

# Pizza and IoT with ASME:

A discussion with undergraduate mechanical engineering students

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The material for this presentation is sourced from an undergraduate-level course titled, “Introduction to IoT and Edge Computing Applications” taught by Prof. Bulusu in the Computer Science Department in GWU.



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School of Engineering  
& Applied Science

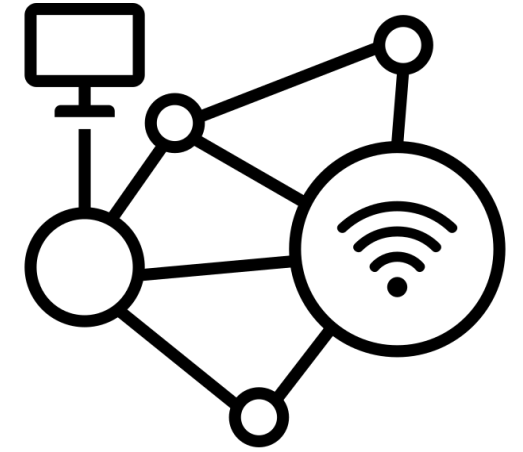
THE GEORGE WASHINGTON UNIVERSITY

Photo: Kartik Bulusu

# Our discussion today is preceded by rich history ...

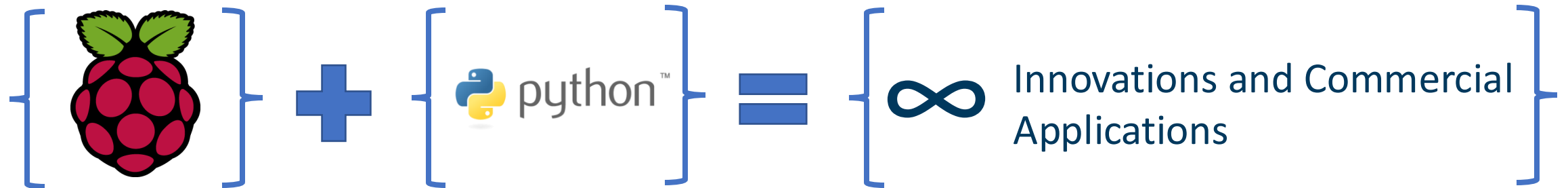
- **1<sup>st</sup> industrial revolution:** 1760 to 1840 -> Railroads
- **2<sup>nd</sup> industrial revolution:** Late 19<sup>th</sup> century to 20<sup>th</sup> century -> Mass production and electricity
- **3<sup>rd</sup> industrial revolution:** 1960s -> Digital revolution
- **4<sup>th</sup> industrial revolution:** NOW -> Ubiquitous and mobile communication

Sources:  
K. Schwab. The Fourth Industrial Revolution



Icon Source: IoT by Alla Zaleuska from [Noun Project](https://www.nounproject.com/)

**IoT with edge computing capability is going to be the backbone of the Industry 4.0.**



# Communication hasn't been the same!

Sources:  
L. Bernardi, S. Sarma and K. R. Traub, The Inversion Factor: How to Thrive in the IoT Economy  
<https://webstorytelling.org/index.php/2017/05/14/dominos-and-iot-reinventing-the-pizza-story/>  
[https://en.wikipedia.org/wiki/Lombardi%27s\\_Pizza](https://en.wikipedia.org/wiki/Lombardi%27s_Pizza)  
<https://uspizzamuseum.com/about/>  
<https://uspizzamuseum.com/2019/02/05/lost-forefathers-of-pizza-in-america-discovered/>  
<https://corporate.dominos.co.uk/about-us>

By Elaine Chan and Priscilla Chan - Derived from: File:MarkZuckerberg.jpg, CC BY 2.5, <https://commons.wikimedia.org/w/index.php?curid=27431613>  
By ArnoldReinhold - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=69603043>

## “Things” haven’t been the same!

Telephone

Boston  
March 10, 1876

1<sup>st</sup> pizzeria in the US  
Lombardi's pizza opened  
(circa 1905 in NYC)



Tim Berners-Lee CERN www-  
browser and HTTP server  
August 23, 1991

Antje Danielson  
and Robin Chase  
Cambridge  
(circa 2000)

Zipcar

Internet was through dial up and ethernet cables  
AOL Time Warner (2001–2003)  
Amazon had yet to turn a profit  
Microsoft was selling office productivity suites

Mark Zuckerberg *et al.*,  
Facebook  
January 4,  
2004



Apple  
First-generation iPhone  
January 9, 2007



Pizza

Domino's and IoT:  
Reinventing the Pizza Story  
(circa March 217)



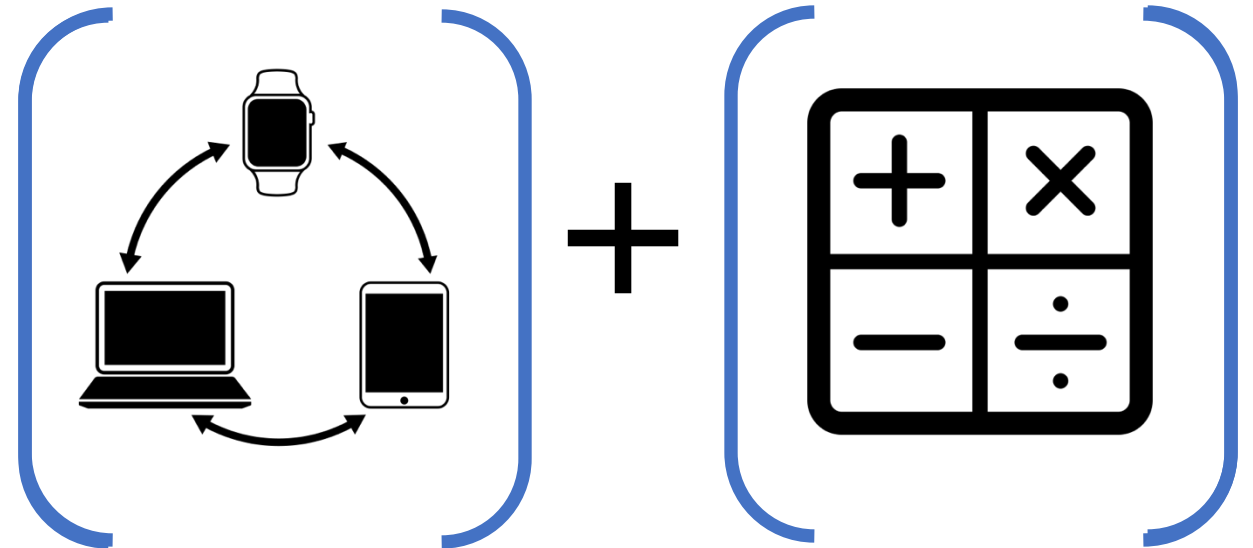
# What's the “thing”?

Sources:  
Calculator by Markus from <https://thenounproject.com/browse/icons/term/calculator/>  
internet of things by Davo Sime from <https://thenounproject.com/browse/icons/term/internet-of-things/>  
L. Bernardi, S. Sarma and K. R. Traub, The Inversion Factor: How to Thrive in the IoT Economy

## Paradigm #1

- A **thing** is self-contained and only operates within the confines of its physical shell.
  - **Thing** carries out only those functions that its designer envisioned when it was fabricated.
- The **thing** contains a powerful computer inside but is completely hidden from the user.
- The **thing** has firmware (not called software).

## Paradigm #2



## Paradigm #3



# Internet of Pizza



Peter Regas discovered this Filippo Milone pizzeria advertisement in the May 9, 1903 issue of *Il Telegrafo*, an Italian language newspaper published in New York City. [Peter Regas' scan/New York Public Library]



Domino's adopted IoT technologies to reinvent their pizza story

Two questions up for discussion

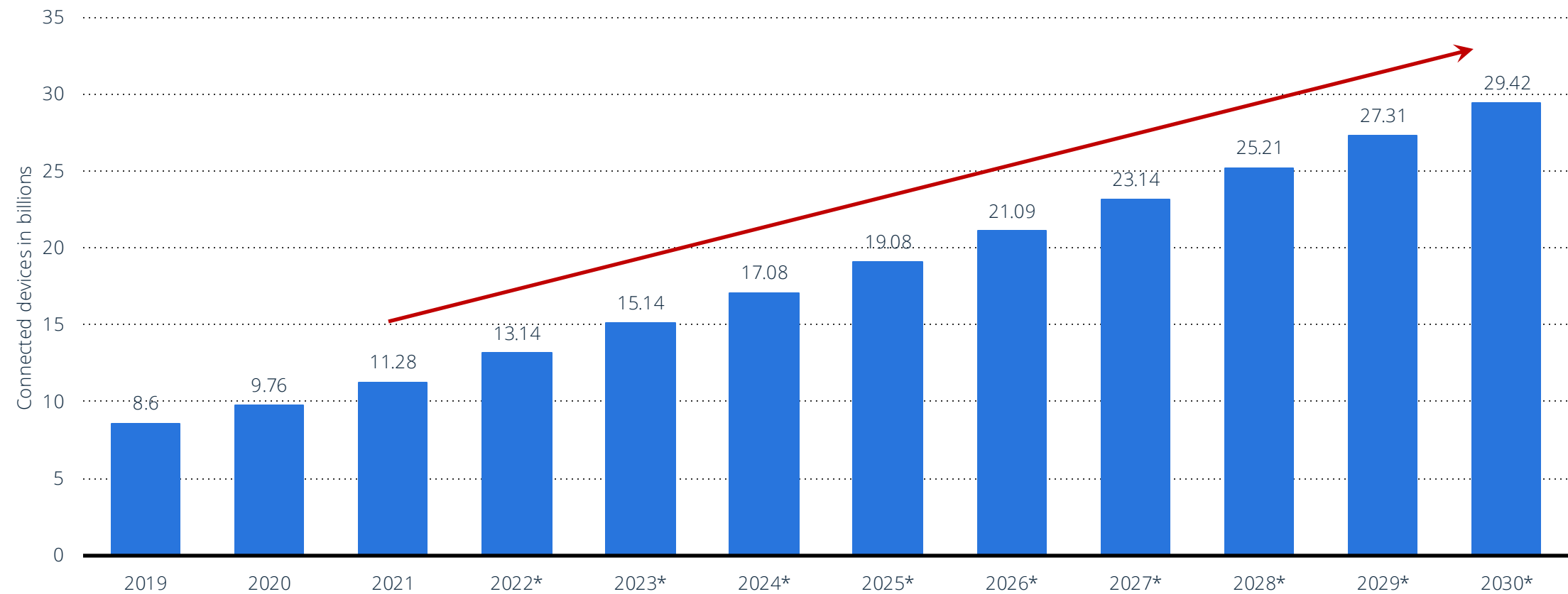
1. How should we start perceiving an IoT system, physically ?

2. How / Where do we place the "thing" in that system ?



# Number of Internet of Things (IoT) connected devices worldwide from 2019 to 2021, with forecasts from 2022 to 2030 (in billions)

Number of IoT connected devices worldwide 2019-2021, with forecasts to 2030

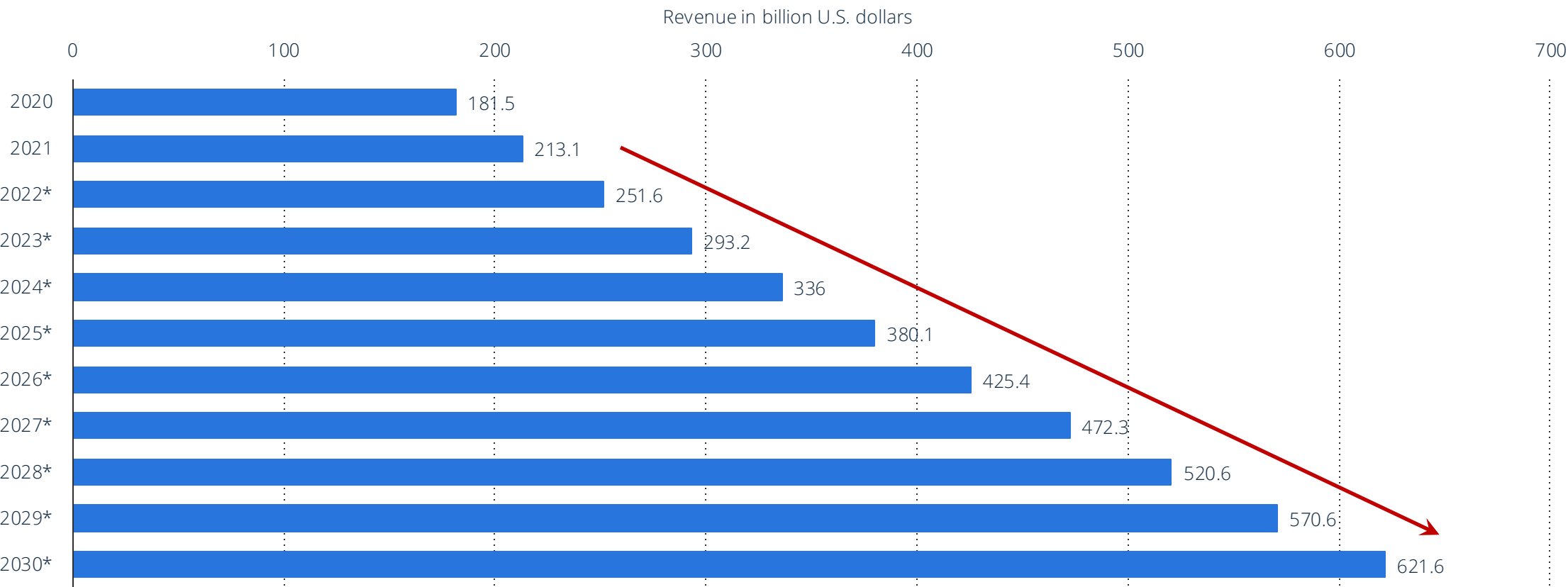


**Note(s):** Worldwide; 2019 to 2022  
Further information regarding this statistic can be found on [page 8](#).  
**Source(s):** Transforma Insights; ID 1183457



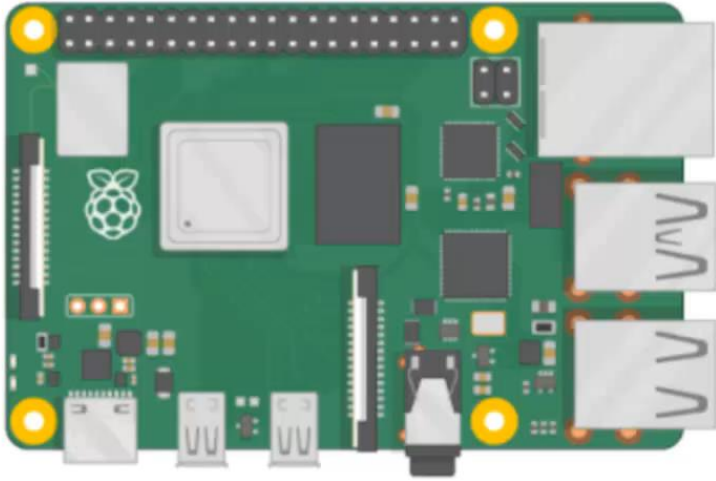
# Internet of Things (IoT) total annual revenue worldwide from 2020 to 2030 (in billion U.S. dollars)

IoT global annual revenue 2020-2030



**Note(s):** Worldwide; 2020 to 2022  
Further information regarding this statistic can be found on [page 8](#).  
**Source(s):** Transforma Insights; ID 1194709

# Hands-on with the hardware!



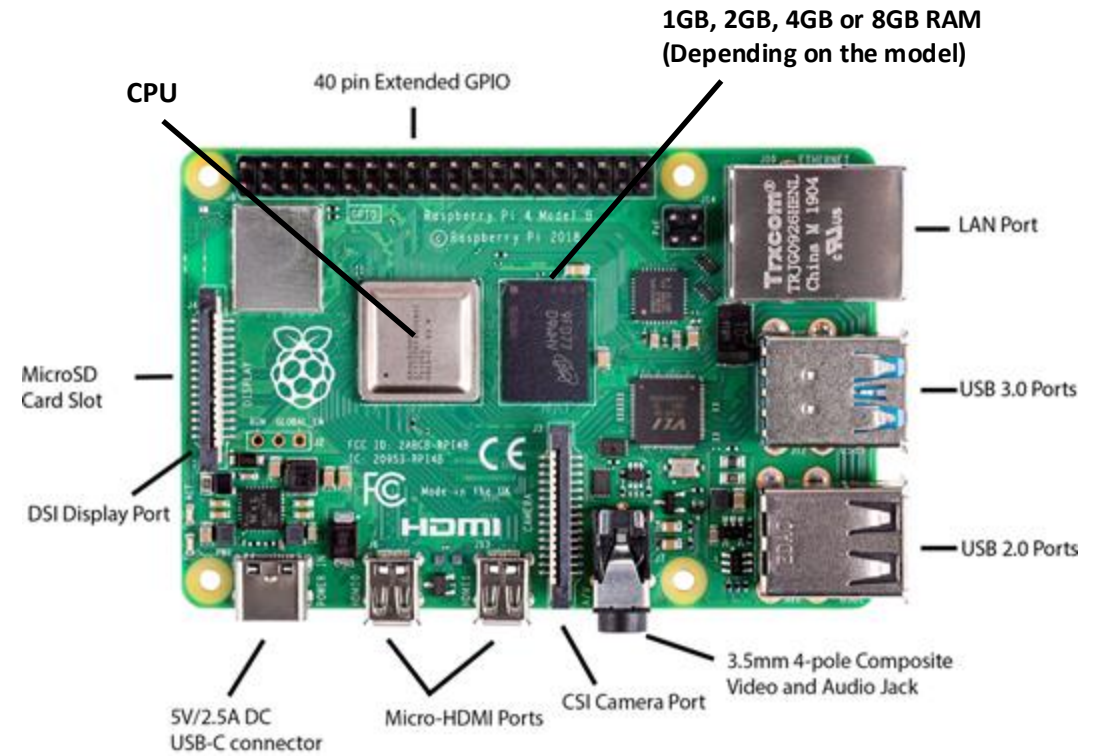
Source: <https://www.raspberrypi.org/help/>

## GET STARTED WITH RASPBERRY PI

Create and explore an **IoT** framework.

Strategize on how-to **edge compute**.

Gain practical and hands-on exposure in “**μ-Labs**” in MAE 6291.



- Raspberry Pi OS (previously called Raspbian) is the recommended operating system for normal use.
- Raspberry Pi OS is a free operating system based on Debian, optimised for the Raspberry Pi hardware.
- The OS comes with over 35,000 packages: pre-compiled software bundled in a format for easy installation.





# Let's try to "Put on the Sense HAT"

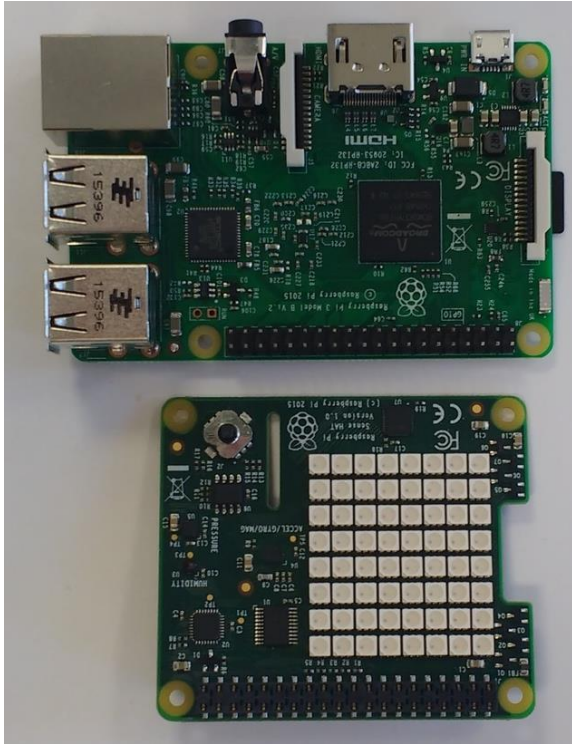


Image and animation source: <https://projects.raspberrypi.org/en/projects/getting-started-with-the-sense-hat/2>

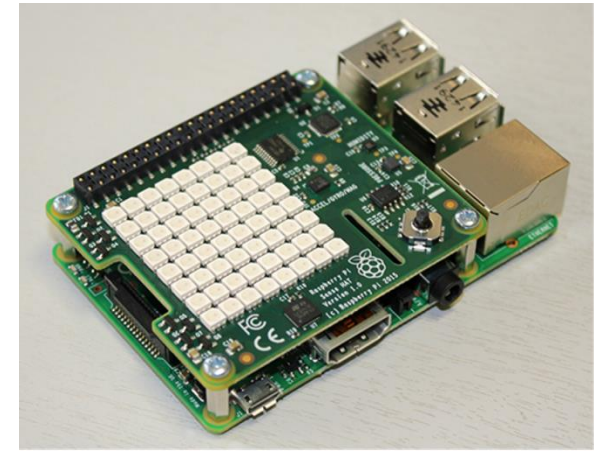
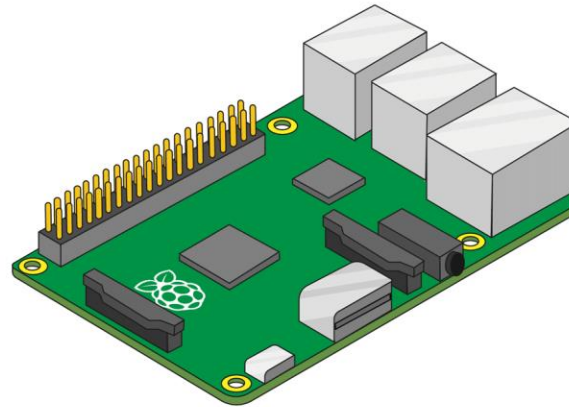


Image source: <https://reference.wolfram.com/language/ref/device/SenseHAT.html>



Source: <https://youtu.be/8NwWNOMqai4>

## "and take a closer look" ...



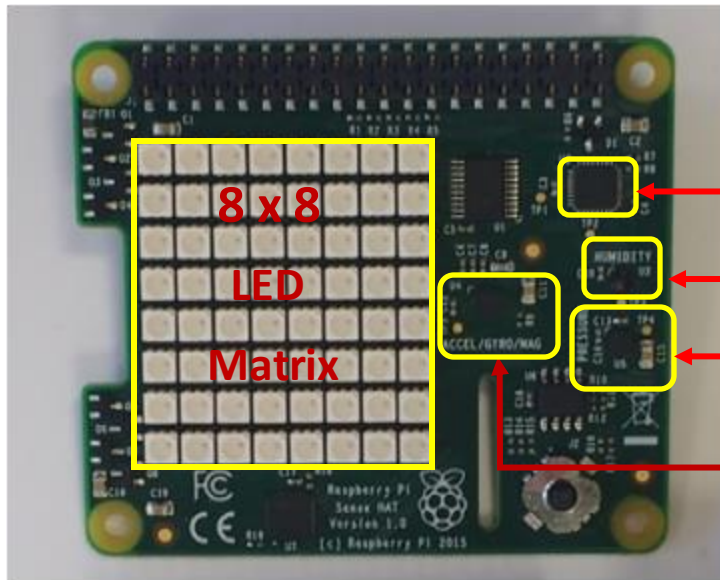
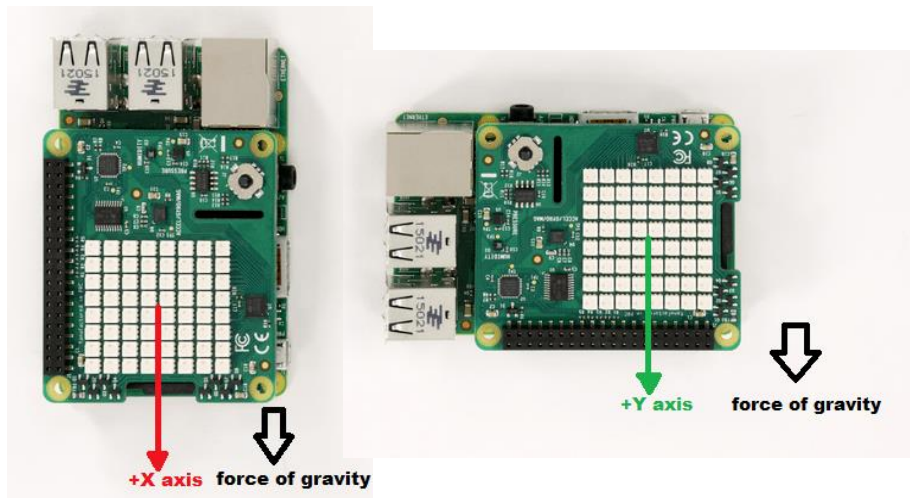


Image source: <https://projects.raspberrypi.org/en/projects/getting-started-with-the-sense-hat/2>

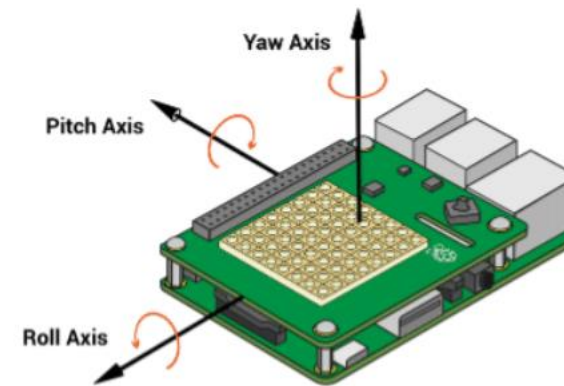


Source: <https://www.mathworks.com/help/supportpkg/raspberrypi/examples/auto-rotate-an-image-displayed-on-sense-hat-led-matrix.html>

▪ The Sense HAT has a variety of sensors that can be read from:

"Temperature"	reads temperature in degrees Celsius
"Humidity"	reads humidity in % RH
"Pressure"	reads atmospheric pressure in millibars
"Rotation"	reads gyroscopic motion in revolutions per second
"Acceleration"	reads acceleration in terms of standard accelerations due to gravity on Earth's surface
"Orientation"	reads orientation relative to magnetic north in degrees
"Magnetic Field"	reads strength and direction of a magnetic field around the sensor in microteslas

▪ The gyroscope, accelerometer, and magnetometer sensors return a list of three values that corresponds to  $\{roll, pitch, yaw\}$ , as oriented according to the following image:



Starting point for further exploration:

[Link for "Getting started with the Sense HAT"](#)

Source: <https://reference.wolfram.com/language/ref/device/SenseHAT.html>



# The Evolution of Things

Sources:

L. Bernardi, S. Sarma and K. R. Traub, The Inversion Factor: How to Thrive in the IoT Economy  
What Is the Internet of Things and Why Should You Care? | MIT Sloan, <https://www.youtube.com/watch?v=I75CrN-hSI>

**IoT**

## Internet of Things

- Devices connected to internet
- Breaking the boundaries of form

**IoT**

## Intelligence of Things

- Devices that host software applications
- Breaking the boundaries of function

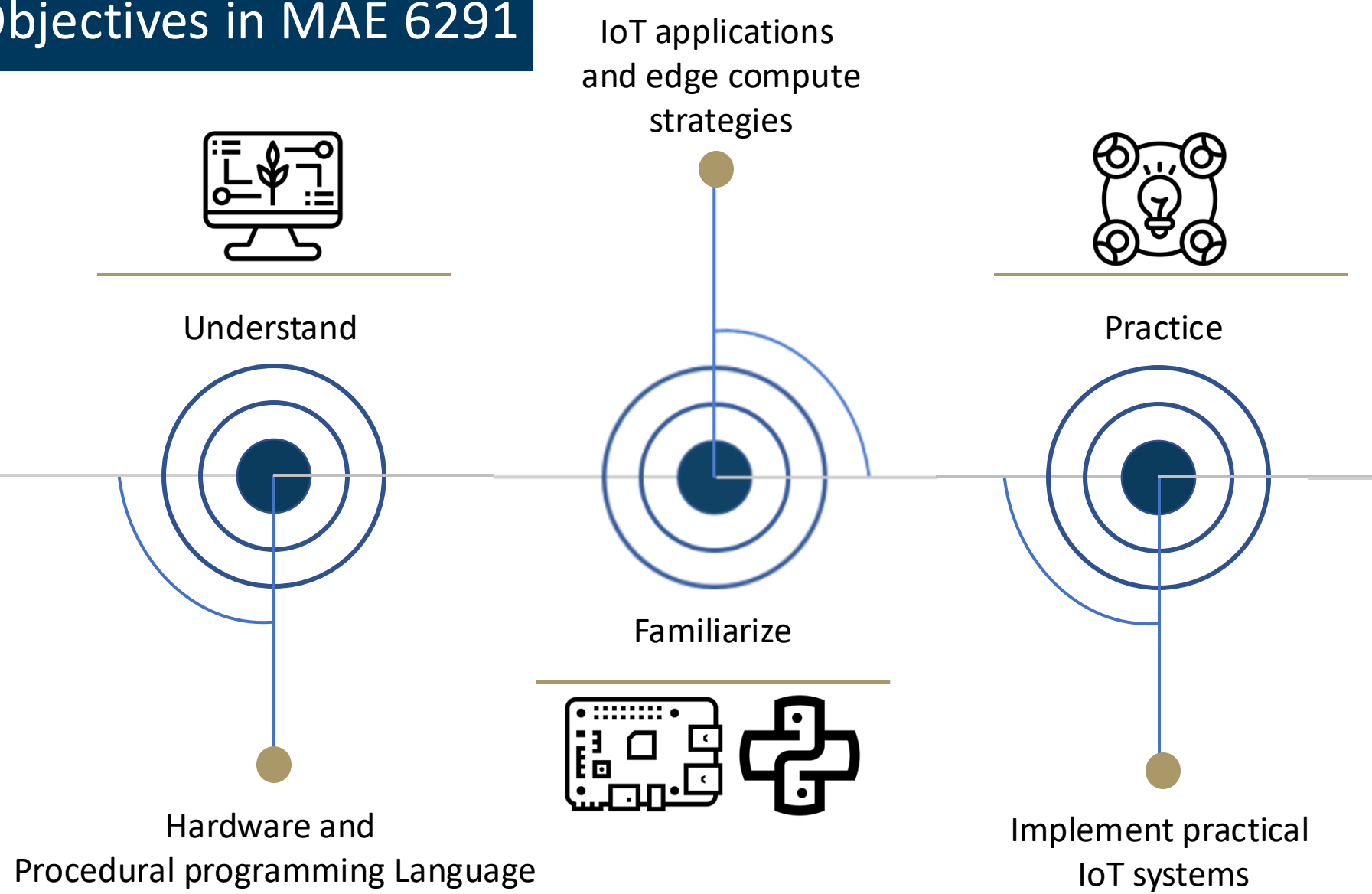
**IoT**

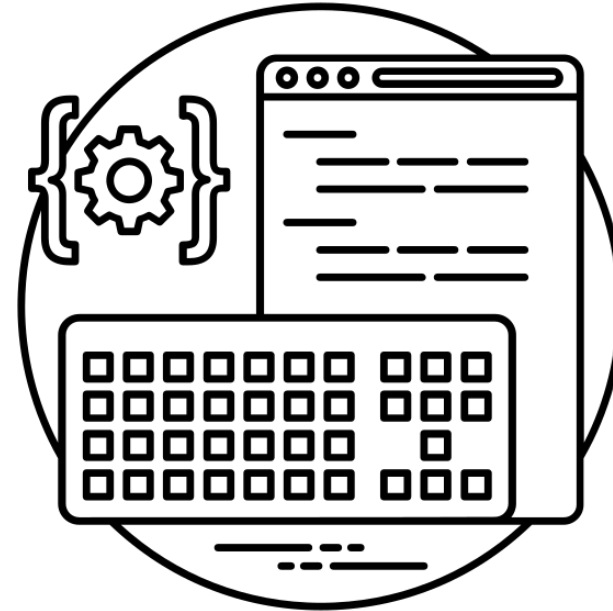
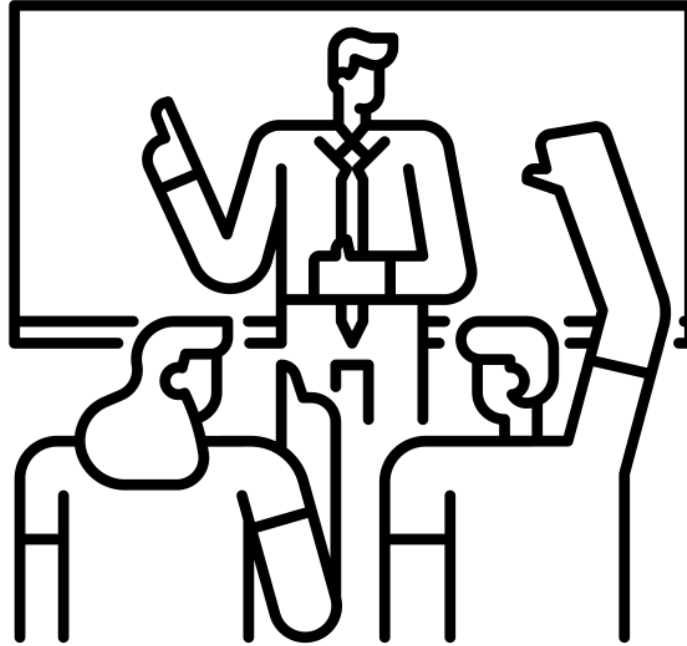
## Innovation of Things

- Devices that become experiences



# Learning Objectives in MAE 6291





MAE 6291 entails a combination of individual and group work entailing hands-on activities and frequent interactions with the instructor.

