that describe each step of the data flow, and execute them using the standalone Metorikku library. While this makes big data development more approachable to non-data developers, our goal is to make it even simpler.

In this project, you will develop a web application for creating data flows on top of Metorikku. Through the web application, users will be able to create, manage, test & deploy complex data processing jobs. The backend side of the application will need to integrate with several types of databases and execute big data flows on top of Metorikku.

Value to the company: The Metorikku web application will have an immediate effect on many teams within Yotpo. It will allow us to decentralize the creation of big data processes from the data engineers, as the Metorikku web application would be used widely within the company. Moreover, the web application will be a significant contribution to our open-source initiatives.

Value to the student: The students will gain experience in numerous modern web & big data technologies. Moreover, the web application developed by the students will be integrated into an open-source project that will affect many organizations.

Recommended background:
- Object Oriented Programming (236703) - Required
- Database Management Systems (236363) - Required
• Concurrent and Distributed Programming (236370) - Advantage
• Advanced Topics in Distributed Systems (236251) – Advantage
• Background in web development - Advantage

Programming languages and development platforms:
• Backend - Ruby, GoLang, NodeJS
• Frontend - HTML5, CSS, Javascript, JQuery
• Big Data - Spark, Hadoop, SQL
**Company:** Shutterfly  
**Project title:** Landmark Recognition with Deep Learning  
**Project field:** Deep learning, LSTM  
**Supervisors:** Nir Aides, Ron Maurer, Nitsan Pri-Hadash  

**Project description:** Shutterfly as a business is constantly searching for ways to provide its users with the best photo-based products (e.g., Photobook, Poster, Coffee Mug, Pillow). The ultimate goal is to offer each user the right products with the right photos in the right context at the right time.

A great timing to offer products to our customers is just after they have returned from a trip. A common problem for our trip detection algorithm is that many photos are missing geolocation information. Recognizing popular landmarks using only photos pixel-data will enable us to detect trips and offer relevant products to our customers even in the absence of geolocation tags.

In this project the students will:

- Explore options for deep-learning algorithms to geolocate pictures:
  - CNN, LSTM, other architectures.
  - Publically available datasets.
- Given an existing LSTM Disney detector, try to retrain it and extend it to detect other popular tourist attractions.
**Value to the company:** Exploration of state-of-the-art deep learning capabilities applicable to improving Shutterfly’s product offering.

**Value to students:** Hands on experience in developing modern deep-learning solutions for a predominant family of problems in the field of computer vision / image understanding.

**Pre-requisites:**
- Python
- Some experience with image processing and analysis
- Advantage: Knowledge or experience with Machine learning and deep learning in particular (or strong drive to learn through hands-on experience)

**Programming languages and development platforms:**
- Python
- Deep learning frameworks (e.g., PyTorch)