Modelling of the environmental impact on professional cyclists and people in buildings

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General Context

Environment

- all that surround us
  $\rightarrow$ climatic conditions
- constantly exposed to environmental impact: either indoors or outdoors
  $\rightarrow$ influences our comfort & sports performance
- wide range of possibilities to make measurements
- processing the data obtained using the Pulse software

Source:
weeklyvoice.com/canada-is-warming-faster-than-the-rest-of-the-world/

Groupama-FDJ

Source: groupama.com

- Project follow-up
- Study environmental impact on cyclists
- More accurate simulations

CEMOSIS

- IBAT project [1]

→ energy performance of the building

→ quality of life of its occupants

- Analyse environmental effect on people in working offices

Source: cemosis.fr/

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Road Map

- **Issues**:
  subdivide work
  into tasks

Road Map

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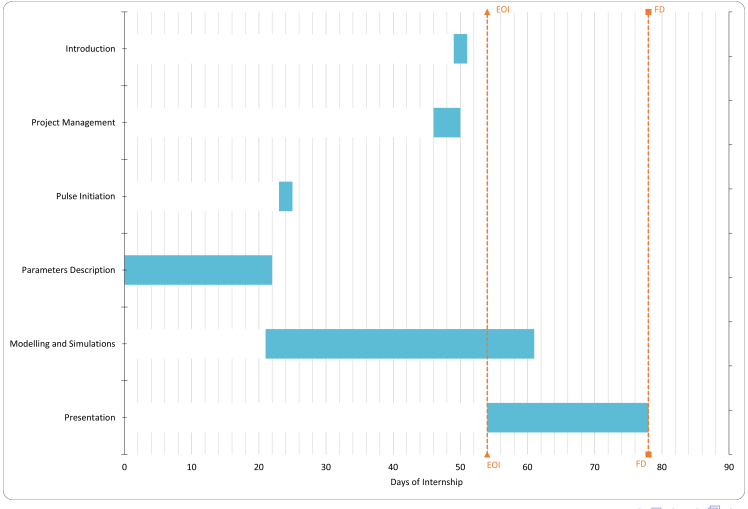
  → *Final defense (FD)*

Road Map

- **Issues**: subdivide work into tasks
- **Milestones**: sub-objectives
  → *End of internship (EOI)*
  → *Final defense (FD)*
- **Project**: *Pulse Environment*

Gantt Chart


EOI
FD
Introduction
Project Management
Pulse Initiation
Parameters Description
Modelling and Simulations
Presentation
0
10
20
30
40
50
60
70
80
90
Days of Internship

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Structure with example on atmospheric pressure

Definition & Description

Atmospheric pressure is the force applied on a surface by the air above it as gravity pulls it to the earth. [...]
With increasing altitude, the atmospheric pressure decreases. This leads to a reduction in the amount of oxygen available. [...] [3]

Structure with example on atmospheric pressure

Definition & Description

Atmospheric pressure is the force applied on a surface by the air above it as gravity pulls it to the earth. [...]
With increasing altitude, the atmospheric pressure decreases. This leads to a reduction in the amount of oxygen available. [...] [3]

Formula (if there is any)

$$P = 760 \cdot \exp(-0.00012 \cdot h) \quad [4]$$

where P : atmospheric pressure ($mmHg$) and h: height over sea level (m)

Structure with example on atmospheric pressure

Implementation

```
    "AtmosphericPressure": {
        "ScalarPressure": {
        "Value": 760.0,
        "Unit": "mmHg"
        }
    }

```

Listing 1: Atmospheric pressure in Pulse JSON file

Structure with example on atmospheric pressure

Implementation

```
1     "AtmosphericPressure": {
2         "ScalarPressure": {
3         "Value": 760.0,
4         "Unit": "mmHg"
5         }
6     }
7
```

Listing 2: Atmospheric pressure in Pulse JSON file

Reference values

Value	Description
Measured at 15°C and 0% humidity [5]	
760 mmHg	Standard sea-level pressure
675 mmHg	1000m altitude
600 mmHg	2000m altitude

Table: Reference Values example for Pulse Parameters

List of parameters

Parameter	Unit
Air Velocity	m/s
Ambient Temperature	°C
Clothing Resistance	clo
Emissivity	/
Mean Radiant Temperature	°C
Relative Humidity	/
Respiration Ambient Temperature	°C
Ambient Gas	/

Table: Pulse Environment Parameters

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Patient File

```
{
  "Name": "StandardFemale",
  "Sex": "Female",
  "Age": {
    "ScalarTime": {
      "Value": 44.0,
      "Unit": "yr"
    }
  },
  "Weight": {
    "ScalarMass": {
      "Value": 130.0,
      "Unit": "lb"
    } ...

```

Listing 3: Beginning of StandardFemale.json

- describes the patient's physical characteristics
- standard female/male (IBAT) + high performance cyclist (Groupama)

Patient File

```
{
  "Name": "StandardFemale",
  "Sex": "Female",
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  "Weight": {
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    } ...

```

Listing 4: Beginning of StandardFemale.json

- describes the patient's physical characteristics
- standard female/male (IBAT) + high performance cyclist (Groupama)

Parameters	
Age	DiastolicArterialPressureBaseline
Weight	HeartRateBaseline
Height	RespirationRateBaseline
BodyFatFraction	SystolicArterialPressureBaseline

Table: Patient File Parameters

Environment & Scenario File

Environment File

- contains previously described parameters
- different files provided by Pulse with same structure

Environment & Scenario File

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- contains previously described parameters
- different files provided by Pulse with same structure

Scenario File

- contains the patient's instructions over time
- possibility to include files as environment, nutrition, ...

Outputs

Parameter	Unit	Parameter	Unit
Blood Volume	L	Respiration Rate	1/min
Carbon Dioxide Production Rate	L/min	Respiratory Exchange Ration	/
Core Temperature	°C	Sweat Rate	mg/min
Fatigue Level	/	Skin Temperature	°C
Heart Rate	1/min	Total Lung Volume	L
Oxygen Consumption Rate	L/min	Total Metabolic Rate	kcal/day
Oxygen Saturation	/		

Table: Output Parameters [6]

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Data Selection

Parameter	Useful Data	Value
Air Velocity	speed	dataset values
Ambient Temperature	temperature	dataset values
Atmospheric Pressure	altitude	dataset values
Clothing Resistance [7][8][9]	/	0.513 *clo*
Emissivity [10]	/	0.90
Mean Radiant Temperature	temperature	dataset values
Relative Humidity	temperature	reference values
Respiration Ambient Temperature	temperature	dataset values
Ambient Gas [11]	/	Nitrogen: 0.7901 Oxygen: 0.2095 Carbon Dioxide: 4×10^{-4}

Table: Pulse Parameters Implementation

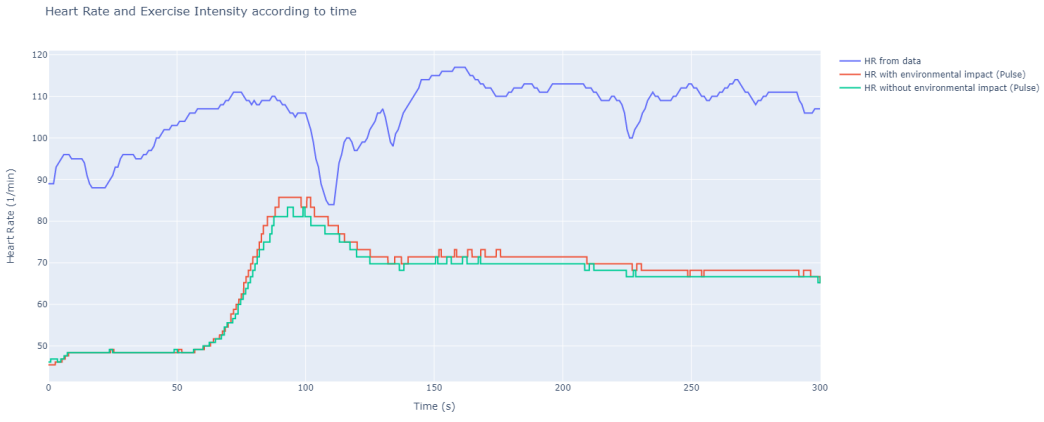
Modelling & Simulations - Mean Squared Error (MSE)

Formula:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2$$

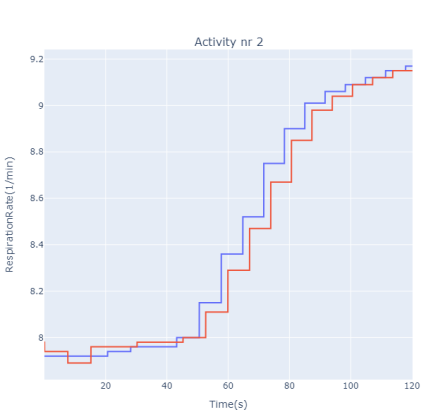
- Numerical value of the differences obtained between the different graphs
- compare our Pulse predictions with or without environmental impact during the simulations
  $\rightarrow$ higher MSE indicates a greater impact of the environment on this parameter

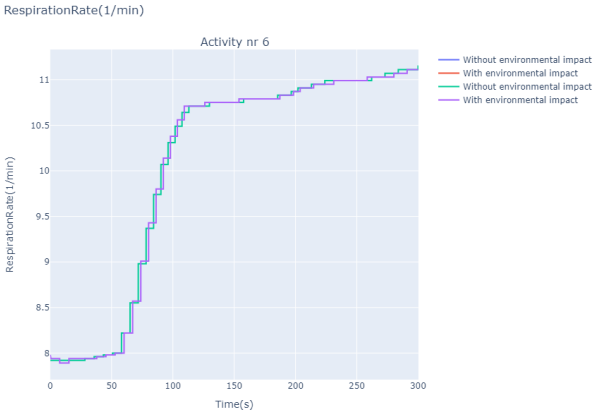
Modelling & Simulations - Real data and predictions



$$MSE = 3.237$$

Modelling & Simulations - Environmental impact on different parameters

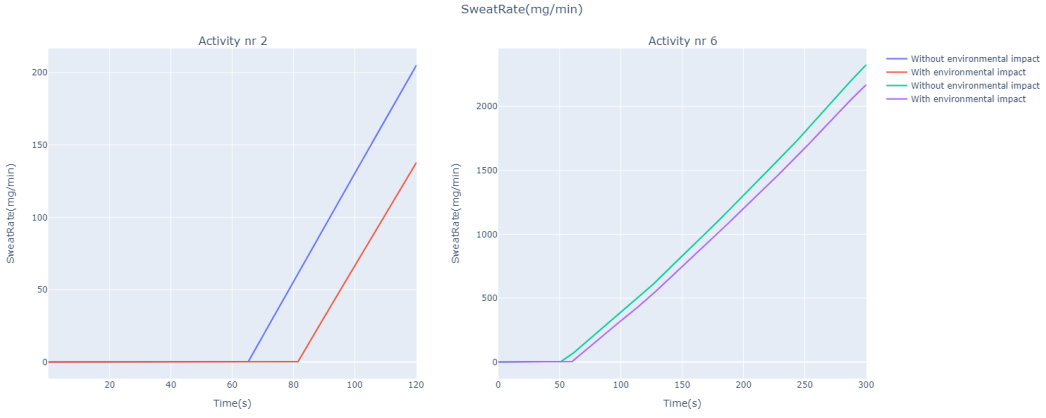




$MSE = 6.663 \times 10^{-3}$

$MSE = 5.202 \times 10^{-3}$

Modelling & Simulations - Environmental impact on different parameters



$MSE = 1.487 \times 10^3$

$MSE = 8.475 \times 10^3$

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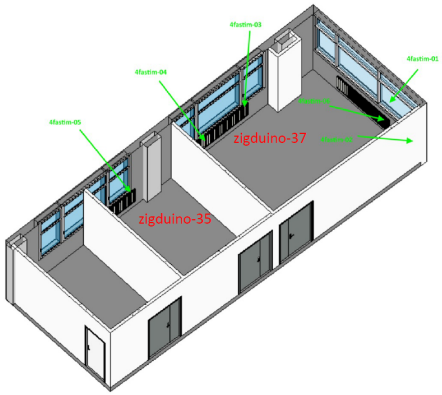
Sensor Distribution



- total of 200 sensors
- type: zigduino and 4fastsim
- measured are: temperature, relative humidity, noise, presence and light intensity at a frequency of 1 measure per second
- Elasticsearch database [12]

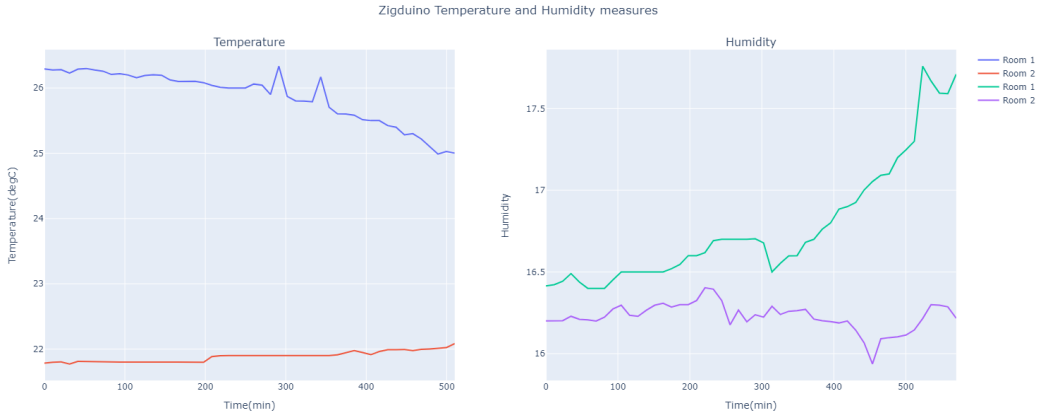
Source: Zohra Djatouti & Guillaume Schreiner

Data Selection

Parameter	Useful Data	Value
Air Velocity [13]	/	$0.1 m/s$
Ambient Temperature	temperature	dataset values
Atmospheric Pressure	/	$746.53 mmHg$
Clothing Resistance [14]	/	Cold: 0.61 *clo* Normal: 0.57 *clo* Warm: 0.36 *clo*
Emissivity [10]	/	0.90
Mean Radiant Temperature	temperature	dataset values
Relative Humidity	humidity	dataset values
Respiration Ambient Temperature	temperature	dataset values
Ambient Gas [11]	/	same as for Groupama

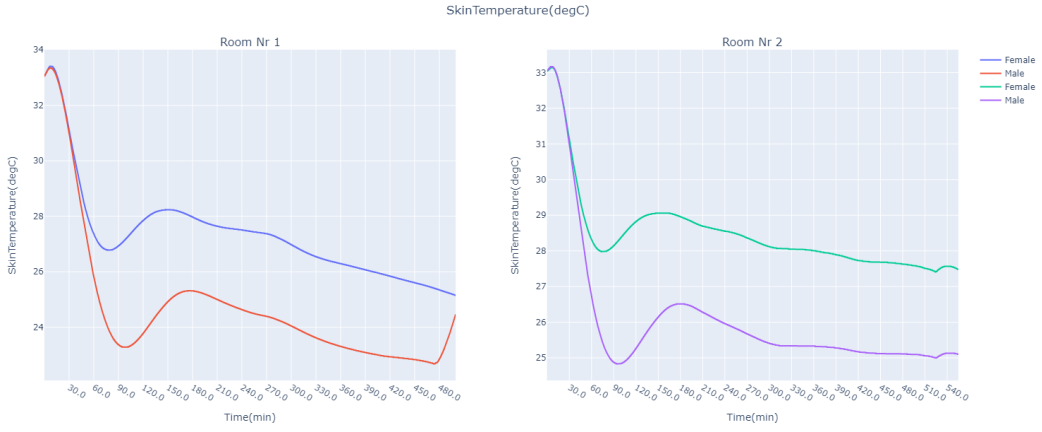
Table: Pulse Parameters Implementation

Modelling & Simulations - Normal (23.04.2021)



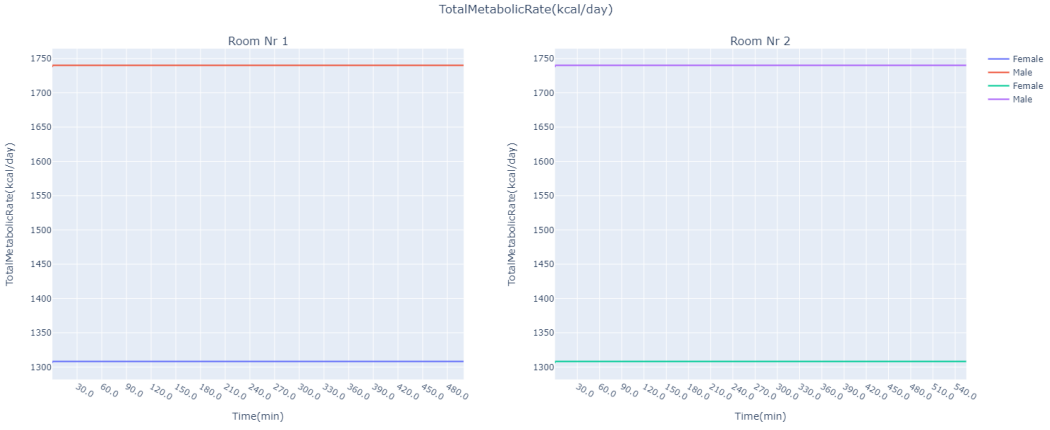
Note: low humidity values

Modelling & Simulations - Normal (23.04.2021)



Note: 1 simulation took about 1h25min

Modelling & Simulations - Normal (23.04.2021)



Note: Generally - woman: $2000 kcal/day$ and man: $2500 kcal/day$

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