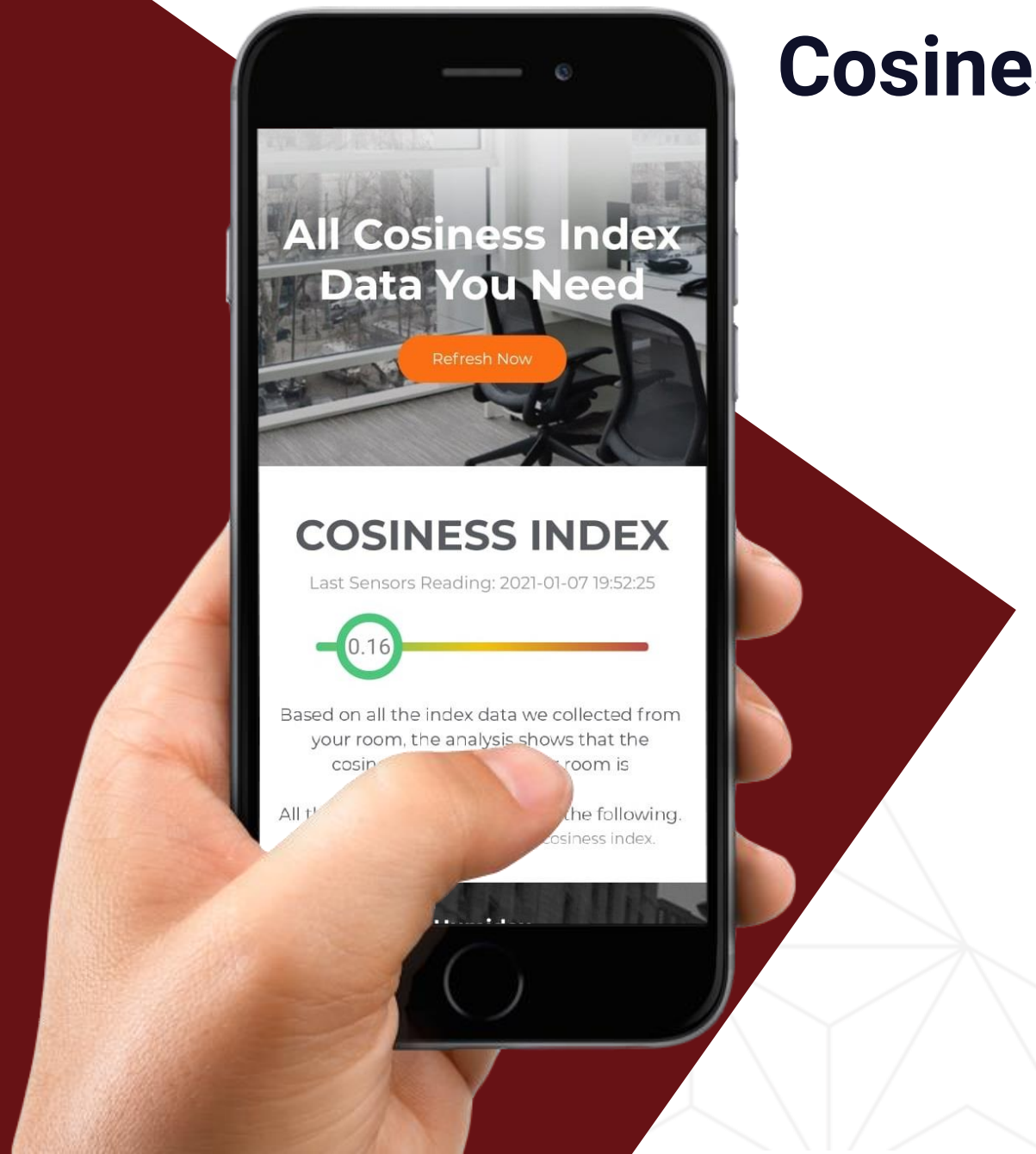

Cosiness Index Project Presentation

Internet of Things Module

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With the support of the Erasmus+ Programme of the European Union

UNIVERSITÉ DE LORRAINE

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  - Summary of Architecture
  - Technologies
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- Part II: Implementation
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  - Cosiness Index Calculation
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Part I
Introduction

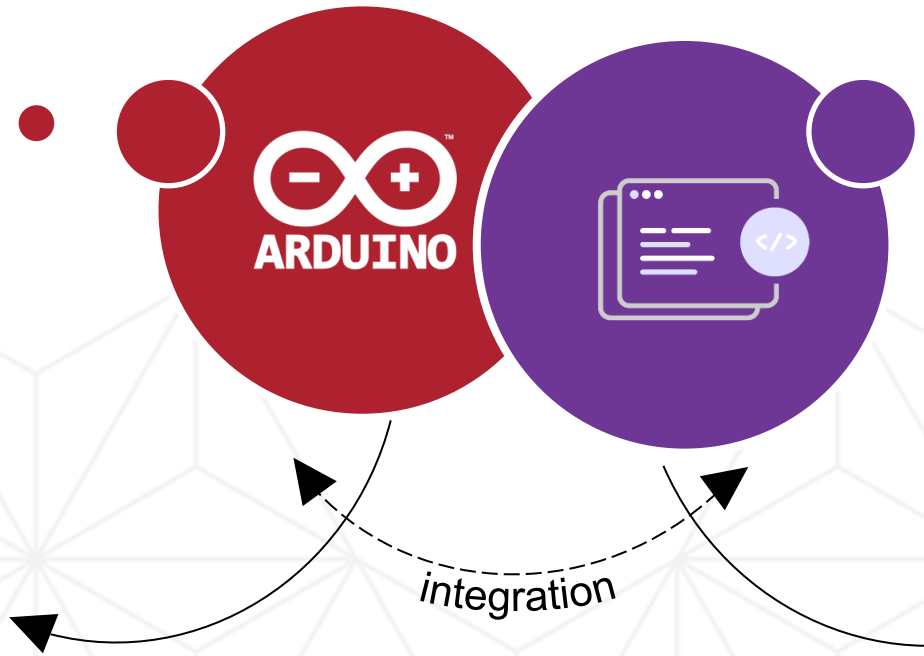
Objectives

Overall: To implement a practical full-stack Internet of Things application, using all knowledge and technologies learned throughout the IoT course.

Application: Deliver for users an index that reflects how cozy their rooms are, based on data given by sensors attached in their rooms.

Arduino Application

Inputting Analog values from sensors and converting them into cosiness data indexes



Full-stack Web Application

a Web application for storing sensors data, analyzing them and showing a final index for end-users

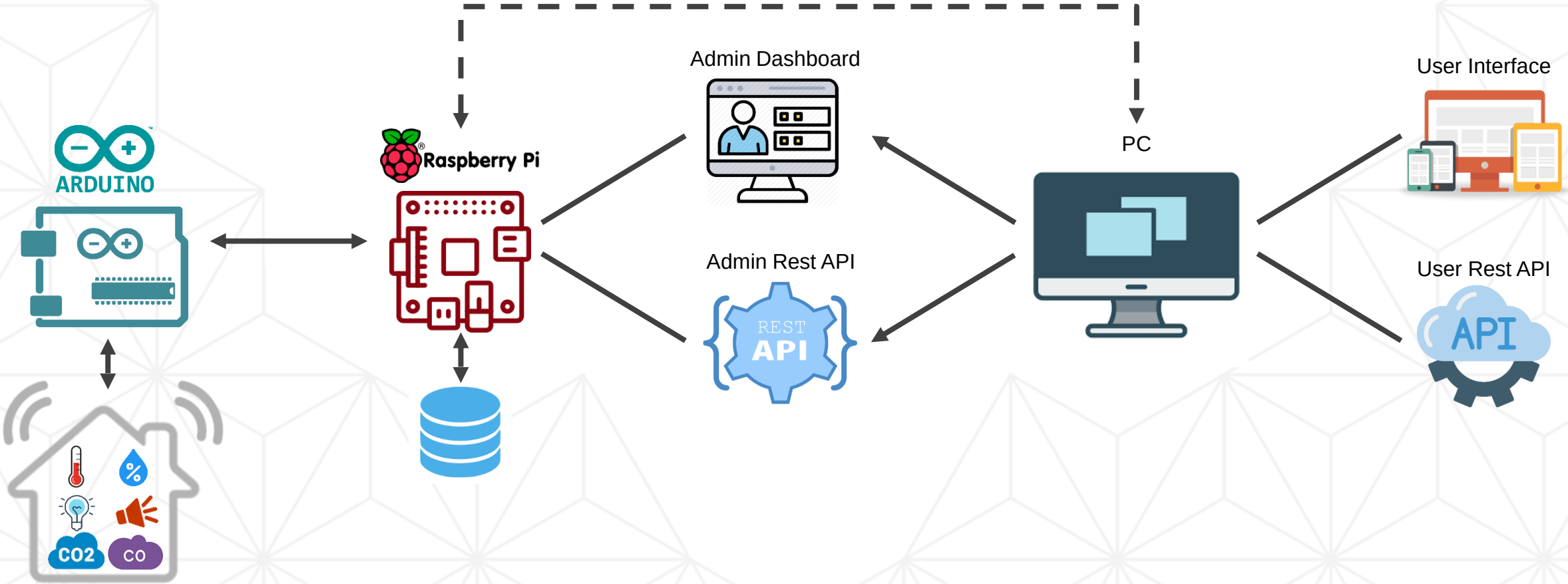
Module Learning Knowledge

Using all knowledge, technologies and skills learned in the IoT course

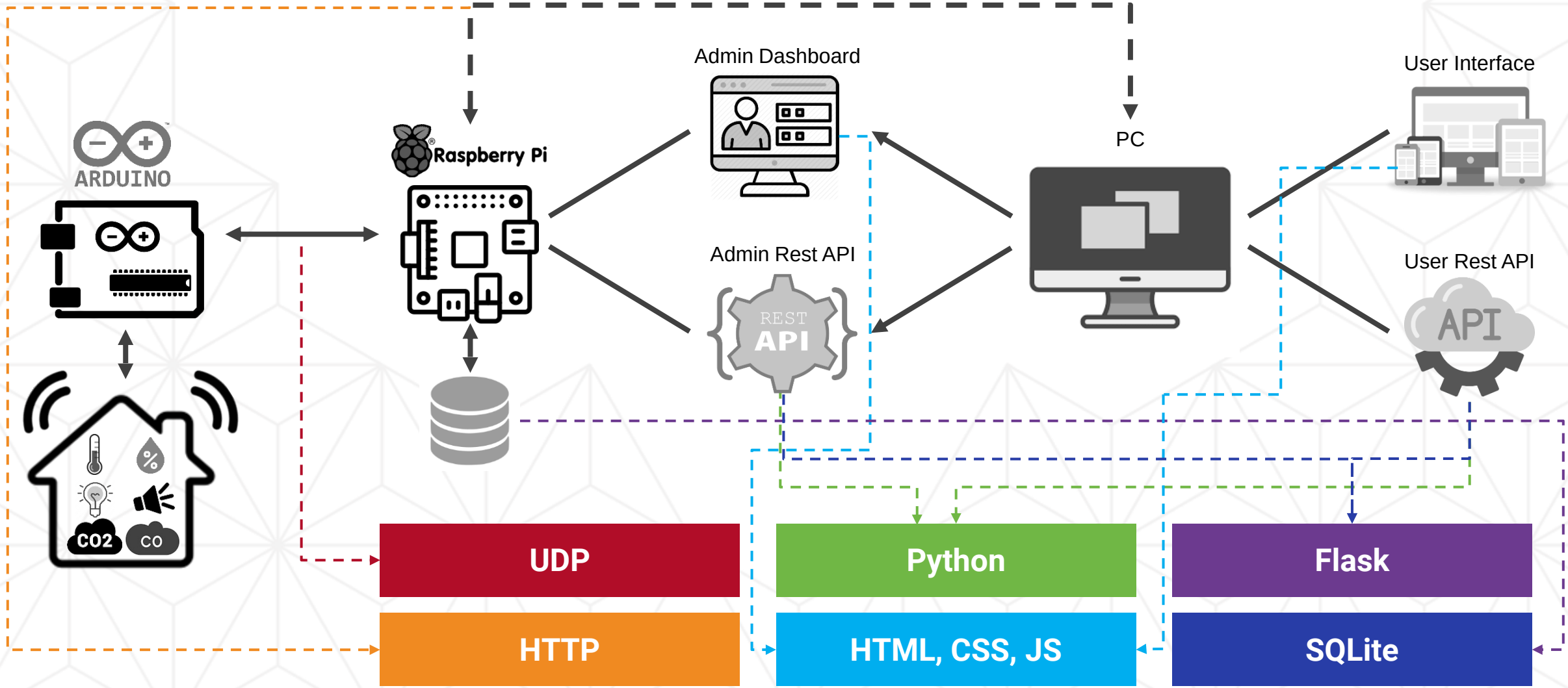
Previous Knowledge

Using personal knowledge to design, implementation and deploy a full-stack web application

Summary of Architecture



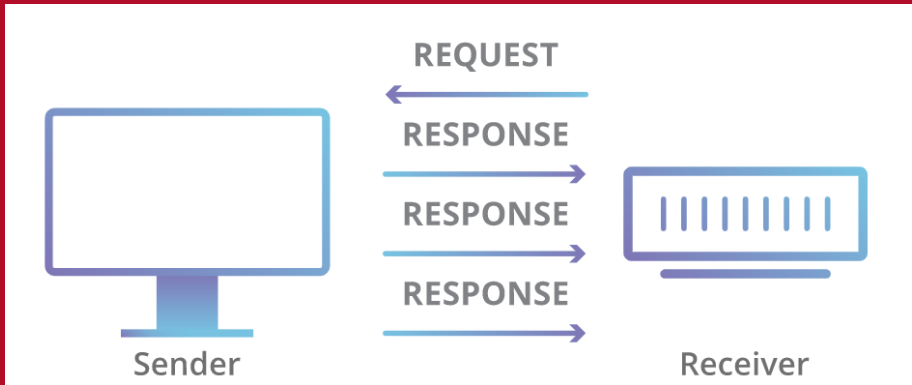
Technologies



Technologies Explanation

UDP

- Real-time so speed is more critical
- IoT devices today contain wireless sensor networks, it is more suitable to use UDP

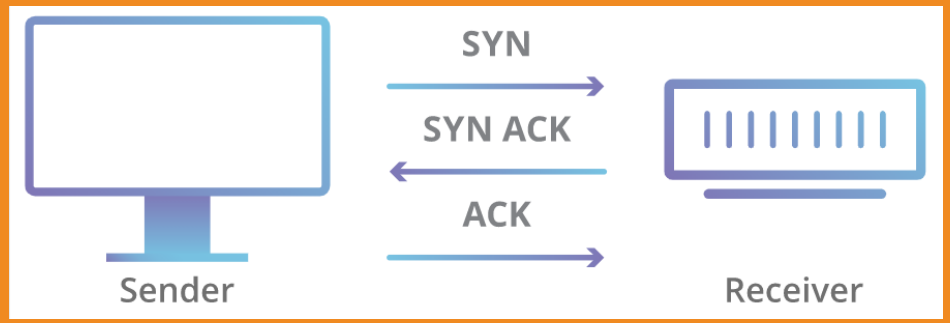


UDP	Python	Flask
HTTP	HTML, CSS, JS	SQLite

Technologies Explanation

HTTP

- CRUD
- Standardized
- Stateless
- Caching Principle



UDP

Python

Flask

HTTP

HTML, CSS, JS

SQLite

Technologies Explanation

Why REST Architecture?

- Client-Server Pattern
- Cache
- Stateless
- Uniform Interface
- Interconnected Resource Representation

Technologies Explanation

Python

- General Purpose cross platform language used for scripting
- To build web mobile and desktop applications for different operating system platforms

UDP	Python	Flask
HTTP	HTML, CSS, JS	SQLite

Technologies Explanation

Flask

- RESTful so supports HTTP
- Lightweight
- WSGI Compliant

UDP	Python	Flask
HTTP	HTML, CSS, JS	SQLite

Technologies Explanation

SQLite

- Serverless
- Lightweight
- Opensource and supports most SQL code (its license is "Public Domain")
- Stores data in a single file which can be stored anywhere.

UDP	Python	Flask
HTTP	HTML, CSS, JS	SQLite

Technologies Explanation

HTML, CSS, JS, JSON

HTML, CSS, JS:

- full flexibility and control over UI

JSON:

- lightweight data-interchange format
- self-describe
- more programmatic

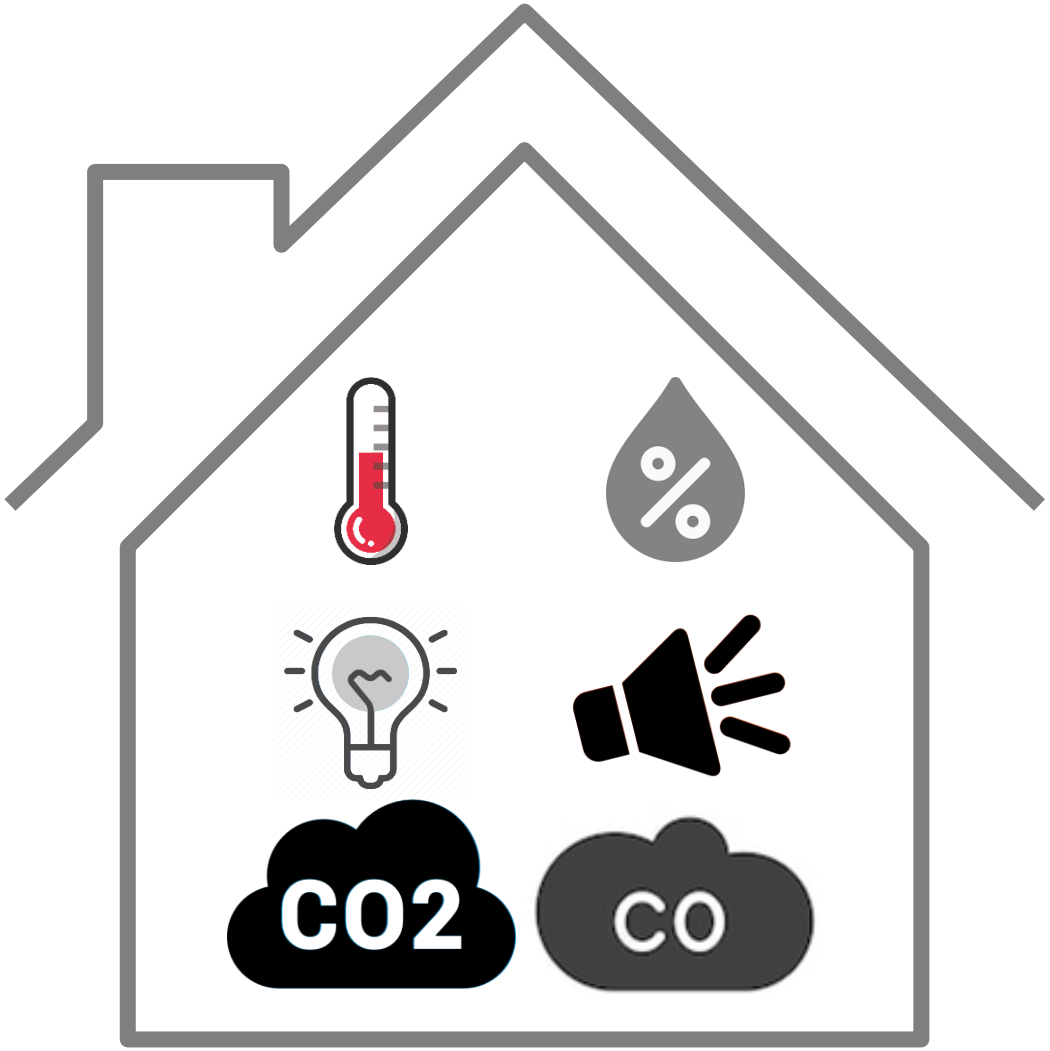
UDP	Python	Flask
HTTP	HTML, CSS, JS	SQLite

Part II
Implementation

Cosiness Indexes Research

Temperature [1]

Temperature in Celcius	Label
<18	Low
18-24	Good
>24	High

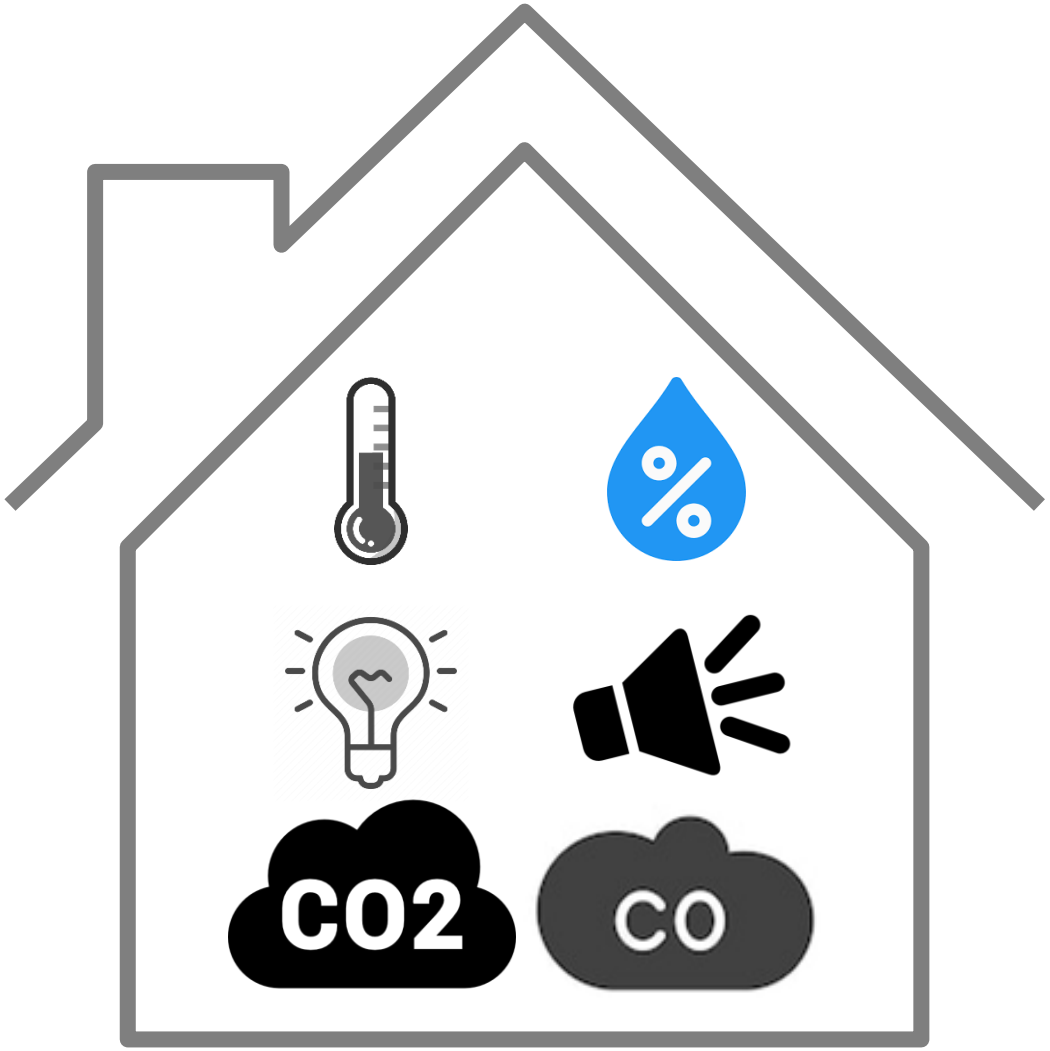


[1] https://hunterconair.com.au/what-is-the-ideal-indoor-temperature/

Cosiness Indexes Research

Humidity [2](*)

Humidity in %	Label
<30	Low
30-50	Good
>50	High



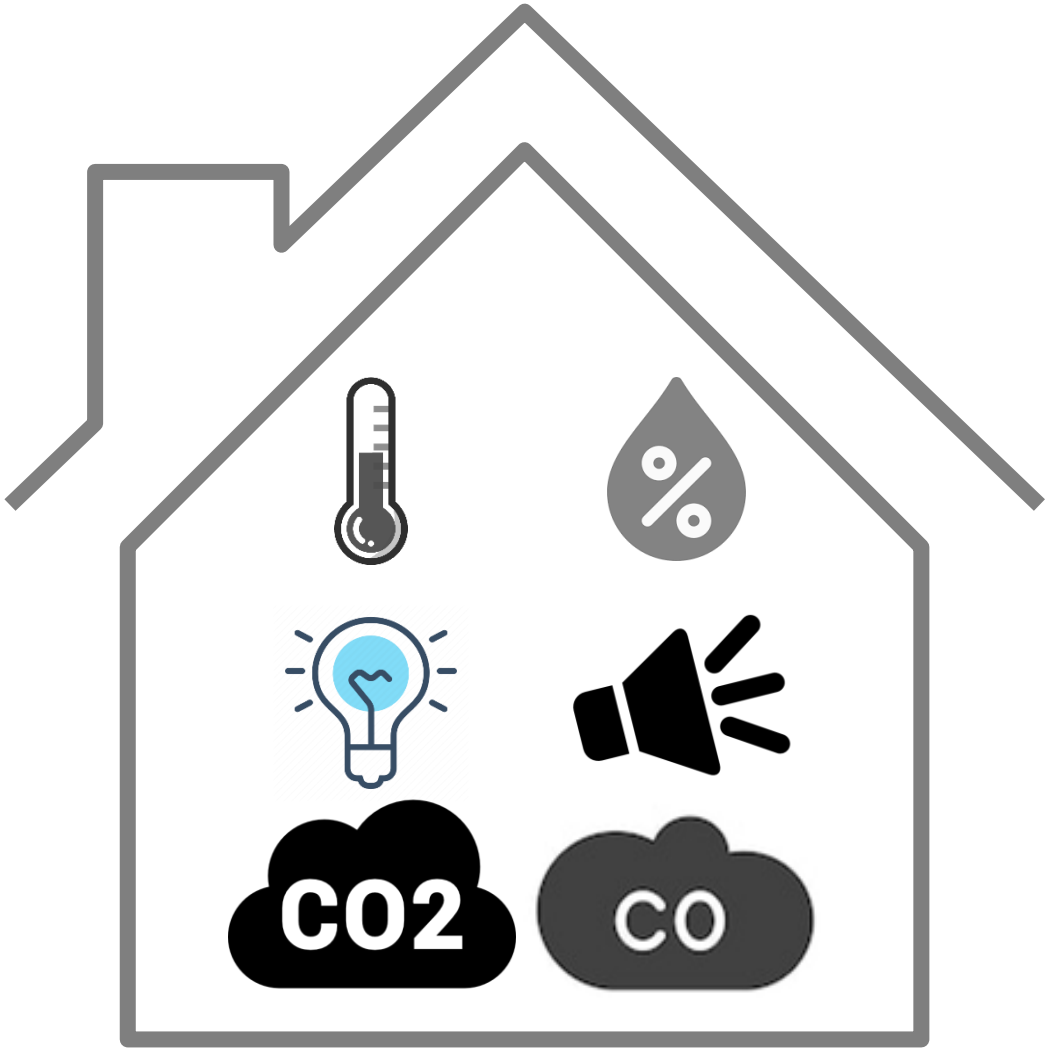
(*) Values were randomly generated

[2] https://www.sensitivechoice.com/indoor-humidity/

Cosiness Indexes Research

Light [3]

Light in Lux	Label
0-200	Not good
200-750	Good
>750	Alarming

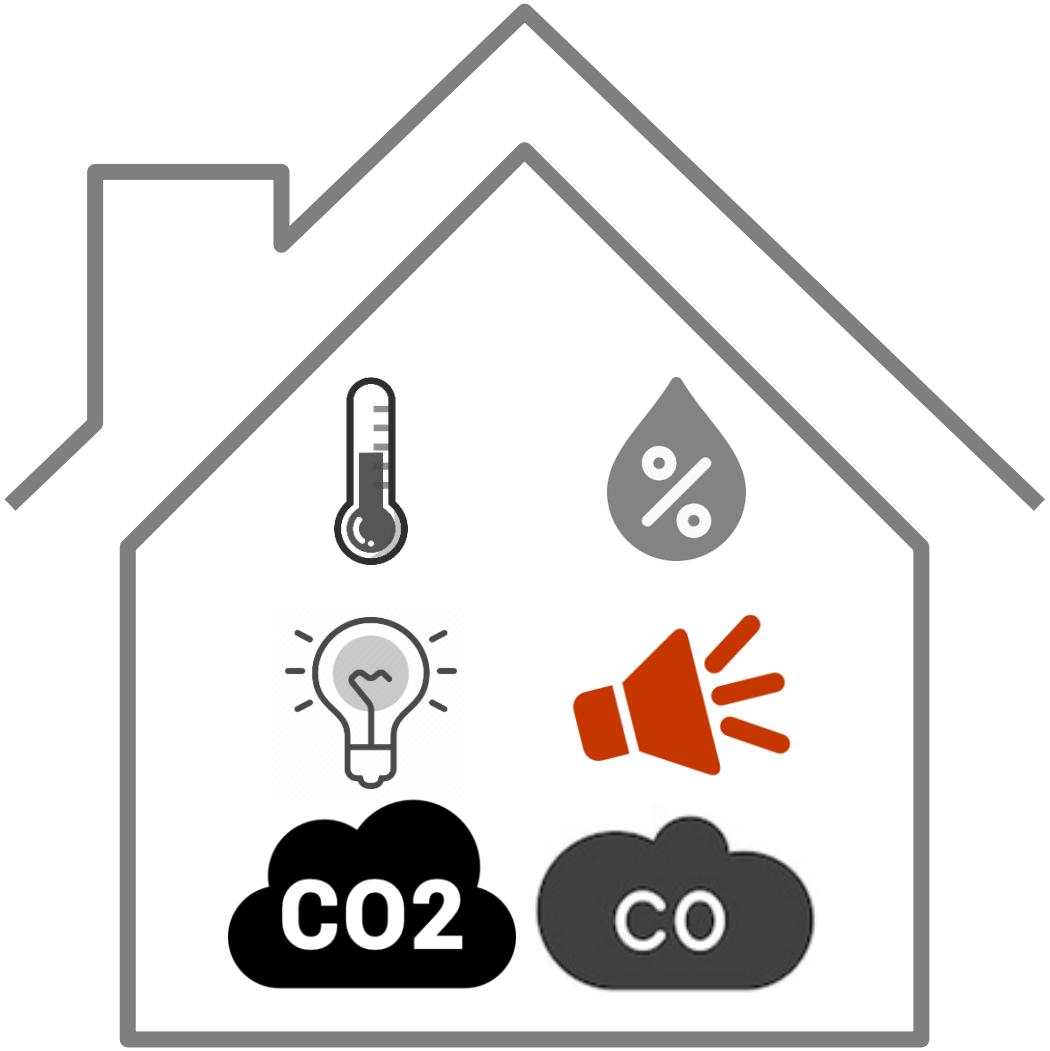


[3] https://www.engineeringtoolbox.com/light-level-rooms-d_708.html

Cosiness Indexes Research

Sound [4]

Sound in Decibel	Label
0-40	Good
40-70	Acceptable
>70	Bad

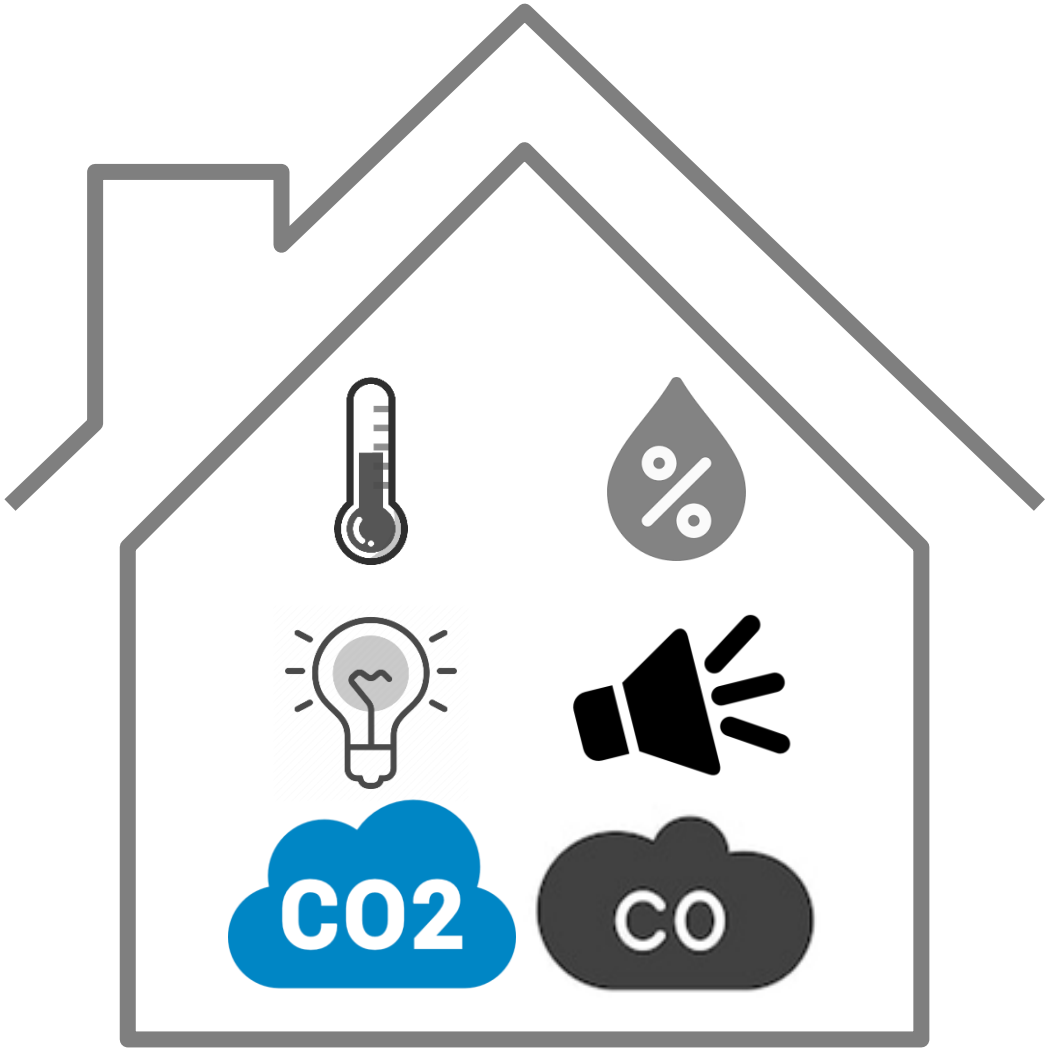


[4] https://www.healthlinkbc.ca/health-topics/tf4173

Cosiness Indexes Research

CO2 [5](*)

Value in ppm	Label
250-1000	Normal
>1000	Bad



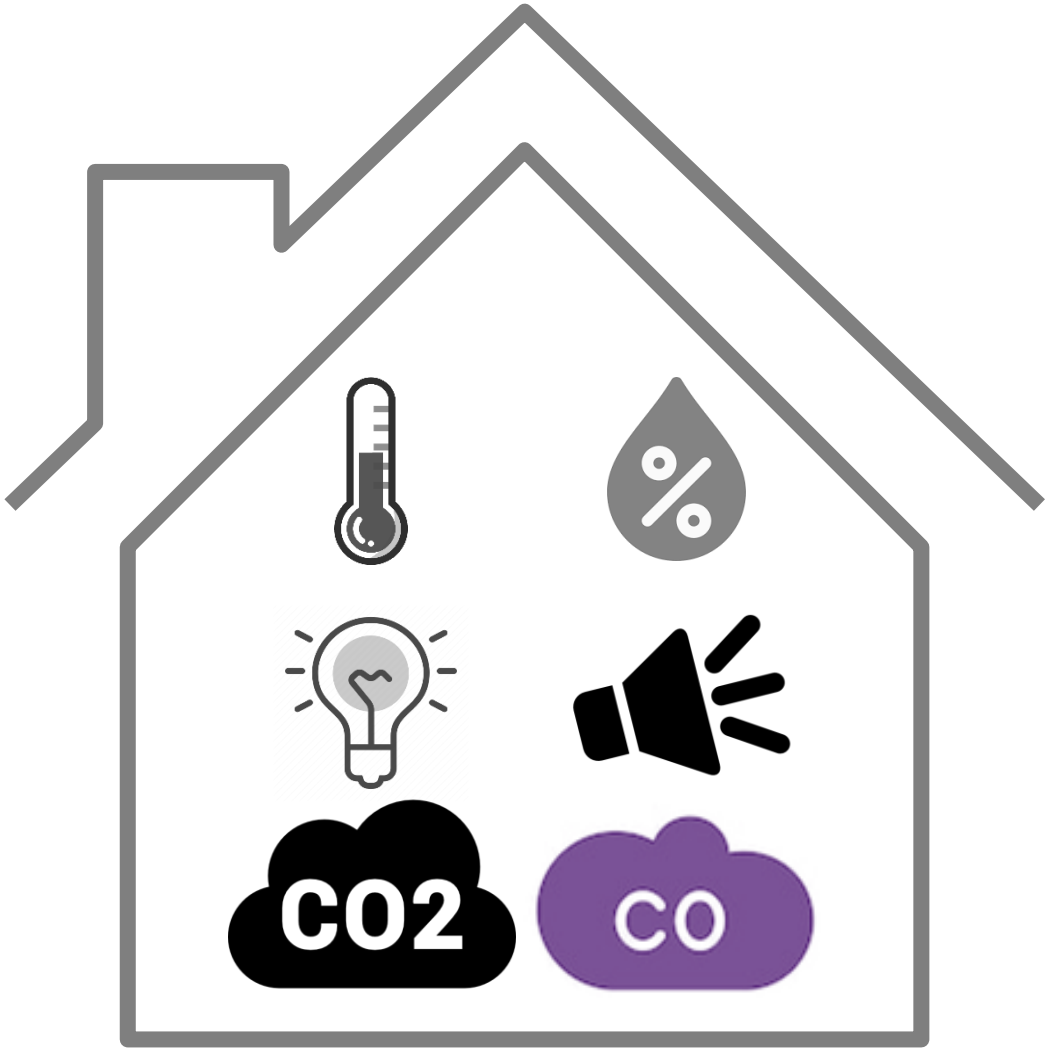
(*) Values were randomly generated

[5] https://www.kane.co.uk/knowledge-centre/what-are-safe-levels-of-co-and-co2-in-rooms

Cosiness Indexes Research

CO [5](*)

Value in ppm	Label
0-9	Good
9-35	Acceptable
>35	Bad



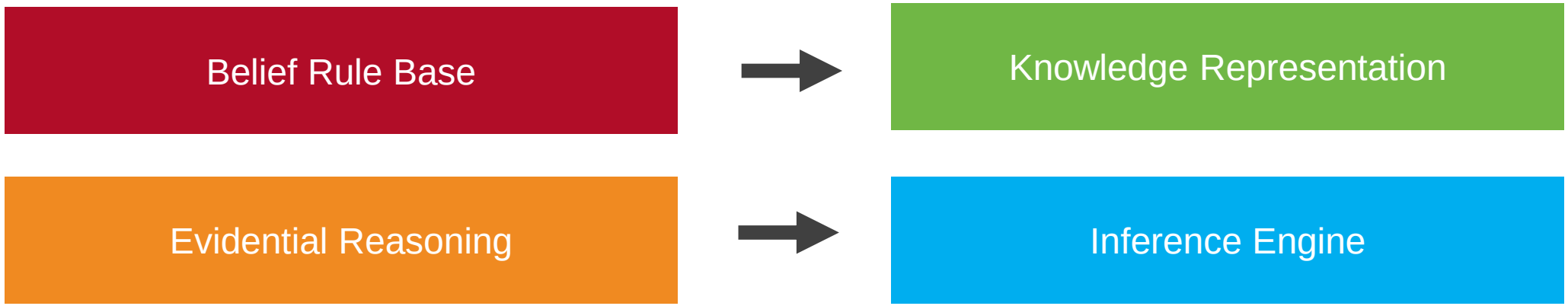
(*) Values were randomly generated

[5] https://www.kane.co.uk/knowledge-centre/what-are-safe-levels-of-co-and-co2-in-rooms

Cosiness Indexes Calculation

Methodology (Belief Rule-Based Expert System)

- **Belief Rule Based Expert System (BRBES):**



BRB Establishment

- extracting belief rules from domain expert knowledge
- extracting belief rules by examining historical data
- using previous rule bases if available
- using random rules if there is no prior knowledge

Cosiness Indexes Calculation

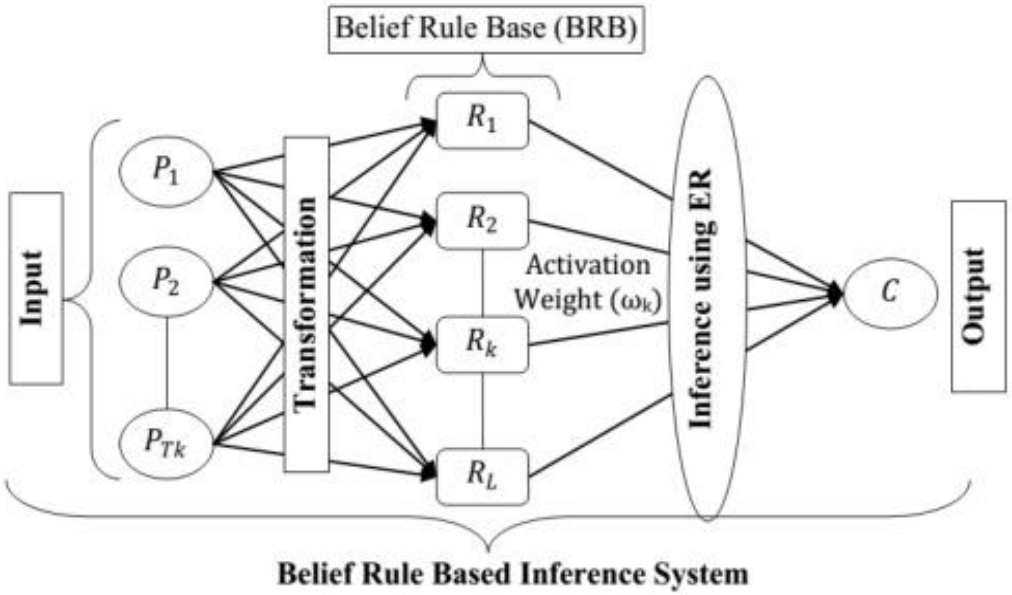
Methodology (Belief Rule-Based Expert System)

Belief Rules

- Antecedent
- Consequent

Knowledge Representation Parameters

- Attribute weight
- Rule weight
- Belief degrees

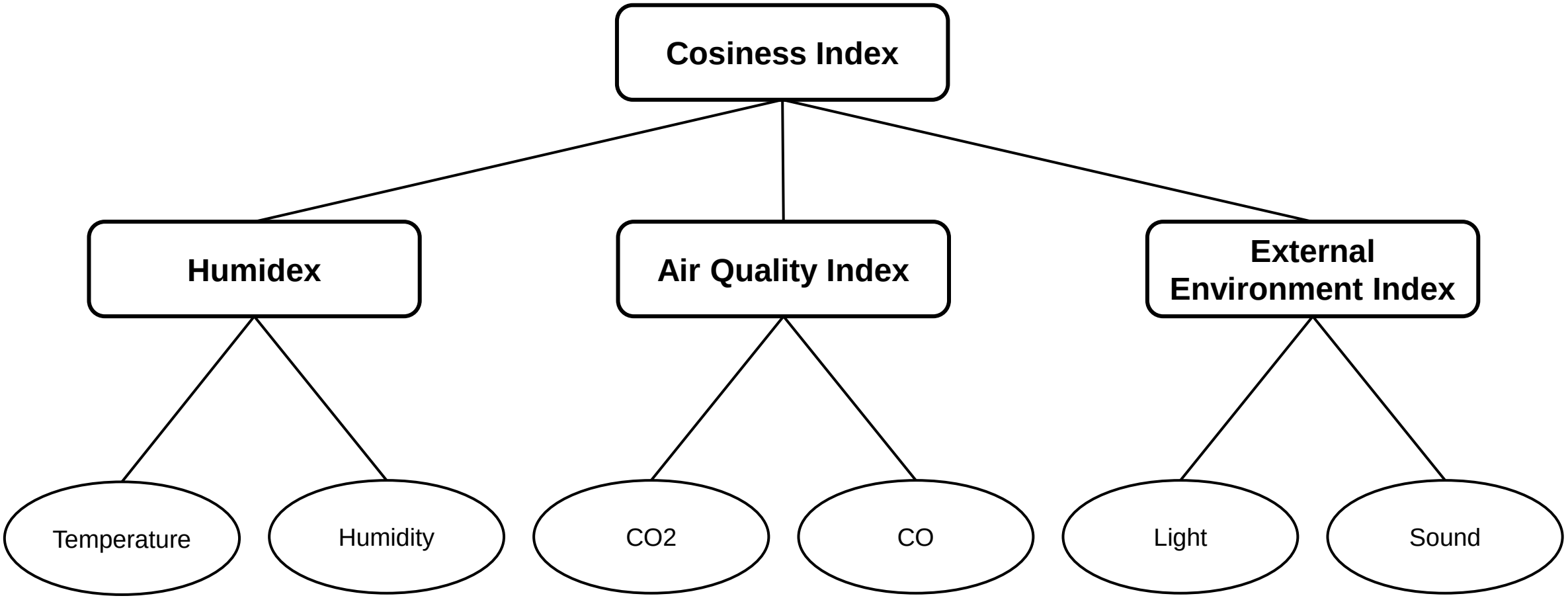


The inference procedures:

- Input Transformation
- Rule Activation Weight Calculation
- Belief Update
- Rule Aggregation Using Evidential Reasoning (ER)

Cosiness Indexes Calculation

BRB Framework to Evaluate Cosiness Index



Cosiness Indexes Calculation

Referential and Utility Values of the Attributes

Temperature

- {High, Good, Low}
- {24, 18, 0}

CO_2

- {Bad, Normal}
- {1000, 250}

Light

- {Alarming, Good, Not Good}
- {750, 200, 0}

Humidity

- {High, Good, Low}
- {50, 30, 0}

CO

- {Bad, Acceptable, Good}
- {35, 9, 0}

Sound

- {Bad, Acceptable, Good}
- {70, 40, 0}

Humidex

- {High, Medium, Low}
- {1, 0.5, 0)

Air Quality Index

- {Unacceptable, Acceptable, Good}
- {1, 0.5, 0}

External Environment Index

- {Alarming, Acceptable, Good}
- {1, 0.5, 0}

Cosiness Index

- {Very Uncomfortable, Uncomfortable, Very Comfortable, Comfortable, Cool}
- {1, 0.75, 0.50, 0.25, 0}

Cosiness Indexes Calculation

Initial Belief Rule Base

		IF		THEN (Humidex)		
Rule ID	Rule Weight	Temperature	Humidity	High	Medium	Low
1		High	High	1.0	0.0	0.0
2		High	Good	0.47	0.53	0.0
…	…	…	…	…	…	…
8		Low	Good	0.0	0.79	0.21
9		Low	Low	0.0	0.0	1.0

		IF		THEN (Air Quality Index)		
Rule ID	Rule Weight	CO2	CO	High	Medium	Low
1	1	Bad	Bad	1.0	0.0	0.0
2	1	Bad	Acceptable	0.93	0.07	0.0
..	…	…	…	…	…	…
5	1	Normal	Acceptable	0.0	0.02	0.98
6	1	Normal	Good	0.0	0.0	1.0

Cosiness Indexes Calculation

Initial Belief Rule Base

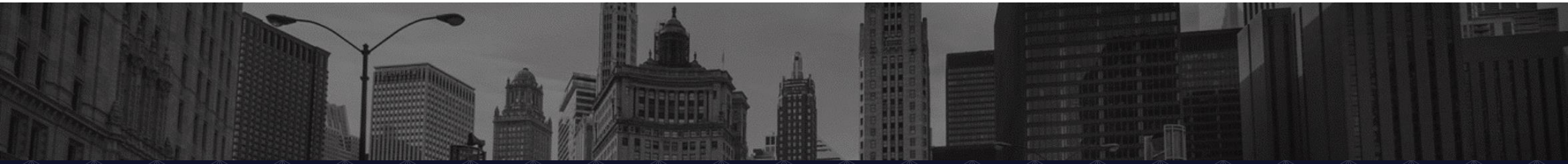
		IF		THEN (External Environment Index)		
Rule ID	Rule Weight	Light	Sound	High	Medium	Low
1	1	Alarming	Bad	1	0	0
2	1	Alarming	Acceptable	0.93	0.07	0.0
..	…	…	…	…	…	…
8	1	Not Good	Acceptable	0.0	0.1	0.9
9	1	Not Good	Good	0.0	0.0	1.0

		IF			THEN (Cosiness Index)				
Rule ID	Rule Weight	Humidex	Air Quality Index	External Environment Index	Very Uncomfortable	Uncomfortable	Very Comfortable	Comfortable	Cool
1	1	High	Unacceptable	Alarming	1.0	0.0	0.0	0.0	0.0
2	1	High	Unacceptable	Acceptable	0.33	0.67	0.0	0.0	0.0
..	…	…	…	…	…	…	…	…	…
26	1	Low	Good	Acceptable	0.0	0.0	0.0	0.67	0.33
27	1	Low	Good	Good	0.0	0.0	0.0	0.0	1.0

Cosiness Indexes Calculation

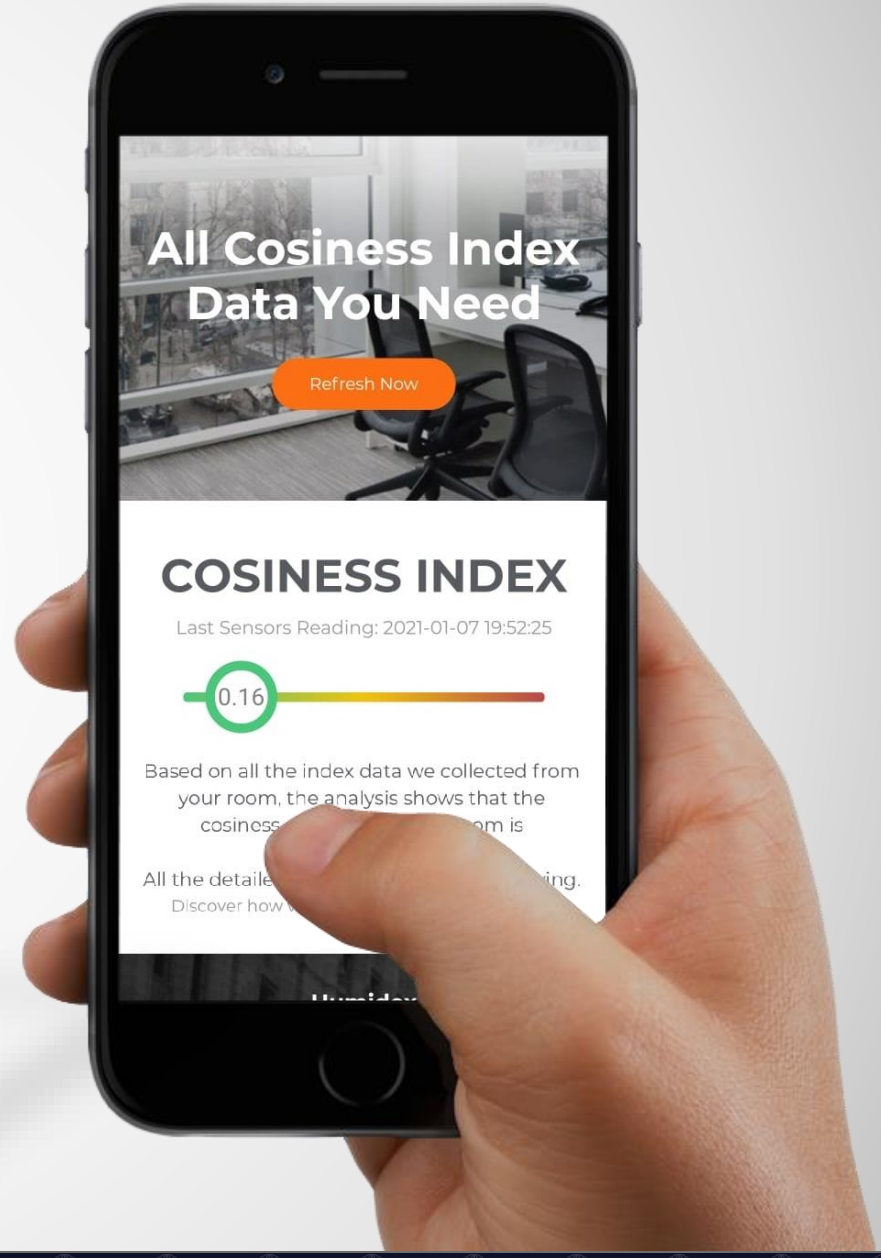
Preliminary Discussion

- Rule weights and attribute weights determine the importance of the corresponding antecedent attributes and rules, whereas the uncertainty of the output is represented by the belief degrees of the consequent attribute.
- Equal weight has been assigned to all the belief rules as well as to all the antecedent attributes, which is 1.
- The initial Belief Rule Bases are created using random rules as there is no prior knowledge available.
- The Belief Rule Base can be trained based on the historical data in order to obtain the optimal learning or knowledge representation parameters which will facilitate to reduce errors and assess the problem domain more reliably.



Part III
Demo

Demonstration



Part IV
Conclusion and Discussion

Conclusion and Discussion

- **Conclusion**
  - Implemented a full-stack (administrator and end-users) IoT project, that is capable of sensing (temperature, humidity, CO2, CO, light, sound), analyzing (Belief Rule-Based Expert System) and delivering a multi-level cosiness index.
- **Discussion**
  - All the sensors were not available, therefore, random values were generated. By this, the final cosiness index is not reflective of the actual condition of the room.
  - For now, all the attributes contribute to the same priority to the calculation of the cosiness index. Future work gears toward training the learning parameters, so that the attributes could contribute realistically.
- **Lessons Learned**
  - How to use what communication protocol
  - How to use different databases
  - How to integrate communication protocols for a real-life problem

Dedicated to

Our Supervisors, Supporters, Colleagues and Presentation Listeners

Thank you for listening!

Q&A Section