Machine Learning and its applicability to Tourism and the BODAH Project

Department of Computer Science,
Munster Technological University

Ted Scully (ted.scully@mtu.ie)

Profile: Ted Scully – MTU

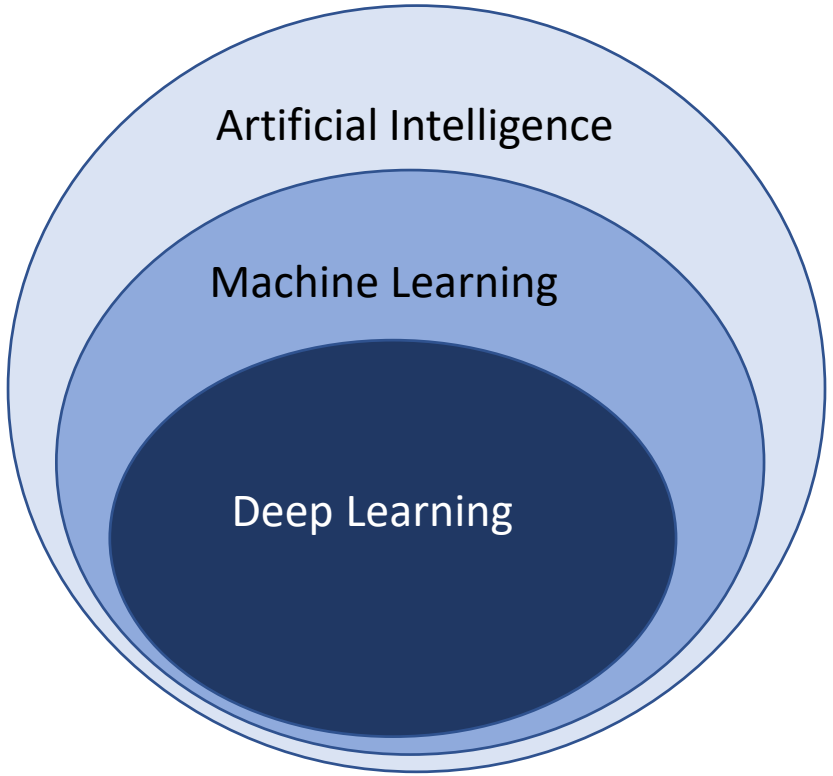
- Senior Lecturer in the Department of Computer Science
  - Principal Investigator in the Ríomh Research Group
  - Associate Investigator with SFI CONNECT
  - Director of the full time MSc in Artificial Intelligence
  - Irish government's advisory group on High-Performance Computing (HPC)

- AI Research and Development Experience
  - Machine Learning (Classification and Regression)
  - Deep Learning (Image Classification, GANs, Compressed Models)
  - Meta-heuristic optimization (Evolutionary, PSO and Ant Colony)

Overview

- Introduction
- **Brief overview of AI/Machine Learning**
- Case Study – BODAH Pilot Site Blackrock Castle Observatory
- Future Work and Challenges

What is AI / Machine Learning/ Deep Learning

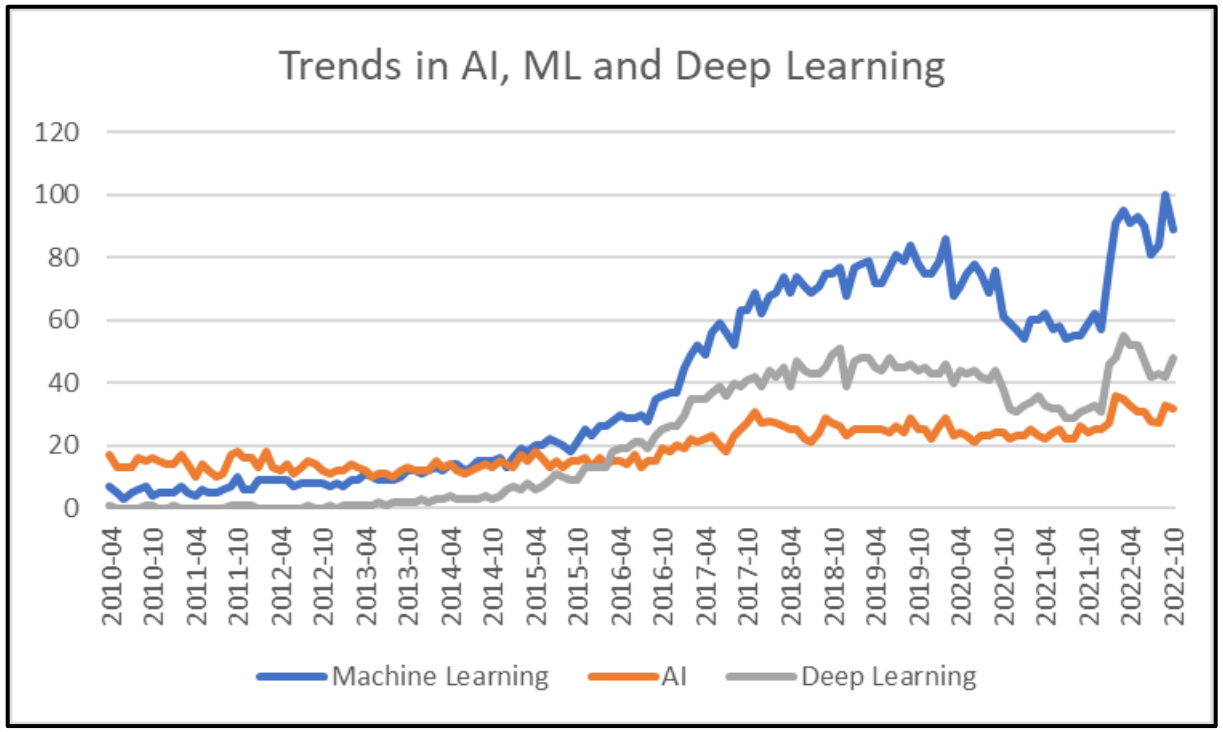


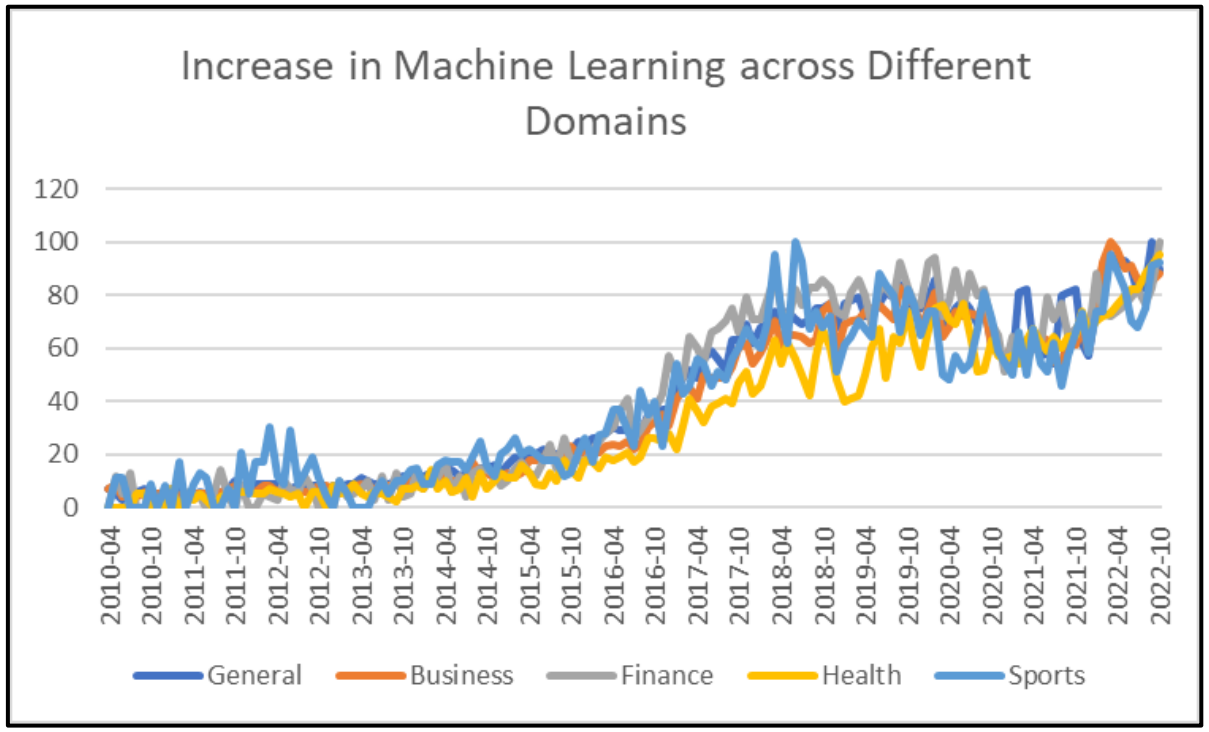
"Artificial Intelligence" typically refers to software that attempts to replicate human level abilities such as cognitive functions, learning and problem-solving.

- Machine Learning is an important subfield of AI and is primary focused on building predictive models.
- Deep Learning is a subfield of ML that focused on the area of artificial neural networks.

  - Recognize faces?
  - Identify objects in images
  - Interpret hand-written text
  - Interpreting spoken language?

What is AI, Machine Learning and Deep Learning





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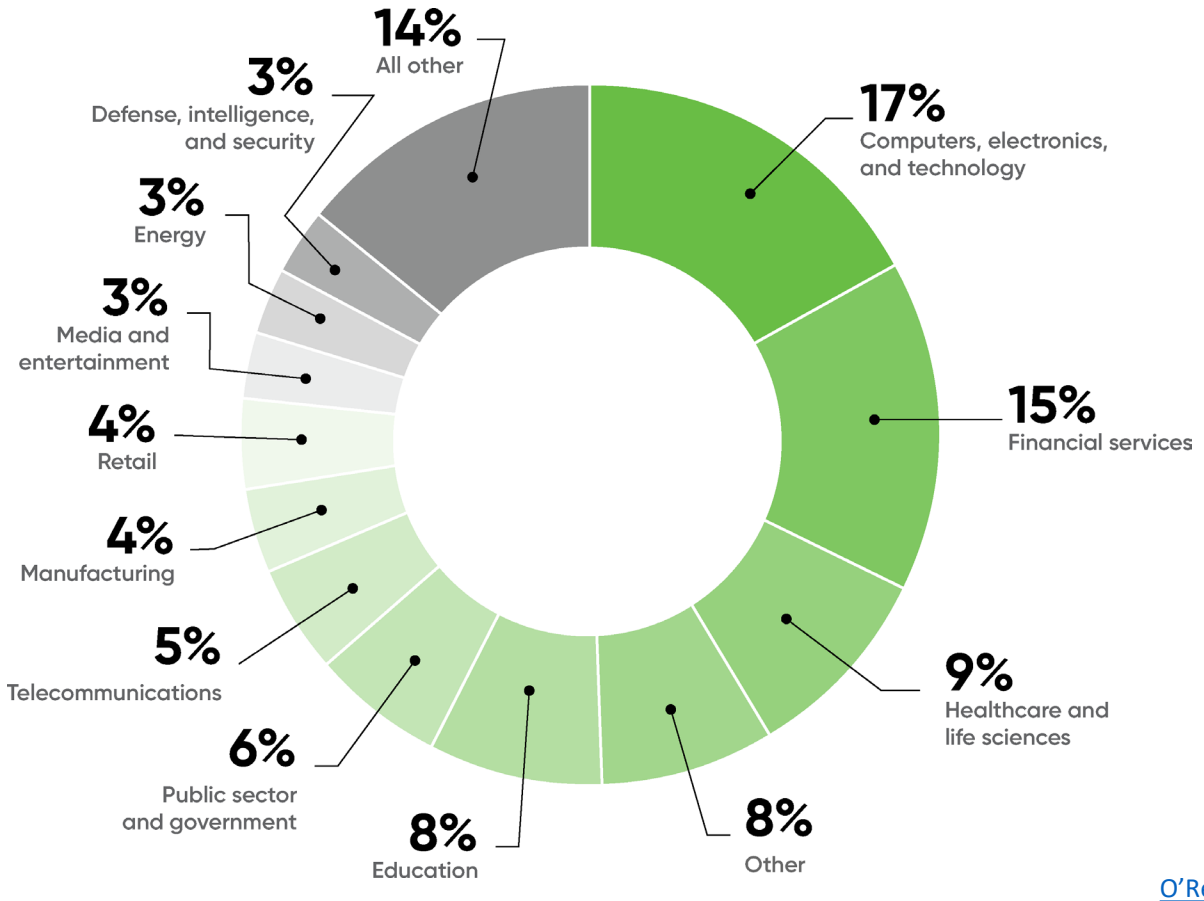
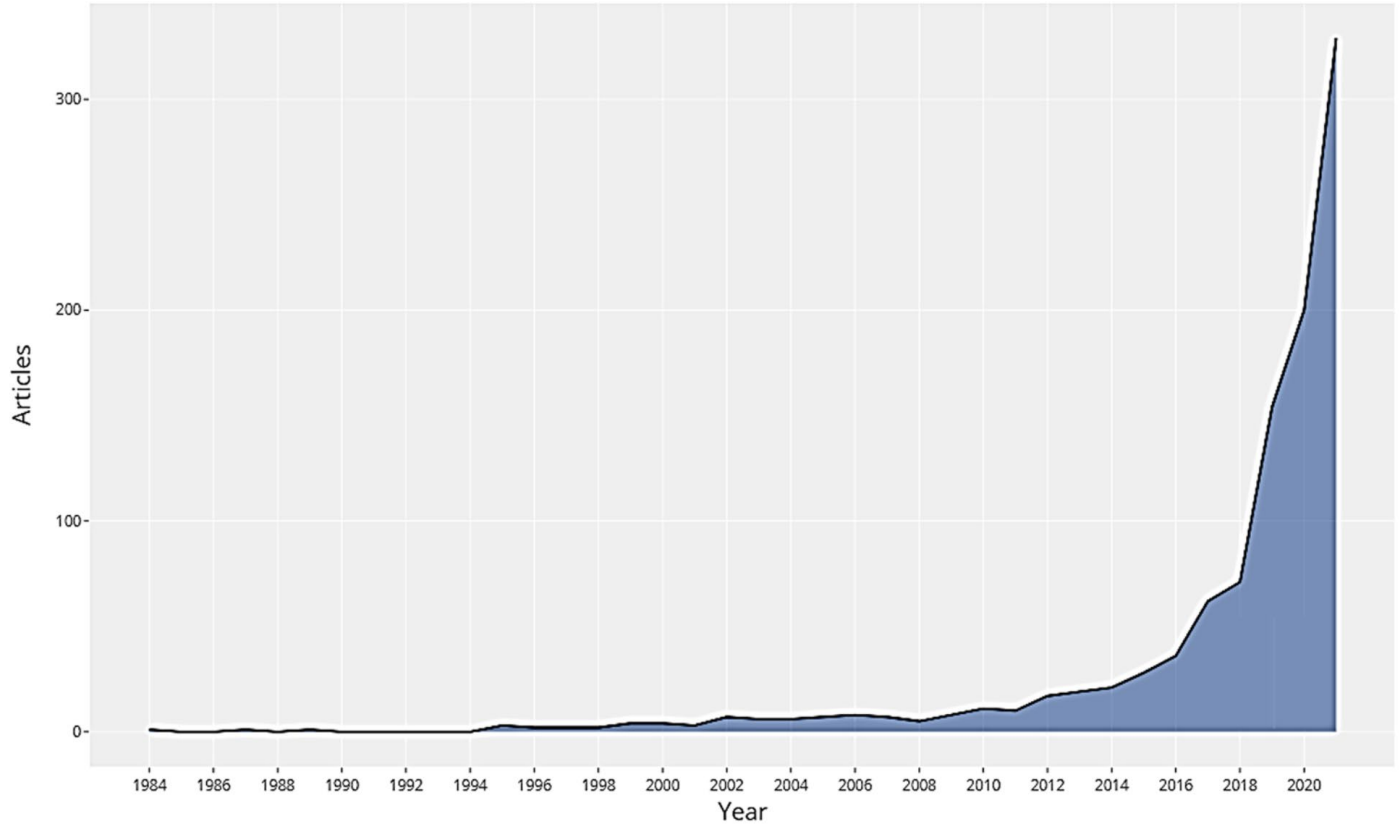


O'Reilly AI Industry Survey 2021

Machine Learning in Tourism

- The graph on the right shows the distribution of publications per year between 1984 and 2021 on the topic of AI in tourism and hospitality.

- **More than half** of the manuscripts depicted in the graph have been published in **2021 and 2020** (529 articles), and only 16 manuscripts were published before 2000.



M. Knani, S. Echchakoui, R. Ladhari. Artificial intelligence in tourism and hospitality: Bibliometric analysis and research agenda. International Journal of Hospitality Management 2022

Machine Learning in Tourism

- AI/ML can provide a **better tourism experience** by providing tourists with more relevant information and better decision-making capability and it can be used to improve many aspects of **tourism management** [1].

- Personalization and Recommender Systems:
  - **Point of interest** recommendations for tourists (using social media posts).
  - **Personalized booking systems** through user profiling
  - Personalized search rankings for users
  - **Smart pricing** (using machine learning to predict the probability of bookings at various price points),
  - Ranking user reviews based on relevance (for example Air B&B rank user reviews based on their relevance to the accommodation and not the location and amenities).
  - **Personalized route recommendations**, etc.

Machine Learning in Tourism

- Forecasting: Can be used to support marketing or management decision-making for the tourism industry.
  - Prediction of tourist arrivals to city destinations, specific heritage sites, **hotel occupancy** and **tourist flows**.
  - Also important is the incorporation of online data for forecasting models to aid these predictions (this varies from social media reviews from multiple sources to Google trends, online reviews twitter etc).

- Language Translations Applications: Language barriers can prevent tourists from fully exploring an area and culture.
  - Machine translation techniques can be used by tourists (to better navigate the area and **discover products, services and sites**) and management/marketing companies to obtain **wider feedback** on the visitor experience.

Machine Learning in Tourism

- Chatbots: A chatbot is software program that engages with users in a natural language. Gartner predict that by 2025, 85 percent of customers will connect to companies without a human.
  - Hotels or other tourism companies have chatbots on social media or instant messaging applications.
  - **Voice-based chatbots** are designed to answer consumer questions, such as ordering food services, taxi services, setting alarms, room services, housekeeping services, etc.

- Robotics: Semi-autonomous physical robots that includes AI and sense the environment.
  - Can be used for security monitoring in hotel settings (robots monitor and gather environmental information such as sounds, high-definition video footage and license plate) . Such robots aim to **supplement hotel staff** with human-like visual and audio capabilities.
  - Robotics in restaurants that monitor customer arrive.
  - Facilitate automatic check in and check out facilities at hotels.

Overview of Machine Learning

- *Machine learning (ML) provides a means by which programs can **infer new knowledge** from **observational data**.*

f1	f2	f3	f4	...	fn	target

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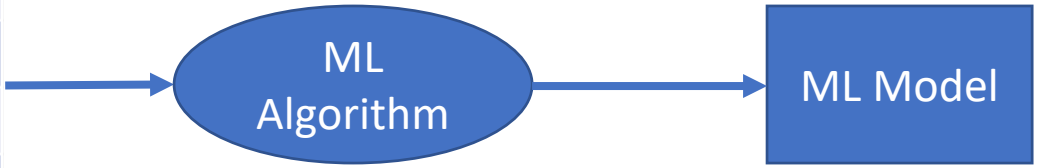
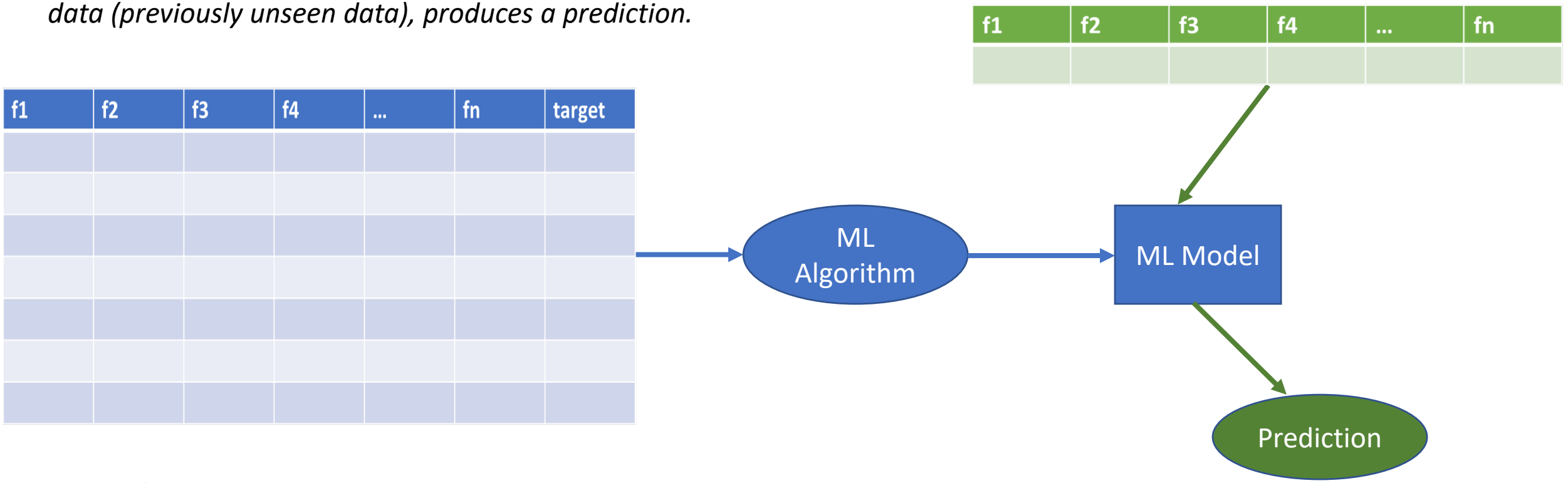


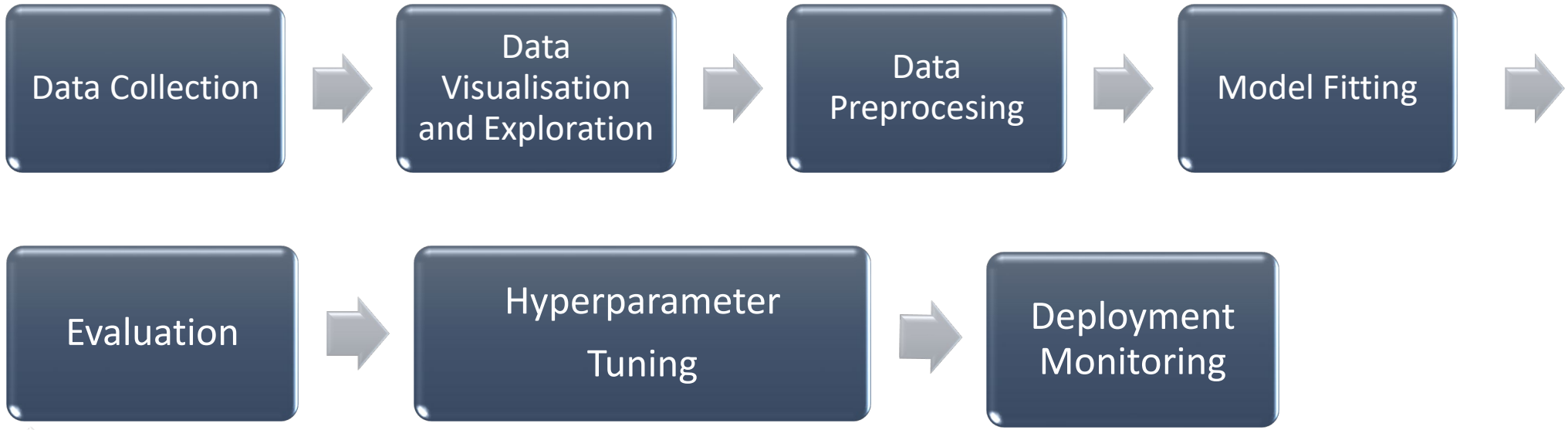
Overview of Machine Learning

- *An ML algorithm creates a predictive model that, when fed with new data (previously unseen data), produces a prediction.*

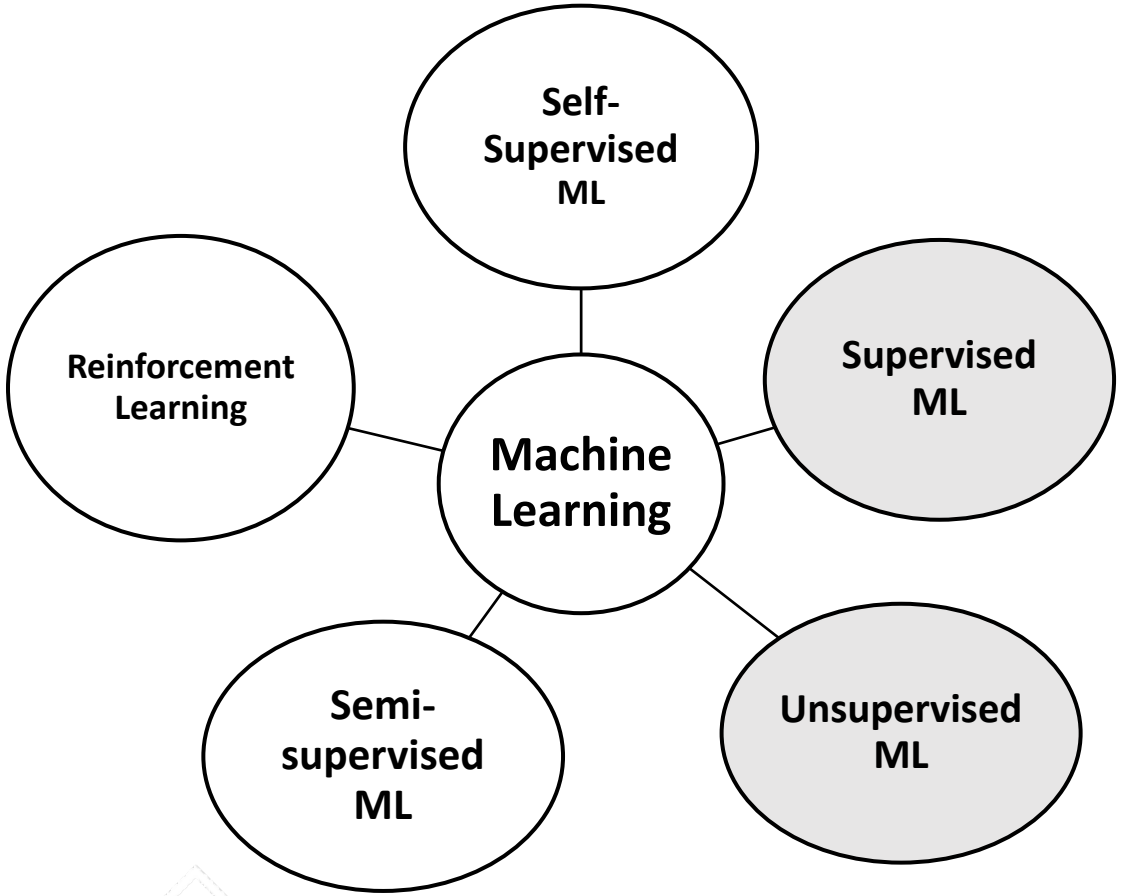


Overview of Machine Learning

- The high-level diagram we illustrate on the previous slide is a gross **simplification** of the ML process.
- The ML process is complex stretching from data collection and storage to hyper-parameter tuning and deployment and monitoring. The diagram below doesn't capture the iterative process between data preparation, model fitting, hyperparameter tuning, and model evaluation takes place



Categories of Machine Learning



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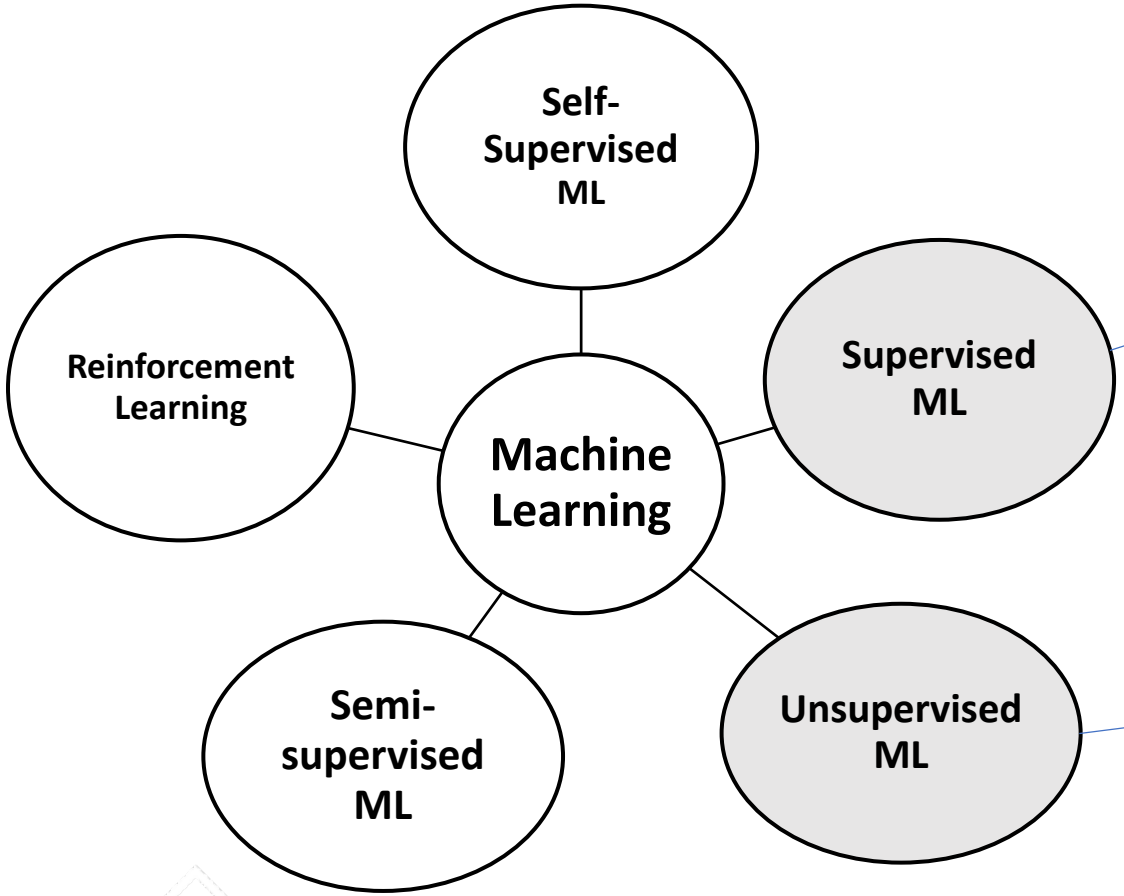

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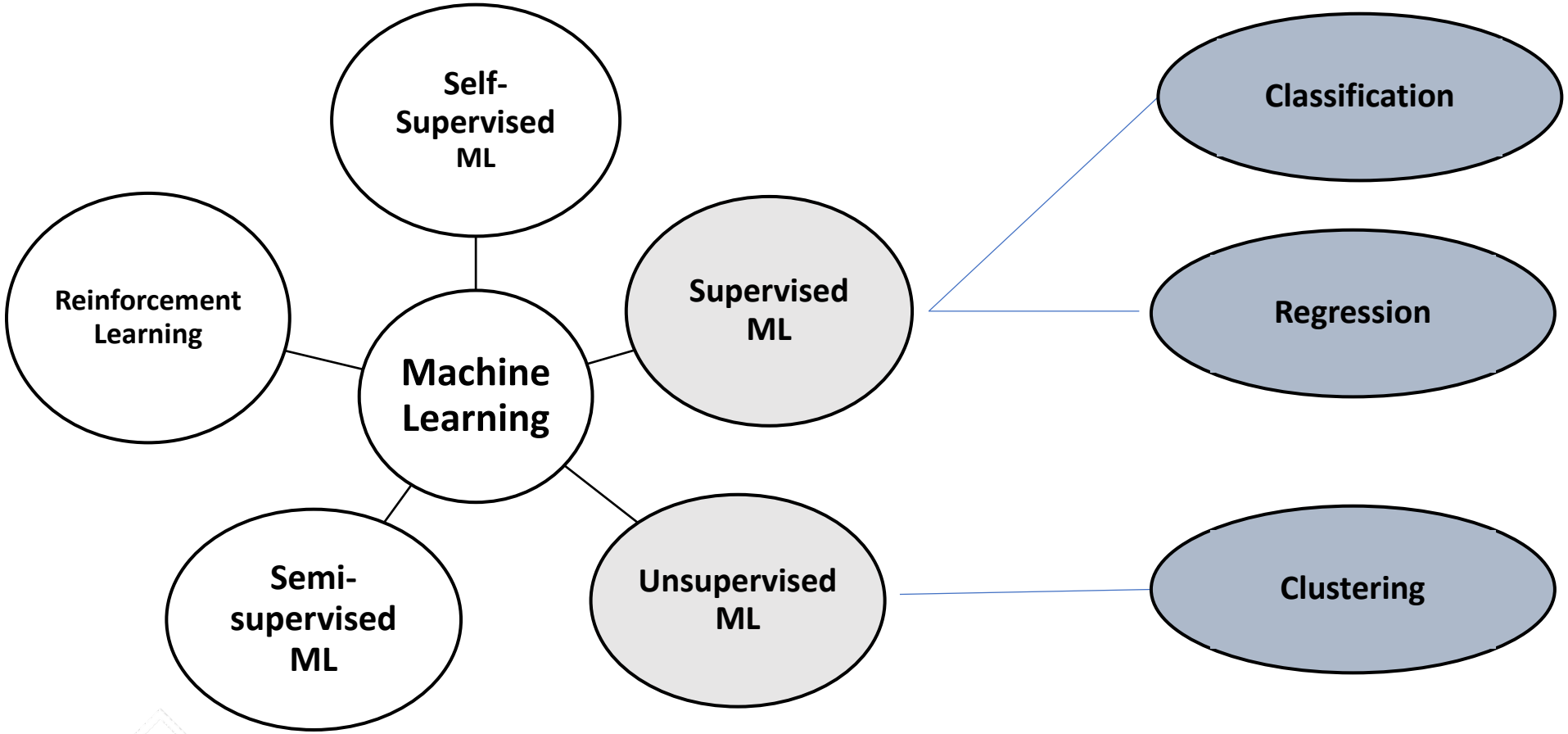

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- Future Work and Challenges

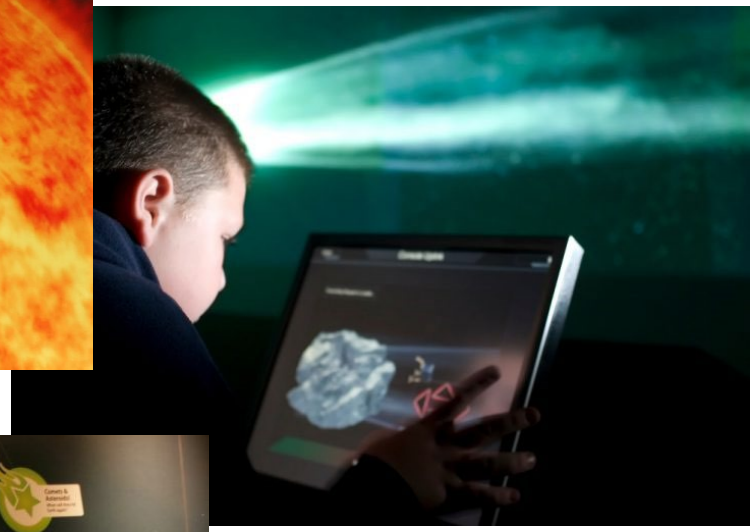
Blackrock Castle Observatory

The MTU pilot site is Blackrock Castle Observatory. It's a castle built in **1604**, on the banks of the River Lee at Cork harbor.

The castle currently houses a functioning observatory and is home an award-winning **visitor centre**.

The annual average number of visitors to the castle is normally in excess of **25000** per annum.

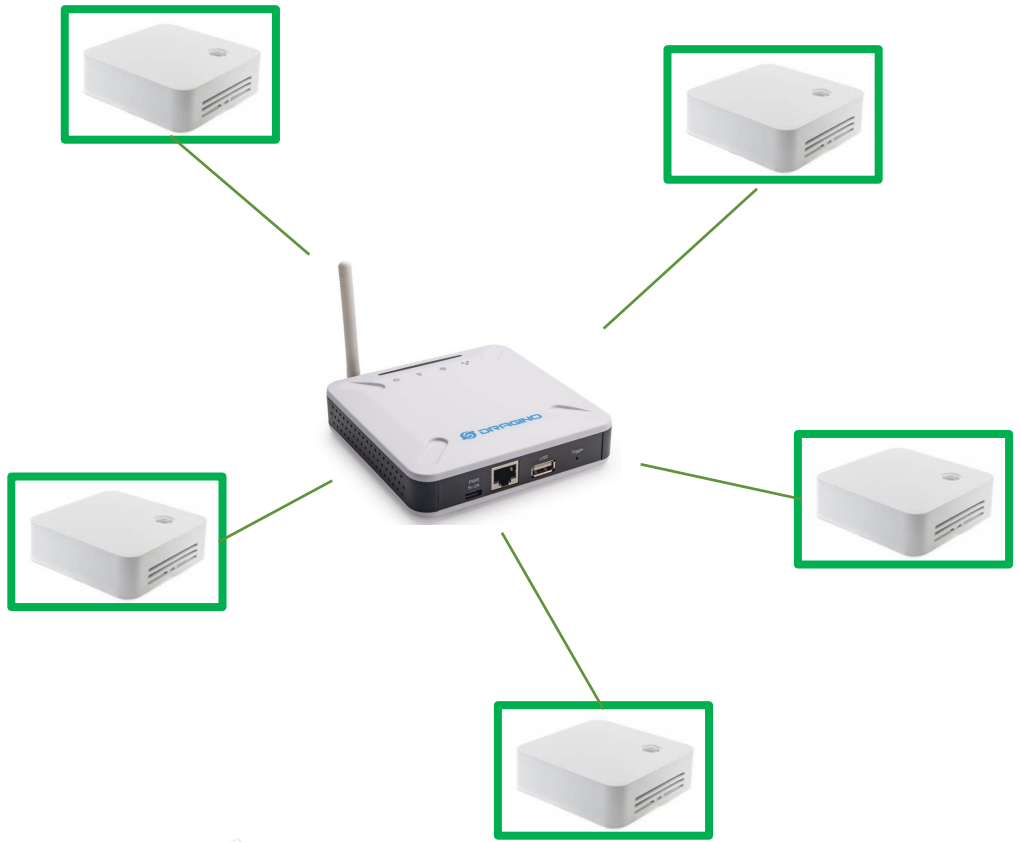
Blackrock Castle Observatory



The visitor centre aims to teach visitors about science and the universe.

Exhibitions range from details about the constellations in the night sky, to the planets in the solar system to the composition of comets.

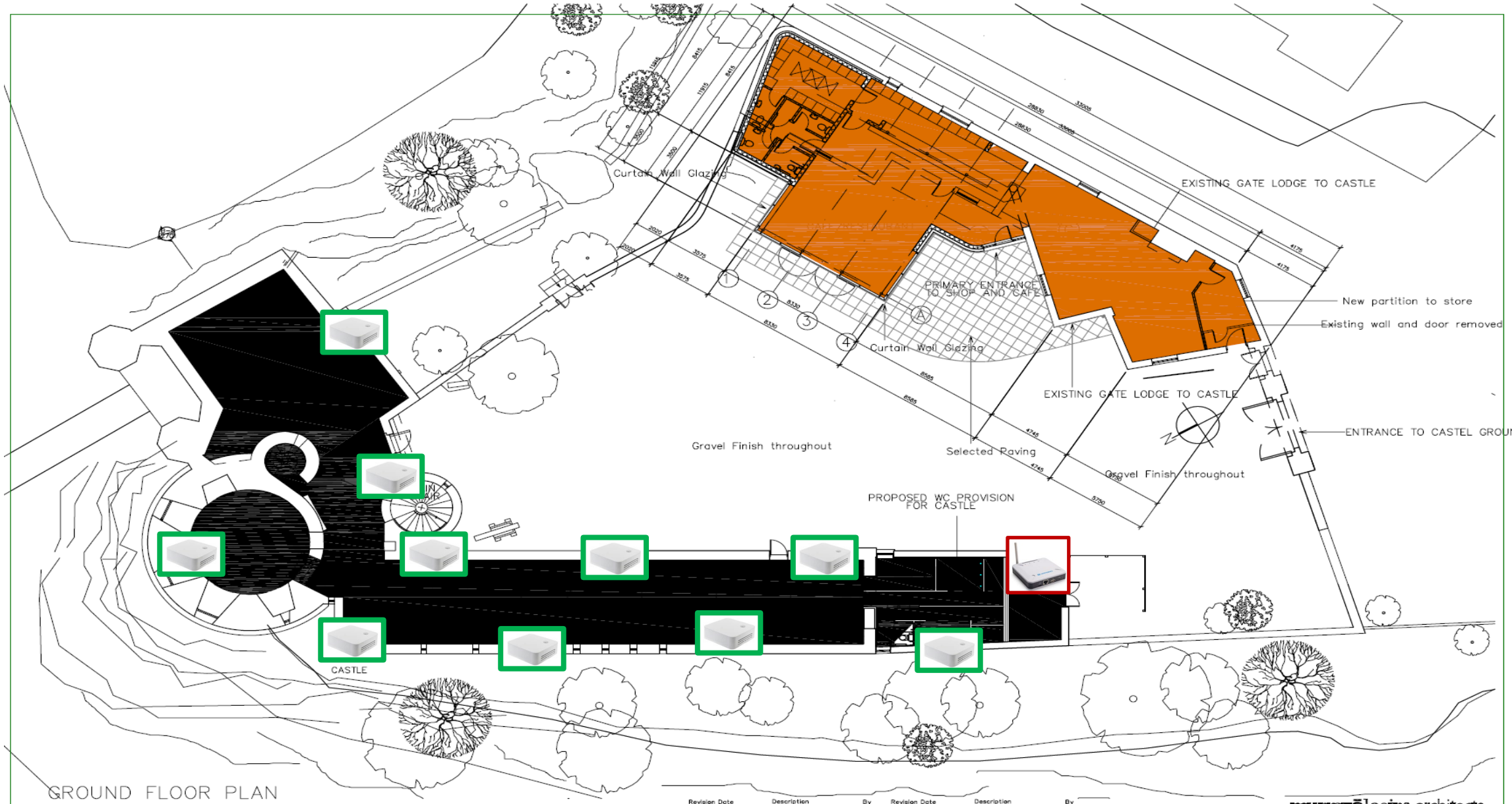
Blackrock Castle Observatory



As part of the BODAH project we deployed a LoRaWAN wireless sensor network on the ground floor of the castle .

LoRaWAN is low power, wide area networking protocol.

These sensors collect and transmit data points such as location, temperature, humidity as well as sound and motion-related data.



GROUND FLOOR PLAN

NOTES / LEGEND

NEW WORK SUBJECT TO THIS APPLICATION

PROPOSED NEW EXTENSION AND WORKS TO EXISTING GATE LODGE

OUTLINE SPECIFICATION FOR NEW EXTENSION TO GATE LODGE:

EXTERNAL WALLS: 'Cedar' Timber cladding to North & West elevations
Walls retained as indicated to existing Gate Lodge Building

INTERNAL WALLS: 100mm concrete blockwork partitions
Walls retained as indicated to existing Gate Lodge Building

GLAZING: Selected PVF finish aluminium curtain walling glazing and clerestorey glazing to 'dining' space as indicated

ROOFS: Standing seam metal roofing over 'dining' space.
Flat membrane roof from existing Gate Lodge over shop area and stores etc.

WINDOWS & DOORS: Double glazed aluminium windows and doors to match curtain walling

RAINWATER GOODS: All rainwater goods, incl downpipes, to be pressed metal, to selected colour.

Revision	Date	Description	By
00	14.01.04	PLANNING PERMISSION ISSUE	MM

Drawing Status: PLANNING PERMISSION

Reply Address:
Victoria House, No.1 Victoria Road Cork, Ireland.
Telephone +353 21 427 1634
Fax +353 21 427 1548
e-mail: mail@murrayolaire.com

General Notes
- DO NOT SCALE. USE FIGURED DIMENSIONS ONLY.
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS AND DRAWINGS.
- ALL DIMENSIONS TO BE CHECKED ON SITE.
- IN THE EVENT OF ANY DISCREPANCIES BETWEEN DRAWINGS THE CONTRACTOR IS TO INFORM THE ARCHITECT IMMEDIATELY.

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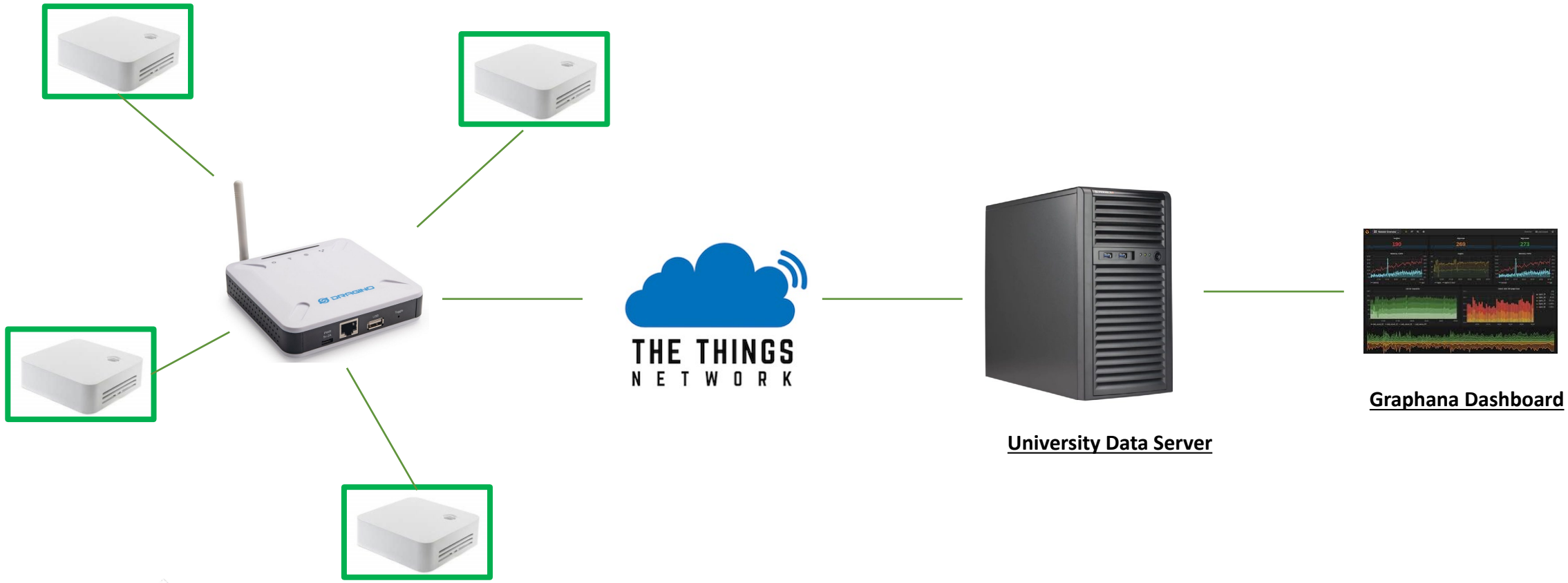
Client: CORK CITY COUNCIL
Project: BLACKROCK CASTLE
Drawing: XXXXXX GROUND FLOOR PLAN XXXXX
Date: JANUARY 2004
Scale: 1: 500
Drawn: MD XXX Plot Check: XX
Stage: 2
Dwg No.: 02085
Rev.: 2002 00
Approved:

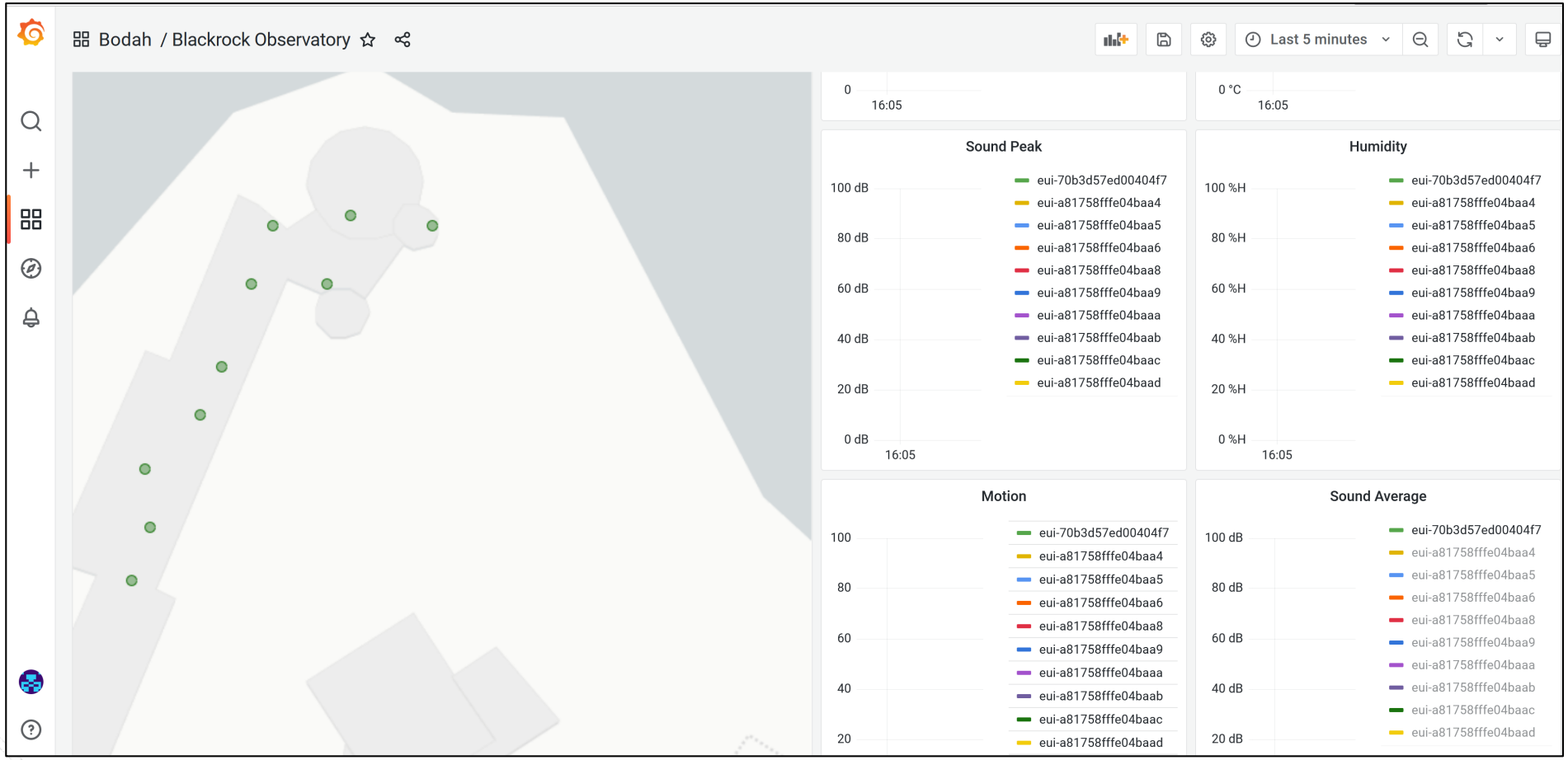
Blackrock Castle Observatory



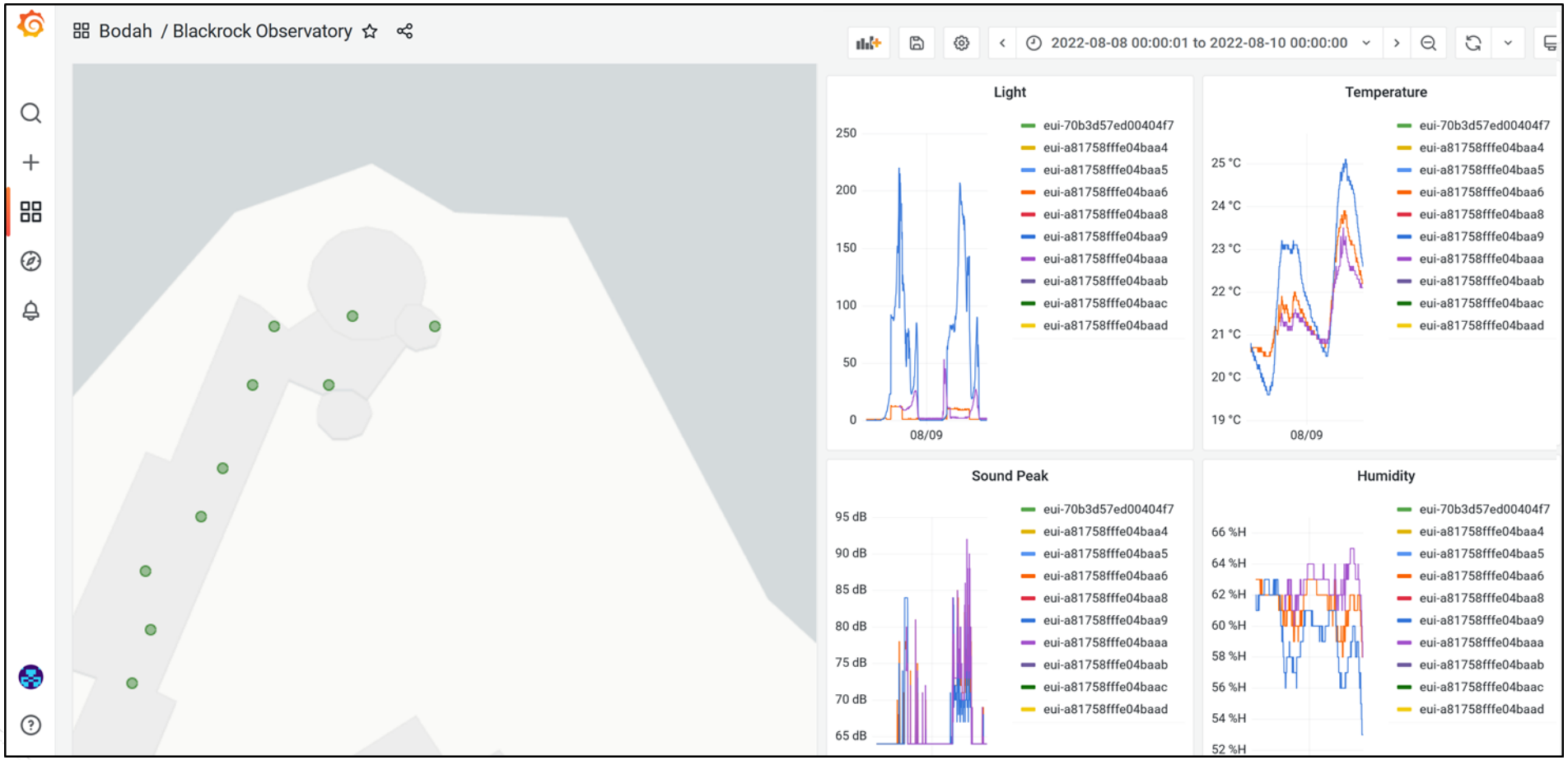
University Data Server

Graphana Dashboard

Blackrock Castle Observatory



Blackrock Castle Observatory



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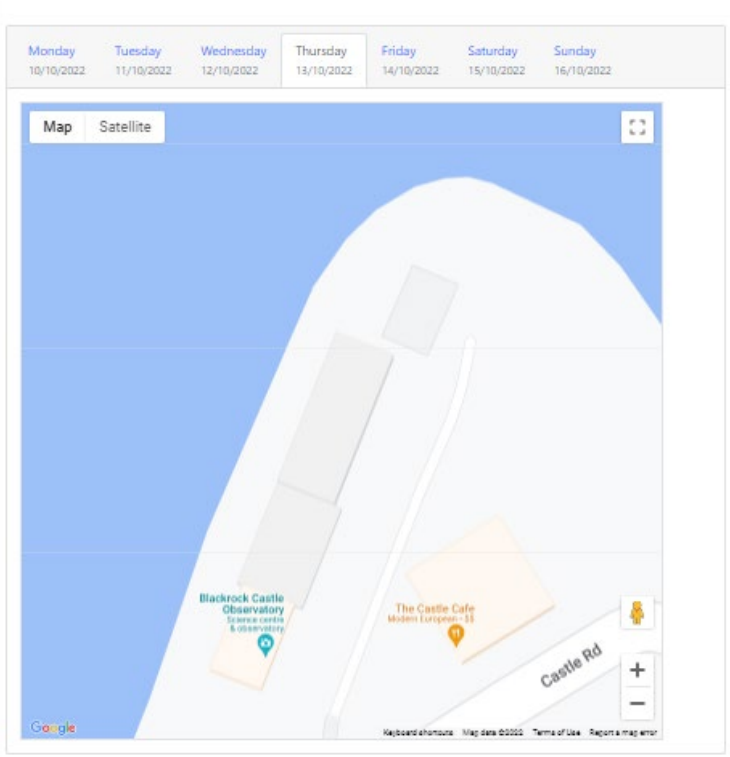
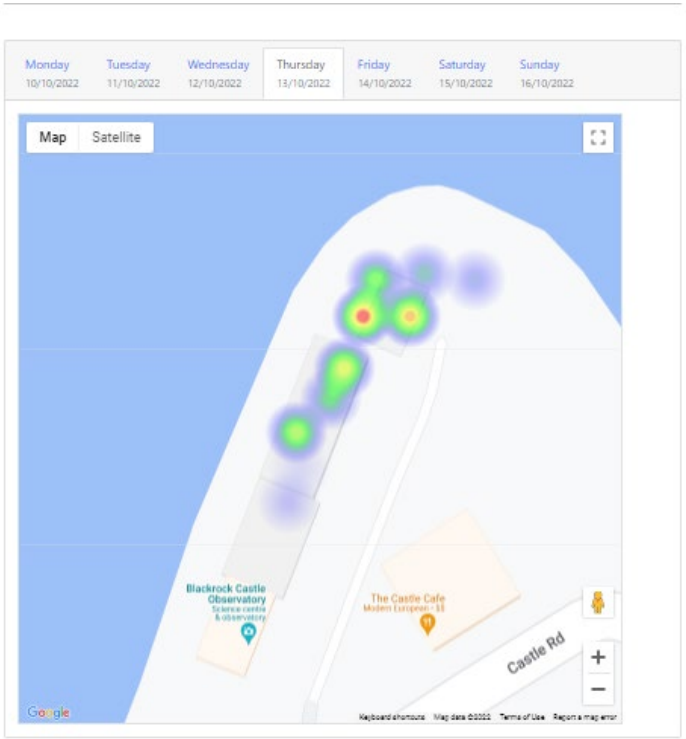




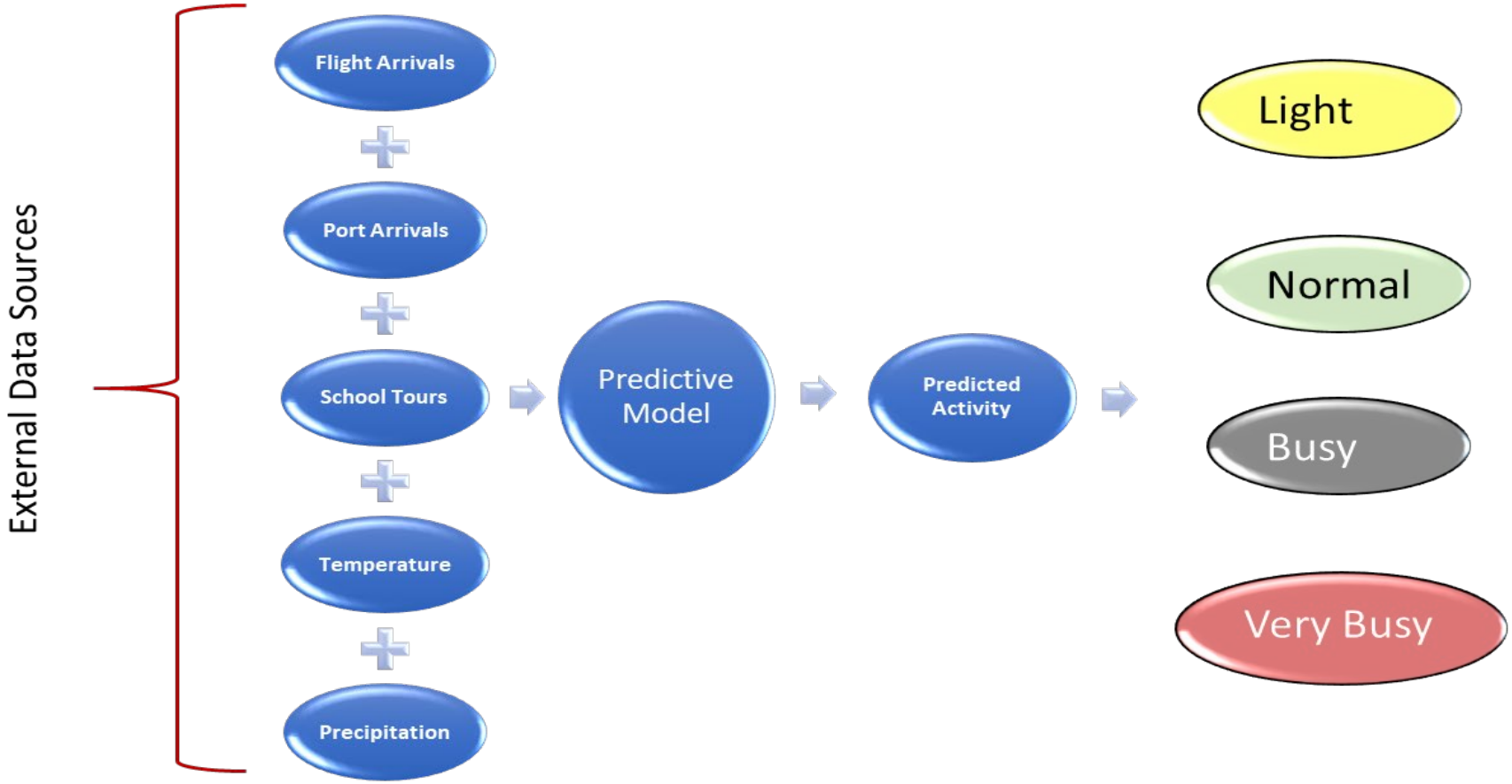
Because BCO were interested in the activity at each of the exhibitions a heatmap is generated on top of the Graphana interface to show activity derived from the sensor data.

The heatmaps can be used to monitor the average activity over a period of time or the activity at a particular period in time.

Blackrock Castle Observatory

We are also interested in developing and embedding **predictive functionality** into the BCO interface.

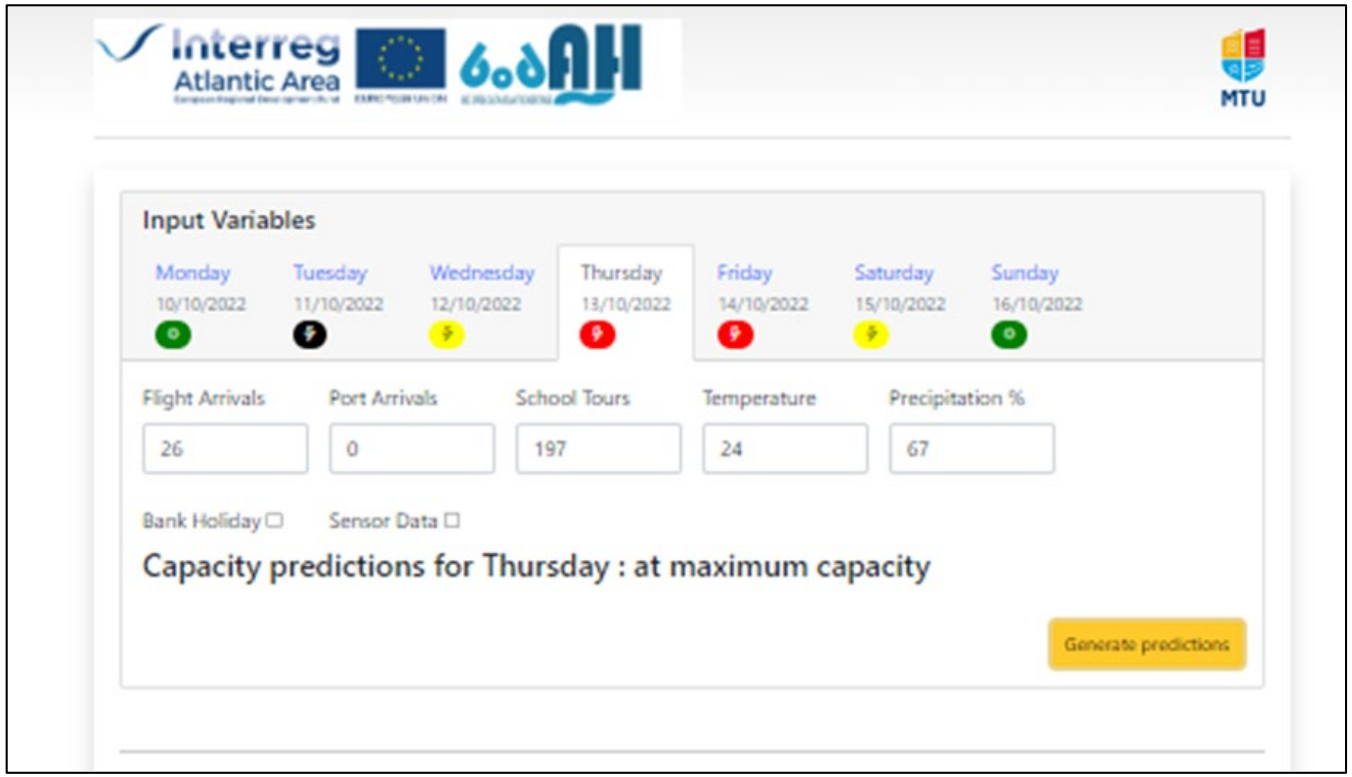
In particular, we aim to take in an array of data points ranging from weather, school tours numbers, flight arrivals etc.



Blackrock Castle Observatory

To illustrate the concept we have built a basic tool to illustrate the concept.

It takes in external data sources such as flight arrivals, port arrivals, school tools, temperature and precipitation levels and use this to predictive the anticipated capacity of BCO for a specific data.



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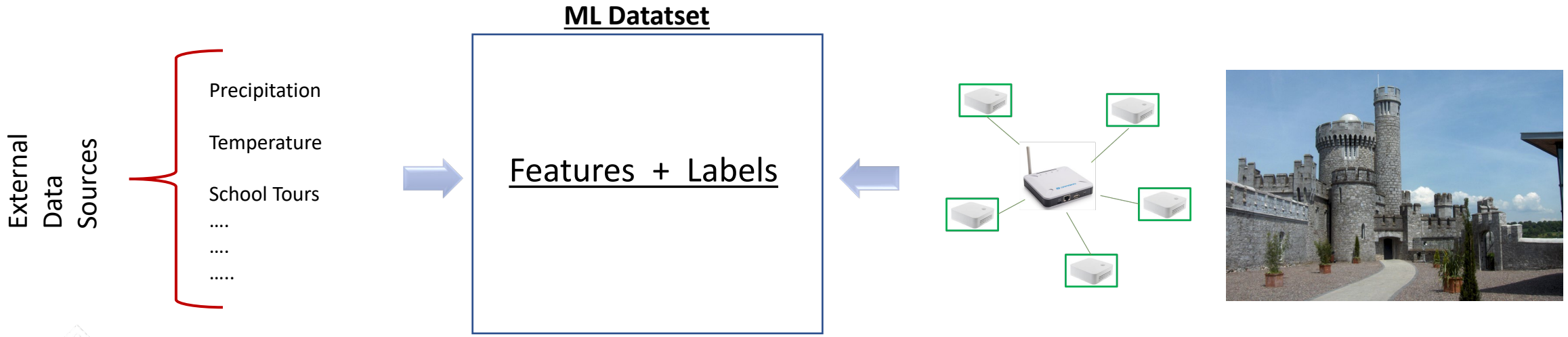
Future Work

- To train and build a **supervised machine learning model** we need build a labelled dataset.
  - The features in the dataset will be the external datapoints such as precipitation, temperature, flight arrivals etc.
  - The label will be the daily average visitors for BCO.

- In the context of predicting visitors numbers at BCO we can marry the external data with the visitor data being generated to build a labelled dataset for a machine learning model.



Challenges

- COVID – 19 (Long shutdowns meant very significant delays in deploying our sensor network. This is a necessitated a change in the test site).
- Obtaining adequate amounts of labelled data.
- Gaining access to data from different sources.
- Ensuring privacy and a non-intrusive monitoring system was an important requirement from the offset.

Any Questions