Cristian Simionescu SE Project Ideas

Proposing an original project idea is highly appreciated.

For the more promising projects a 250$ (negotiable) fund for hardware, cloud compute power, or software purchases will be allocated. This is offered in order to create an MVP, POC, or Prototype (depending on the project). This will be given typically only to the most practical and useful projects. The projects with a "*" in their title are susceptible to receiving these resources, the other projects on this list or others proposed by students can also be eligible if a compelling case for funding and usefulness is argued.

To make use of this fund each team leader must create a detailed list of expenses and argue for their necessity which they must correlate with the other leads to fit into the budget. The final list of expenses will be presented and negotiated before being approved or denied.

All purchases will be performed by me and I will forward the goods to the teams. In cases where the products/services are still usable after the project is finished, they will be returned so that they can be reused by other students.

Misuse of any funds or products is to result in a major point penalty for the whole team.

In cases of successful projects which have market potential, I will try to assist the team to participate in start-up competitions and accelerators or to find funding sources for them.

For Deep Learning research projects I will work closely with the team to provide guidance and assistance as well as GPU/storage training hardware.

Bachelor Projects

1. Smart Parking Lot*

Advanced

A smart parking solution is needed which can detect occupied/free parking spots in a parking lot. The users can access this information through a web and mobile application.

Heuristically making multiple rounds around a location to find a free parking spot is a time, fuel, and energy waste for each driver when looking for a parking spot, this also causes additional traffic congestion to every traffic participant which reduces the effectiveness of whole cities and increases pollution.

The project consists of:

- Create cheap prototype hardware for detecting occupied/free parking spots and transmitting this raw information to a centralized server. This work can be outsourced to students in the DSFUM course but it will influence the total amount of points the project can receive;
- Process the data received from the sensors to clean up the data and identify if the spot is occupied or not;
- Use this curated data in a mobile and web application to show the availability status of the parking lot to the users;
- Suggest parking spots to users which are on their way to that parking lot based on proximity to the parking lot entrance or other factors such as shade;
- Allow users to automatically “reserve” parking spots as they are getting close to the parking lot and the other users should see that parking space as such. This should be done through the mobile app based on GPS location;
- Have the possibility to register multiple parking lots in the application such that the user can see the parking availability in multiple locations in the city;
- Using the Google Maps API, the user can set a destination and the application will search for the nearest available parking space and reserve it when the user is approaching it;

For ease of testing, the faculty parking lot could be used for the MVP/POF/Prototype.

Links:

1. Sensors list https://www.thegeekpub.com/wiki/list-of-arduino-sensors-and-modules/
2. https://www.soracom.io/products/air/

2. EU Open Data (Smart Booking)*

Easy, Intermediate, Advanced - depends on the level of complexity

Using the EU Open Data platform, choose some datasets to aggregate data from to help users create a more detailed and informed decision regarding their holiday locations or real estate properties. For example, the solution can include a browser plugin that operates when browsing on https://www.booking.com. When the user hovers over a potential accommodation the plugin will show a "product" sheet of information regarding air, water, street, audio pollution levels for that location, data that can be taken from this dataset, and others. Similarly, the same tool can be adapted to work for real estate.

In addition to useful tools such as these, the project must include a website where a user can visualize the data in an informative way (for example heatmaps for pollution levels across Europe).

There is no given template to what datasets to use and what applications to create with them, the example above was simply demonstrative. Using multiple datasets, interesting data aggregations, and creating useful applications/tools will result in a larger amount of points assigned to the project.

In the context of the COVID19 pandemic, aggregating information about the current status of the region/country location. Information such as the rate of infection in the area, current traveling restrictions or laws enforced, such as mandatory mask mandates, travel bans, vaccination requirements. In addition it would be useful to scrape the active measures taken by the hotel to limit the risk of infection, do they impose a specific disinfection procedure, do they limit the number of clients in their restaurant, do they close their pool/spa facilities, etc.

Links:

1. EU Open Data Platform http://data.europa.eu/euodp/en/data/
2. Groups of interest:
    a. Environment
    b. Health
    c. International issues
    d. Justice, the legal system, and public safety

3. Smart House Builder*

Intermediate - Advanced

Drawing inspiration from https://pcpartpicker.com/, this application is desired to help a person discover and configure devices for a smart home setup. The app should help users to find devices, IoT or otherwise, which fulfill their needs based on a given budget, home layout, and other criteria.

- The application should make it easy to find devices for a particular functionality. For example, I want to look for devices used for window sensors so I click on the appropriate category and I see a list of devices that satisfy the requirements as well as present other specifications and prices from popular online shops;
- The application should have a “Create setup” wizard:
  - The user can configure his apartment/house/room’s layout, where doors, windows, plans, power plugs, and other relevant elements are situated;
  - After this step the user can start adding devices from various categories and describe where he wishes to place them;
  - The user can see a price estimation for individual items as well as the whole build which is calculated using the real price of the items if they were bought from popular stores such as Amazon, Newegg, or others;
  - As the user adds devices to his setup/build, the application should inform him if various components he has selected have compatibility issues;
  - The application should make suggestions or issue warnings for various scenarios. For example, I should receive a suggestion that I have windows where I did not place sensors for. Or I should receive a warning that a smart lightbulb I selected doesn’t have enough power for the room size I placed it in, etc.
- The application should make it possible to share, view, and discuss other people’s setup’s which were created on the site;
- The application can facilitate users to post, view, and discuss various guides and reviews regarding various topics, such as: “How to set up Alexa to open the garage door when you are close to home”, “Samsung SmartLed review, is it worth it?”, “How to automatically adjust the color of your lights based on the daily local weather” etc.
- The application can suggest entire builds. After the user describes the layout of his home, sets a budget, and selects/deselects certain features he desires (for example a user might not be interested in smart locks for his doors), the application will try and compose a setup that is within budget and can fill out as much of the desired functionality as possible;

Links:

1. https://pcpartpicker.com/
2. https://affiliate-program.amazon.com/

3. Already existing domain name: http://smartbuildup.com/

4. Social Media Aggregate

Easy

Create a web or desktop application that will serve as a proxy to multiple social media platforms.

- The user can post content to multiple platforms at once, must include at least 4 of the following, more platforms are welcomed and even desired:
  - Facebook
  - Instagram
  - Twitter
  - Tumblr
  - Linkedin
  - Snapchat
- The user can view the stats of their post on the various platforms such as likes, comments, and shares;
- The user can respond to comments on various platforms directly from the application;
- In addition to the main application, a chrome plugin can be created which will activate on social media websites. When the user tries to post content on one of the sites the plugin will offer the functionality of automatically posting the same content on the other selected platforms;

5. Automated Packing Robot

Easy, Intermediate, Advanced - depends on the level of complexity

Consider the problem of shipping packages. Create an application which, given a set of boxes that need to be delivered, a fleet of delivery cars that have certain dimensions and capacities and the destinations of each package, create an application that will automate the entire decision process:

- Choosing how to place the packages in the car such that they fit, the car can carry it, and the boxes don't get damaged by the weight of the packages above it;
- Knowing a car's list of destinations, generate instructions regarding the order in which the car should be loaded such that they can be taken out in the order they are delivered, for example, you shouldn't have to get a package from the other end of the car when delivering to the first client;
- Knowing the delivery items, destinations and cars, generate the paths each car should take in order to fulfill their orders, consider optimizing the amount of fuel required to

complete each path. For this, you can consider the length of the path, the fuel consumption of each car, and the weight it is carrying along the way;

- Create visual interfaces that would allow delivery workers to easily digest the information, from a 3D render of how the car should be loaded to an app for the driver to know the path and what package should be delivered at each destination;

6. Uber for Electric Car Charging*

Intermediate

Taking inspiration from Uber and other peer-to-peer business models, create an application where users can register electric car charging locations from their homes or businesses to be used by electric car owners transparently and simply.

- If a user has a charging port at their home or place of business they can register their resources on the application, describing the types of charging it offers, the price per kWh they are demanding, other services offered at their location (coffee, phone charging, etc.)
- An electric car owner can use the app to find charging locations near him. Integrating Google Maps to take him to that destination;
- Users who registered their charging station can get paid directly through the application, just as owners can pay directly through the application to these registered stations;
- Users can input their car model, battery capacity, current charge status, and a destination using Google Maps. The application can create a route to the user’s destination adding stops along the way for charging, taking into account the charging rate of the stations used, range of the car between stations, price of charging. The charging stations will be chosen from users which registered their station in the system as well as other known external stations e.g: E.ON/Kaufland;

7. Fiscal Documents EDI API*

Intermediate - Advanced

A platform to which fiscal documents, such as invoices and receipts, can be uploaded and imported through an API. The platform should define a standardized data representation for the data. The same platform must facilitate back-office developers with an API to download documents issued for a given business directly in their solution.

The application will facilitate the communication between back-office solutions to directly send and receive documents necessary for the bookkeeping and accounting of their business partners.

Currently, companies have to depend on man-hours of manual data entry and are exposed to risks such as loss of the original documents or human errors while inputting the data with serious legal and financial implications.

The application should also make it possible to visualize statistics and various metrics for each business.

Take the following scenario:

1. A software development company buys a batch of laptops for its employees;
2. The hardware store's back-office automatically uploads the corresponding invoice on to the platform where only themselves and the buyer can access it;
3. The client can access the online application to view the documents that are addressed to its company;
4. The back-office solution of the client will automatically download and import the documents, removing the need for manual intervention.

Further functionalities can be added. Specialized OCR mobile/web/desktop application for fiscal documents to be processed directly into the platform. Since not all businesses will implement the API, this serves as a quick way of uploading a picture/PDF of the document and have it processed as needed. A separate API for banks to automatically upload transaction history for a firm such that the firm's ERP can import bank transactions directly from the platform.

8. Bureaucracy Hacks

Intermediate - Advanced

Create an application that makes it easy to find information regarding various Romanian governmental institutions.
The main functionality of the application will be the ease of figuring out what documents are required for various tasks and processes. For example the list of documents and taxes needed to issue a police record.

The application should also contain accurate information regarding the operating hours of the institution. Users should be able to add their experienced waiting time using that to calculate an average waiting time so that other users can make a more informed decision when going to an institution.

The other critical functionality for the application would be to analyze the document requirements for a certain bureaucratic process and identify where a user can get it.

Using google maps, when a user selects a certain task they have to get done, the application creates a route for them to take to various institutions or copy centers in order to acquire all necessary documents, using the estimated wait time, a user can estimate the amount of time it will take to finish everything or if they can only partially complete the task.
For example:
A user selects that he desires to issue a police record, the application will identify that the user needs to create a photocopy of their ID, buy 2 stamps from a post-office, fill out a request form and bring their original ID. From this the application will find the fastest route that includes a post-office, copy center, and police station, it will also warn the user that he is required to have his ID on him, and that he would need to pay a total of 40 RON, and that the algorithm estimates the process will take a total of 2 hours.

Users should also be able to comment on various tasks/processes/institutions such that they can warn other users of mistakes in the information presented in the application, gather feedback to then forward the institution's management, or share certain useful information such as closest parking spots. The POC is accepted to be designed only for the city of Iasi.

9. Tepes.AI

Intermediate - Advanced

Create an anti-corruption tool for journalists and informed citizens. The tool will consist of a website that crawls, analyzes, and generates visual profiles for public servants. This tool does not have any political affiliation or angle, fighting corruption is an ethical stance not a political one. Some directions:

- crawl and extract information about public servants and politicians in Romania
- extract information regarding professional relationships between people (e.g. X is boss of Y), connections between them (X is the brother of Y), and their institutions
- using public information such as wealth statements, interest statements, public CV's, automatically identify suspicious activity such as unjustified assets, income, or positions of power not justified by their academic or professional careers
- visualize them and compare them based on ranks, income, and spending
- find outliers - people with too many connections, big differences between income and spending, etc.
- make meta-analysis about public institutions to identify the public services/goods at most risk from corruption

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Master Projects

1. Social Media Post Impact Prediction*

Intermediate

Using machine learning algorithms implement a social media post-impact predictor. Given the desired image, the neural network must predict the expected number of “likes” or reactions that the post will generate. Extend the application to also use the description to more accurately predict the post-impact.

The application can then be further extended so that the user feeds it a list of photos and the algorithm will pick the best one of them and can even suggest a post description to maximize its results. A deep learning approach is recommended.

2. Music Generation*

Advanced

Listen to this first: https://jukebox.openai.com/?song=787888438
Generate music using Artificial Neural Networks. Attempt to reuse a GPT style architecture to generate song lyrics, specialize in at least one music style. Using the generated lyrics, next generate the instrumental and vocals of the song with a GAN model, similar to the OpenAI Jukebox project. Attempt to use the Image GPT idea for melody generation.

- https://openai.com/blog/jukebox/
- https://jukebox.openai.com/
- https://towardsdatascience.com/gpt-3-primer-67bc2d821a00
- https://openai.com/blog/image-gpt/
- https://github.com/teddykoker/image-gpt
- https://benanne.github.io/2020/03/24/audio-generation.html
- https://analyticsindiamag.com/top-8-pre-trained-nlp-models-developers-must-know/
- https://towardsdatascience.com/t5-text-to-text-transfer-transformer-643f89e8905e

3. MitoEM Challenge*

Advanced

Apply advanced self-supervised training techniques and architectures to obtain state-of-the-art segmentation results on a medical imaging task.

The task of this challenge is to make instance segmentations on a large-scale 3D mitochondria dataset. This dataset was obtained from mammalian tissue, introducing new challenging tasks, such as, separate multiple mitochondria instances when they are entangled with each other or identify mitochondria-on-a-string (MOAS) instances, which are prone to false split errors due to the voxel-level thin connection.

- https://mitoem.grand-challenge.org/MitoEM/
- https://zudi-lin.github.io/pytorch_connectomics/build/html/tutorials/mitoem.html
- https://donglaiw.github.io/page/mitoEM/index.html
- https://biomedicalimaging.org/2021/

4. AI Outfit Shopping Assistant*

Intermediate - Advanced

Consider online clothes shopping. Taking an input image of a model proceeding a set of apparel items (shirt, pants, shoes, etc.) try to find the exact item's listing on online shops such as AboutYou, H&M, Zara, Fashiondays, Amazon. Even if the exact items can't be identified, suggest the closest clothes that match the ones in the picture. Integrate this tool in a chrome-plugin/website/mobile app, so that users can easily interact with it. The core use scenario is the following: a user browsing sites such as Pinterest/Instagram and finds a model wearing an outfit they are interested in buying themselves they can input the image in the system and get a set of links to the closest matches of the items found (for all the types of apparel found in the image: hats, shirts, dresses, pants, shoes). A deep learning approach is recommended.

5. Renewable energy investment calculator*

Intermediate - Advanced

Consider open geographical data, such as known air current patterns and land features. (such as hills, forests, etc.)

For a given patch of land, using information such as known sun exposure around the year, elevation, angle of the terrain, wind strength, calculate the profitability of renewable energy solutions to be installed.

Automatically analyze world map data to identify good prospective locations to expand green energy efforts. The algorithms must accurately take into consideration all factors which will impact the real efficiency of either solar panels or wind turbine installations, such as the angle of the terrain, the elevation, periods in the year with poor weather, etc.

The system can be expanded to also include real-estate data to integrate the price of lands and green energy solution prices to calculate return on investment (ROI) for purchasing a plot of land and installing the optimal green energy generation system. This way the system can automatically suggest profitable green energy opportunities to investors or governments to help accelerate the world's transition to sustainable energy.

- LP DAAC - Release of NASADEM Data Products
- Elevation – Polar Geospatial Center
- Free GIS Datasets - Categorised List
- Earthdata Search
- Mapdwell
- Solar Power | Open Energy Information
- Photovoltaic Geographical Information System (PVGIS) | EU Science Hub
- Global Solar Atlas
- Global Solar Atlas Romania
- bopen/elevation: Python script to download global terrain digital elevation models, SRTM 30m DEM and SRTM 90m DEM.
- Centralizatoare
- Property Prices
- Copernicus Land Monitoring Service - EU-DEM — European Environment Agency
- 5 Free Historical Imagery Viewers to Leap Back in the Past - GIS Geography
- World Development Indicators | Kaggle