INDOOR AIR QUALITY AT PEROLLINO DAY NURSERY

R-SÛR – a collaborative R&D project at the school of engineering and architecture of Fribourg (HEIA//FR)

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The aim of this R-SÛR project is to demonstrate the feasability and the benefit of keeping a constant check, with remote monitoring, on the indoor air quality (IAQ) in a building accommodating young children (0-5). The idea is to ensure a 100% healthy environment in the medium term, as this young population is very sensitive and can be affected in its physical and psychological development. This topic represents a true public health issue.

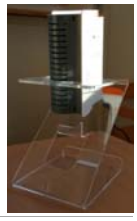
With this in mind, a major step will be to raise awareness and educate the nursery staff on this issue in the future.

Carbon dioxide, volatile organic compounds, fine particles, radon are part of the indoor pollution sources of of the air breathed all day long.

Up to now, this study has mainly been developed into two parallel parts :

- measuring, in collaboration with Amstein & Walthert, the usual indicators with a standard measurement device, to get a first characteristic signature of Perollino nursery air
- designing at HEIA-FR a measurement prototype, as open and flexible as possible, and testing the measurement recording, the data transfer as well as the data analysis

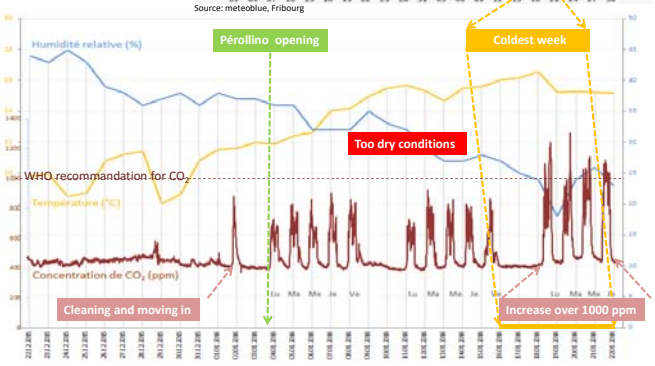
Measurements at Perollino



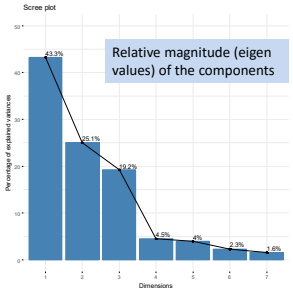
The Amstein&Walthert fireflies device used is a multi-sensor platform that measures :

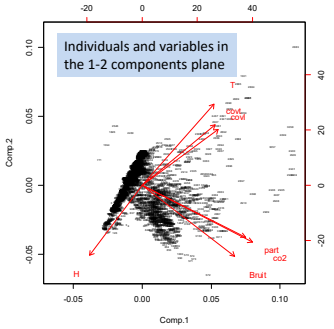
- Temperature (°C)
- Relative humidity (%)
- Carbon dioxide CO_2 (ppm)
- Noise level (dB)
- Light volatile organic compounds (µg/m³)
- Total volatile organic compounds (µg/m³)
- Fine particles, 0.5 to 1.5 µm (Mpart/m³)

We can observe portions of raw data directly:



We can also summarize the data – 7 variables (see above) observed on 3409 individuals (different timing) – with principal component analysis (PCA). This method consists in building virtual variables to best explain the variance contained in the data. These virtual variables, the components, are linear combinations of the true variables, defined mathematically as the eigen vectors of the correlation matrix. The graph on the right shows the projection of individuals in the plane of components 1 and 2; Arrows are the projections of true variables in the same plane. Their lengths and relative positions show which variables are important and which are correlated.





Further work:
Validation of the hypothesis of normality for PCA method.
Investigation of classification methods to characterize these time series, with the objective to get identified profiles of indoor air quality in a specific building, in particular at Perollino.

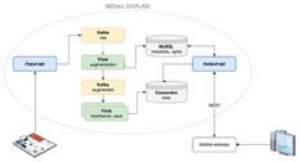
Development of a prototype at HEIA//FR

We have implemented several types of sensors, commercially available: calibrated or not, more or less cheap, in order to test what we can measure dynamically.
The main advantage, compared to the fireflies platform, is that we can monitor the different sensors, add or remove a sensor according to our wishes or results, thus improving our prototype design with time.

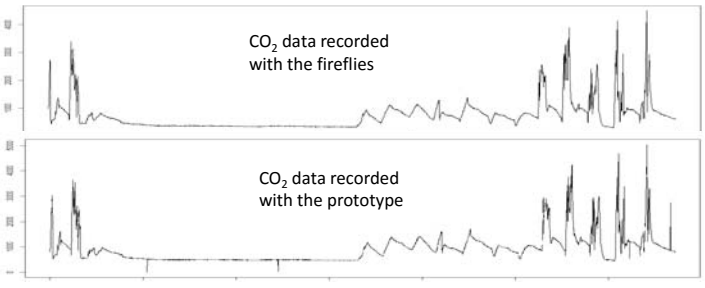
The prototype consists of two sensors boards protected by a box (see picture above) and is connected to a portable computer by USB. The communication architecture relies on POP-C++ objects and can be generic, independently of the actual sensors used; a driver must be available for each sensor.
To get and save measurements, we address two databases:

- a local database with raw records, that we can question by SQL queries (Structured query language)
- A remote database, hosted by the BBData platform. This platform offers also an interface to display easily the recorded sensors measurements. This is accessible from anywhere on the internet network

https://r-sur.daplab.ch



The comparison of the data collected with our prototype and the flyerflies system is quite promising; even if there is a shift, the relative behaviour is very close, as for CO_2 for instance:



Further work:
Study of sensors calibration – investigation of different sensors – improvement of prototype autonomy and measurement robustness

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