

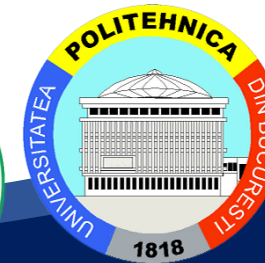


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Advanced Optimization: Techniques and Industrial Applications

Module 3: Optimization and Its Applications in Industry 4 Era



Curriculum Development
of Master's Degree Program in
Industrial Engineering for Thailand Sustainable Smart Industry

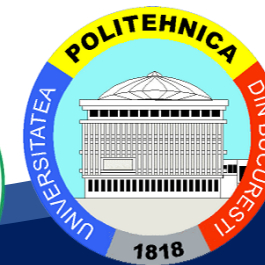


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Session 3.1:

An Overview of Digital Technologies



Curriculum Development
of Master's Degree Program in

Industrial Engineering for Thailand Sustainable Smart Industry



Module 3: Optimization and Its Applications in Industry 4 Era

3.1 An Overview of Digital Technologies (1 hr.)

- 3.1.1 Digital technology concept
- 3.1.2 Digital technology hardware & software
- 3.1.3 Digital technology applications

3.2 Optimization (Opt) concept and Its Applications in Industry 4.0 Era (2 hrs.)

- 3.2.1 Optimization concept in Industry 4.0 era
- 3.2.2 Optimization applications in Industry 4.0 and mobile support
 - Opt in Warehouse and Inventory Management
 - Opt in Transportation problems
 - Opt in Scheduling problems

3.3 Optimization (Opt) Design in I4.0 (2 hrs.)

- 3.3.1 System analysis concept
- 3.3.2 System architecture, module and component design
- 3.3.3 Data input/output user interface design
- 3.3.4 Optimization programming, modeling, and simulation
- 3.3.5 Evaluating the designed system

3.4 Real-Time Optimization (2 hrs.)

- 3.4.1 Checking optimality conditions when input data change
- 3.4.2 Setting initial solution when input data change

3.5 Case Study (3 hrs.)





3.1 An Overview of Digital Technologies

- Today is “digital business” context.
 - Students discuss why today is digital business.
 - Give some extraordinary examples
- **Speed and timing** are importance as a competitive advantage in an increasingly real-time economy.
 - Why??
- A large amount of data are generated by IoT devices (i.e., from mobile technologies for engaging with customers).
- However, businesses don't want data. They want **visibility and dashboards to be fast and timely**.
 - Examples??
- Therefore, cybersecurity tools and **data analytics** are required to invest (source: PWC).
- Industry 4.0 brings new opportunities to realize a smarter factory.
- Challenges from Industry 4.0 (Xu et al., 2016) in terms of research aspect:
 - ✓ Modeling a system with IoT devices (i.e., **sensors, GPS, camera, or connected devices**) is generated a large amount of data.
 - ✓ Those **data may keep arriving and changing**, and so any optimization model of such a system must be efficient and dynamic.
 - ✓ Connection and integration among different system components creates another challenge; an **integrated system has many more decision variables**.



3.1.1 An Overview of Digital Technologies

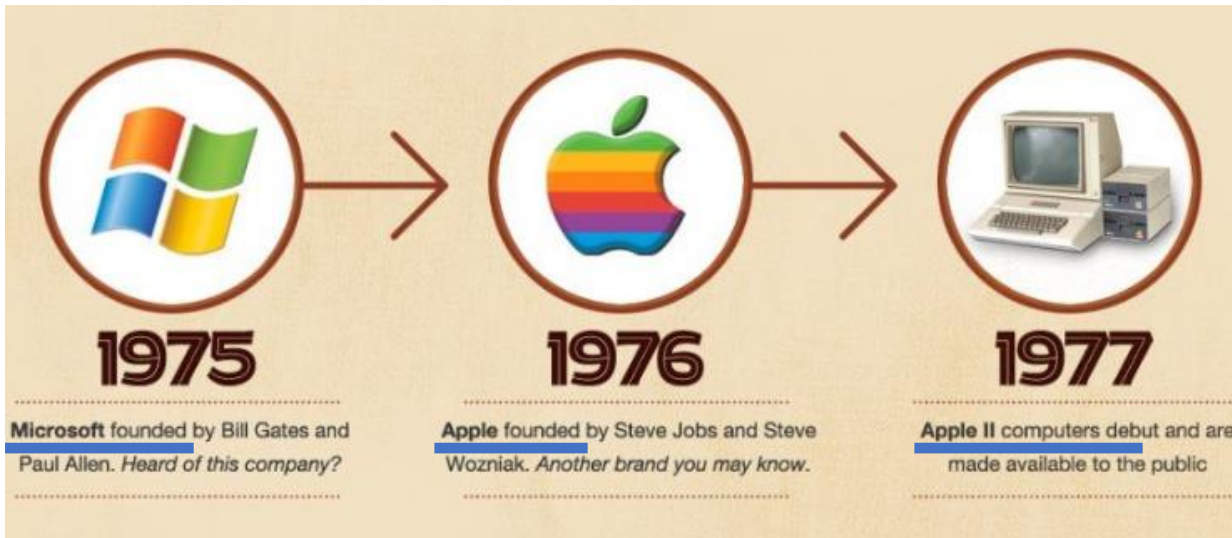


Source: <https://www.visualistan.com/2015/04/the-history-of-technology-infographic.html>

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3.1.1 Digital technology history and concept



1981

- IBM releases first IBM PC
- Microsoft releases MS-DOS

1983

Whoa!

- The Internet is Born when ARPANET officially uses Internet Protocol
- Microsoft Word released

1984-1985

- 1984 - Apple Macintosh introduced to the public
- 1984 - Sony makes the first 3 1/2" computer disk, which replaces floppy disks
- 1985 - Symbolics corporation registers the first .com domain

1986-1989

- 1986 - IBM reveals the PC Convertible, the first laptop offered for sale to the public
- 1986 - EMAP defined for email transfer
- 1988 - Cornell student launches first worm virus
- 1989 - Very first release of Microsoft Office

Source: <https://www.visualistan.com/2015/04/the-history-of-technology-infographic.html>



3.1.1 Digital technology history and concept

1991

- Internet becomes available for unrestricted computer use
- Number of computers on the internet reaches **1 million**

1993

- Intel introduces **Pentium** microchip
- World Wide Web made "official" at **CERN**

CERN (Conseil Européen pour la Recherche Nucléaire) is the organization that made the web (a tool once available only to the scientific community) available to the public domain

1994-1996

- 1994 - Netscape Navigator released
- 1994 - Jeff Bezos founds Amazon
- 1995 - Microsoft releases Windows 95
- 1996 - Ebay founded
- 1996 - 10 Million computers now on the internet
- 1996 - Ask Jeeves founded

1997-1999

- 1998 - Google founded
- 1998 - Apple releases the iMac to the public
- 1999 - Napster released
- 1999 - Blogger released by Pyra Labs

2000

Dot Com Bubble bursts (Told you this internet thing was just a fad)

2001

Wikipedia goes online, Microsoft releases Windows XP and Drupal is created

2003

MySpace launches, Wordpress launches and Google acquires Pyra Labs/Blogger

2005

Mark Zuckerberg and Dustin Moskovitz begin running Facebook full time and YouTube launches

2006-07

Jack Dorsey creates Twitter in 2006 and first public version of Magento released in 2007

2008-09

Rackspace Hosting and NASA jointly launch OpenStack, an open source cloud-software initiative in 2010



3.1.1 Digital technology history and concept

2010-PRESENT



.....
2010 - As more and more people access the web on mobile devices, **Responsive Web Design** starts to gain more traction
.....



.....
2014 - **HTML5** is published as a **W3C** recommendation, upholding the standard to make the web a more beautiful and efficient place
.....

W3C®

Responsive Web Design, HTML5

Source:

<https://www.visualistan.com/2015/04/the-history-of-technology-infographic.html>

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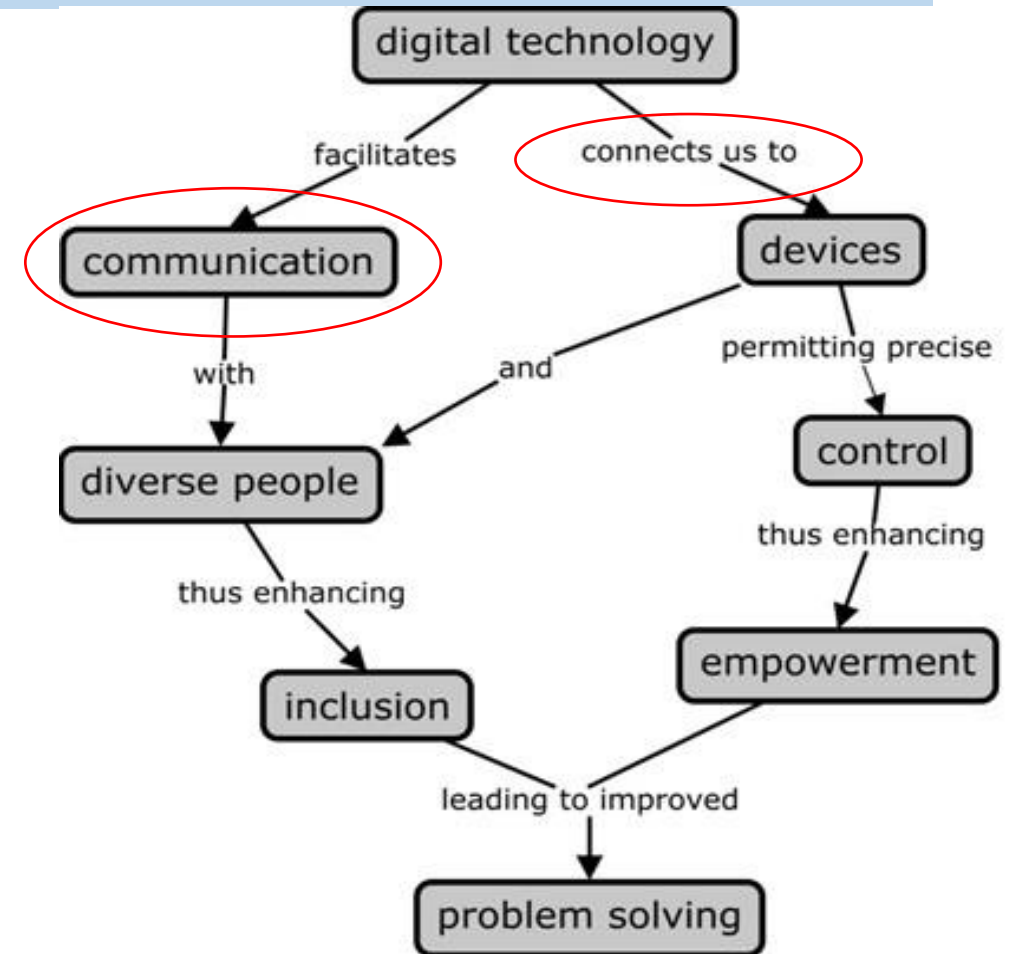
3.1.1 Digital technology concept

- **Digital optimization** is the process of using digital technology to improve existing operating processes and business models (www.gartner.com).
- **Digital technologies** are electronic tools, systems, devices and resources that generate, store or process data.
(<https://www.education.vic.gov.au/school/teachers/teachingresources/digital/Pages/teach.aspx>)
- The digital systems concept focuses on the components of digital systems: **hardware and software** (computer architecture and the operating system), and **networks and the internet** (wireless, mobile and wired networks and protocols). This concept is addressed in both strands.
- **Well known examples** include social media, online games, multimedia and mobile phones.

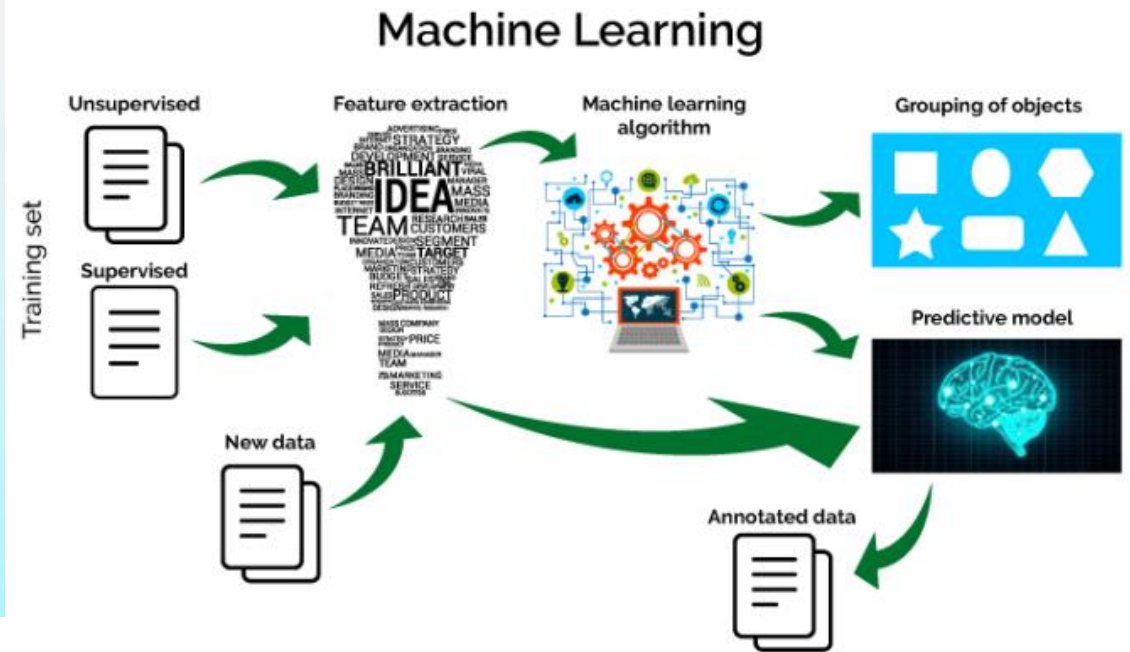
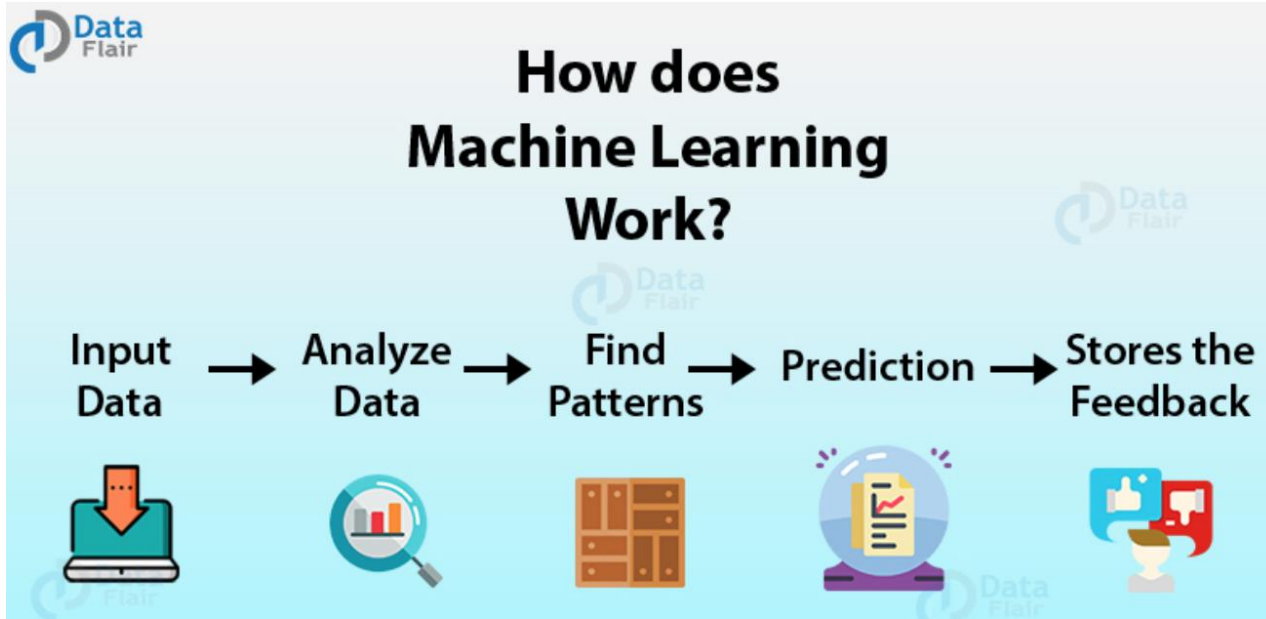


3.1.1 Digital technology concept

- **Digital technology** facilitate **communication** by and with **diverse people**,
- Enhancing **inclusion** and participation by more segments of society.
- These technologies connect us to the material world in new ways, permitting more precise **control** of environment.
- Jointly, these two aspects, **inclusiveness** on the one hand and **empowerment** on the other, lead to better **problem solving**.



Example of the Use of Digital technology “Machine Learning”



Source: <https://data-flair.training/blogs/machine-learning-tutorial/>



3.1.2 Digital technology hardware & software

Types of Digital Technology

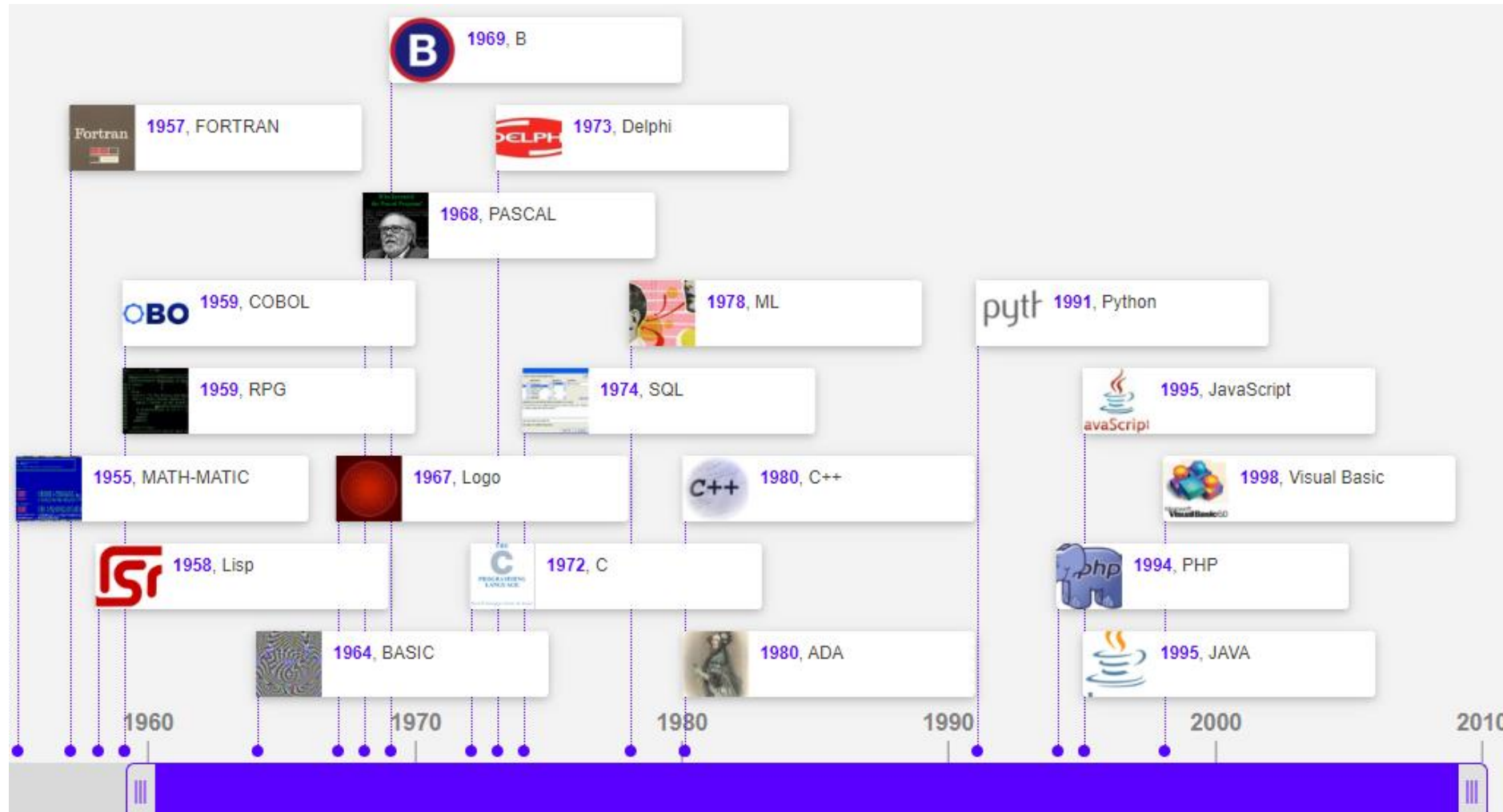
- Search Engines
- Digital Camera
- Microsoft Office
- 3D Printing
- Wearable Technologies
- Virtual Currencies (Bitcoin)
- Smart Home Technologies

Digital Technology Hardware

- desktop computers.
- laptop computers.
- mobile phones.
- tablet computers.
- e-readers.
- storage devices, such as flash drives.
- input devices, such as keyboards, mice, and scanners.
- output devices such as printers and speakers.



Software

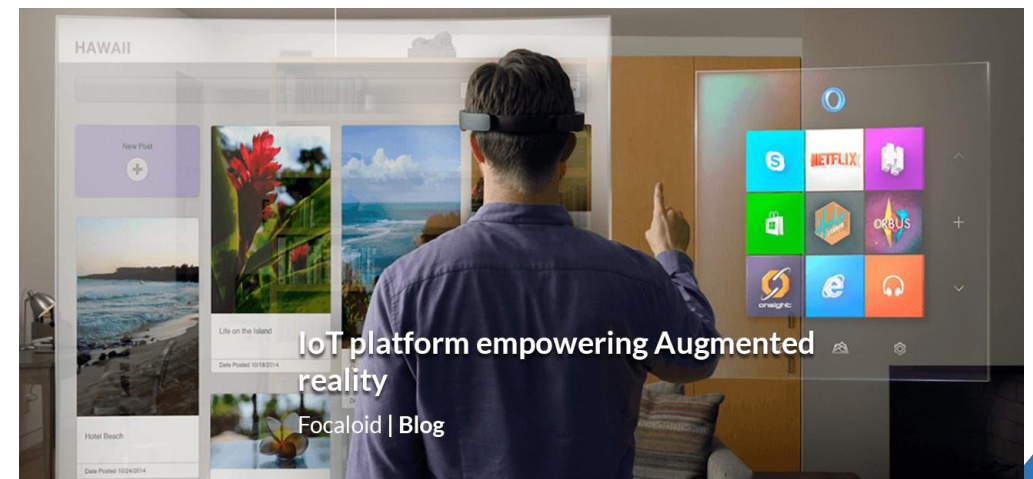
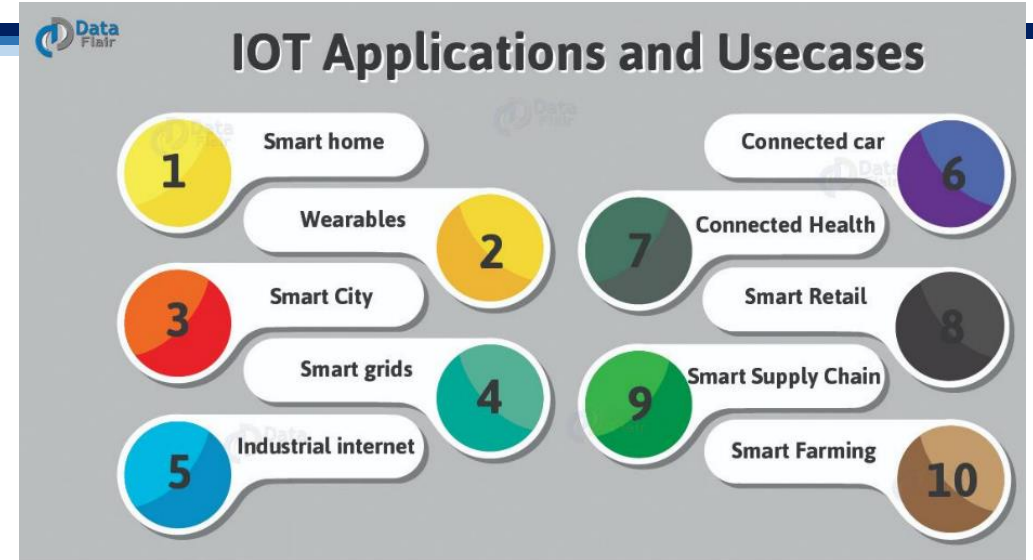


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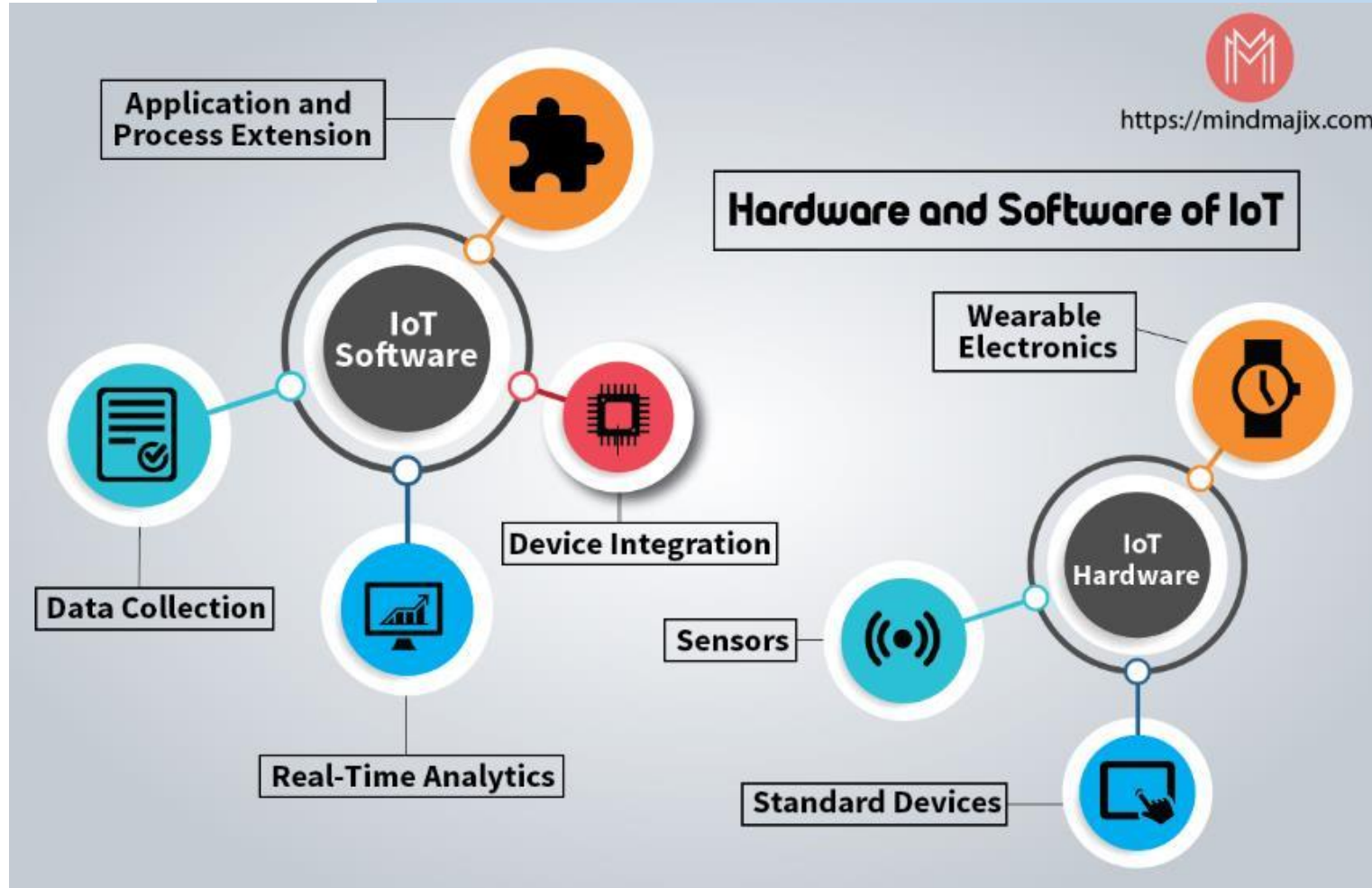


The Key Technologies of I4.0

- The Internet of Things (IoT)
- Cloud Computing (CC)
- Big Data (BD)/Machine Learning
- Simulation
- Augmented Reality (AR) is technology that uses the camera of a tablet or phone to show the real world environment on the screen and then rendering digital assets on the screen combining the digital world with the physical world (Indiecad.com.au).
- Additive Manufacturing (AM):
- Horizontal and Vertical Systems Integration
- Autonomous Robots
- Cyber Security
- 3D Printing



IoT hardware and Software



- **IoT Hardware** includes a wide range of devices such as devices for routing, bridges, sensors, GPS, camera, or connected devices etc.
- **IoT devices** manage key tasks and functions such as system activation, security, action specifications, communication, and detection of support-specific goals and actions.

3.1.3 Digital technology applications

Smart environment application domains.

	Smart home/office	Smart retail	Smart city	Smart agriculture/forest	Smart water	Smart transportation
Network size	Small	Small	Medium	Medium/large	Large	Large
Users	Very few, family members	Few, community level	Many, policy makers, general public	Few, landowners, policy makers	Few, government	Large, general public
Energy	Rechargeable battery	Rechargeable battery	Rechargeable battery, energy harvesting	Energy harvesting	Energy harvesting	Rechargeable battery, Energy harvesting
Internet connectivity	Wifi, 3G, 4G LTE backbone	Wifi, 3G, 4G LTE backbone	Wifi, 3G, 4G LTE backbone	Wifi, satellite communication	Satellite communication, microwave links	Wifi, satellite communication
Data management	Local server	Local server	Shared server	Local server, shared server	Shared server	Shared server
IoT devices	RFID, WSN	RFID, WSN	RFID, WSN	WSN	Single sensors	RFID, WSN, single sensors
Bandwidth requirement	Small	Small	Large	Medium	Medium	Medium/large
Example testbeds	Aware home [29]	SAP future retail center [30]	Smart Santander [31], citySense [32]	SiSViA [33]	GBROOS [34], SEMAT [35]	A few trial implementations [36,37]

Source: [https://www.semanticscholar.org/paper/Internet-of-Things-\(IoT\)%3A-A-vision%2C-architectural-Gubbi-Buyya/72c4d8b64a9959ea45677ca1955d3491ef0f1c62/figure/1](https://www.semanticscholar.org/paper/Internet-of-Things-(IoT)%3A-A-vision%2C-architectural-Gubbi-Buyya/72c4d8b64a9959ea45677ca1955d3491ef0f1c62/figure/1)





Assignment I (a group of 3 persons)

- Find an example of the Use of Digital technology in the optimization area such as :
 - Scheduling
 - Transportation
 - Resource allocation
 - Production planning
 - etc
- Discussion on why the industry are using it
- How to apply the Digital technology and constraints

