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Fribourg Statistiques et Applications des Mathématiques
Freiburg Statistik und Angewandte Mathematik
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SECTION OF EDUCATION & RESEARCH

Pitch Your Research in Statistics 2017

Friday, October 6th 2017, 1.30 – 5.30pm,
University of Fribourg, Pérolles 90, Fribourg

PROGRAM

13:30-14:00	Welcome coffee
14:00-14:45	Laurent Donzé: Why fuzzy logic in statistics? An introduction
14:45-15:15	Redina Berkachy: Demonstration with R how to analyse data in a fuzzy perspective
15:15-15:45	Coffee, demos, and poster session
15.45-16.45	**Short presentations** Corinne Hager Jörin: The different interpretations of 2×2 contingency tables Nayla Sokhn: Structure and Dynamics of niche-overlap graphs Martin Huber: Detecting heterogeneous effects of an experimental educational intervention based on machine learning
16:45-17:30	Aperitif and discussion

Abstracts

Session 1 ***Laurent Donzé:*** **Why fuzzy logic in statistics? An introduction**

Abstract:

The fuzzy set theory can help the statistician to model fuzziness embedded in data. It is extremely well suited for applications involving natural language, and for modelling non-stochastic uncertainties. We focus our attention on data for which imprecision, vagueness or fuzziness, are coming from linguistic variables, derived from linguistic questionnaires. First, we define "fuzzy numbers" and explain the main operators of fuzzy logic. Follows a description of the so-called "fuzzy process". We end our talk by the presentation of several applications of fuzzy statistics.

Rédina Berkachy: **Demonstration with R: How to analyse complex survey data in a fuzzy perspective?**

Abstract:

Considering our interest in studying questionnaires composed by linguistic variables e.g. categorical variables using *fuzzy logic* and applying it in real life data, we show how to compute and analyse this type of data in a fuzzy perspective. We propose an individual and global evaluations of the so-called "linguistic questionnaires" using the signed distance defuzzification method, and we provide an application of these evaluations on real data coming from a survey of the financial place of Zurich, Switzerland. At last, our most recent research showed that one can extend statistical inference methods in the classical theory to the fuzzy one. We supply as instance an example of hypotheses testing in this context.

Session 2

Corinne Hager Jörin: The different interpretations of 2×2 contingency tables

Abstract:

Three different examples of 2x2 tables are presented: one based on the total number fixed design, one based on the one margin fixed design and one based on paired data. The corresponding null hypothesis and the statistical test used to analyse these data are explained. Although the 2x2 table has a simple form, the analysis of such data is not obvious because it depends on the design of the study.

Nayla Sokhn: Structure and Dynamics of niche-overlap graphs

Abstract:

Niche-Overlap graphs depict the competition between species in the nature. We explored these networks from three different perspectives: algorithmic, structure and dynamics.
We developed a novel algorithm to detect efficiently chordless cycles and showed that these cycles are numerous in niche-overlap graphs. We moreover investigated the factors influencing their presence, pointing out the important role of omnivores in these graphs. By quantifying the competition between species, we revealed the prevalence of weak links in chordless cycles, and their strong effect in reducing the number of chordless cycles when they are removed from the network. We simulated the abundance of species over time using systems of Lotka-Volterra differential equations. We then related the persistence of species to their structural properties inside the networks using the generalized linear model. Results revealed a strong significant influence of the degree and to a lesser extent of the frequency of chordless cycles and of clustering coefficient.

Martin Huber: Detecting heterogeneous effects of an experimental educational intervention based on machine learning

Abstract:

We present an experimental evaluation of the impact of an information leaflet about environmental implications of coffee production on the awareness about such environmental issues as well as self-assessed buying behaviour among high school and university students in Bulgaria. Specifically, we combine our randomized experiment with a machine learning method, namely regression trees, to investigate whether the causal effects of the leaflet are heterogeneous across specific subgroups of students. We find that w.r.t. creating awareness about environmental issues, the leaflet had the largest (and statistically significant) impacts on older students, in particular those going to non-technical universities, while the effects on younger (i.e. high school) students were mostly not statistically significantly different from zero.

Posters

Title	Presented by
Modelling neural circuit sensorimotor transformations in drosophila larvae	Lucia de Andres
Quel air respirent les Suisses romands dans leurs habitations économes en énergie ?	Corinne Hager Jörin
Characterization of double positive and double negative feedback loop	Xavier Richard
Impact of organizational and psychographic variables on perceptions of work-life conflict	Mathias Rossi and Mélanie Thomet
Indoor air quality at Perollino day nursery	Pascale Voirin

Demos

Title	Presented by
Interactive Web Apps presentation using Shiny and R	Nayla Sokhn
Jupiterhub	ASAM Group

MODELLING NEURAL CIRCUIT SENSORIMOTOR TRANSFORMATIONS IN *DROSOPHILA* LARVAE

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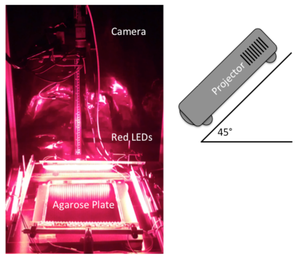
Experimental larval navigation

Behavioural set up

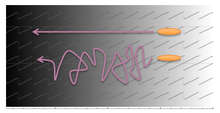


Larvae are presented with a **light** input that comes from a projector at **45°**

Important navigation parameters

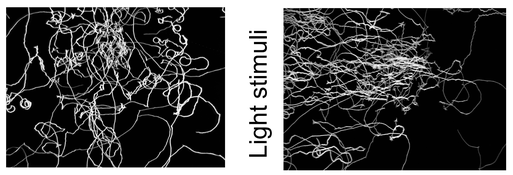
$$NI = \frac{v_{M,x}}{v_M} = \frac{\Delta x}{s}$$

$v_{M,x}$ = Velocity in x axis
v_M = Mean speed in all directions
Δx = Distance travelled in x axis
s = Overall distance travelled



NI=-1
NI≈-0.2

How "efficient" are larval navigations?

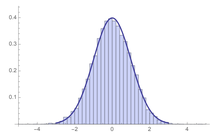


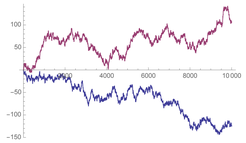
Larvae **consistently** avoid light, yet their movements seem to be very inefficient for this purpose, unexpectedly **stochastic**

Modelling larval behaviour

No stimuli: Brownian movement

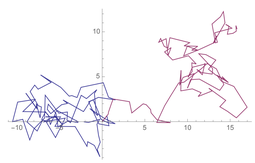
1. Gaussian distribution of random numbers





2. Random walk in 1D. Random walks of 10.000 steps each

3. Random walk in 2D. Lists of pair of number using two independent gaussians



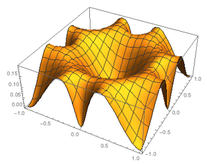
Metropolis, a biased random walk

The **metropolis algortithm** can be used to asses how often larvae go against the gradient.

According to this model a system can **go upwards** in energy with a probabilty:

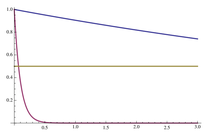
$$R < e^{-E/T}$$

E = Energy, extrinsic part



Steepness of the field

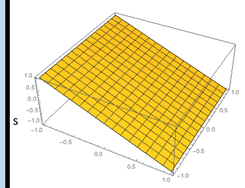
T = Temperature, intrinsic part



Larval "internal energy", ability to go against the field

Biological purpose of this intrinsic randomness?

A random walk can be biased in a field



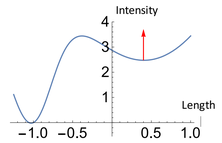
Larvae would feel a strong force that would direct their movements "**downwards**" in the field while still being quite random

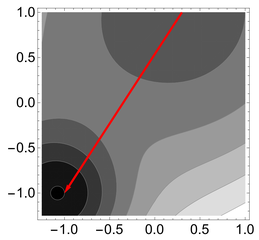
Possible fields:
Light, odour, gustation

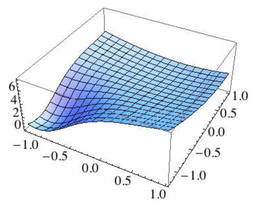
The safest behaviour is to take risks

Fields in the real world are more complicated, they have **local** and **global** minima

- ✓ To find the best minima you have to go up
- ✓ Trade-off: speed-efficiency
- ✓ Randomness is robust, maybe genetically hard-wired



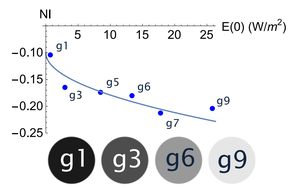




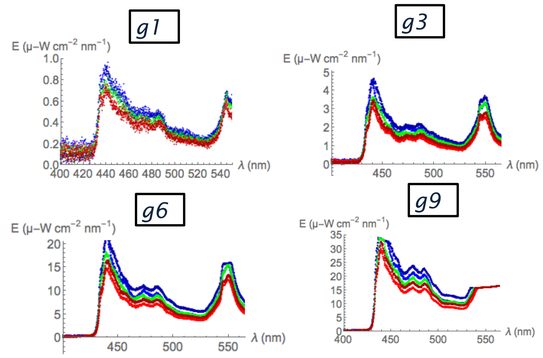
Larval response to light: important parameters

Steepness of light gradient, intensity

Larvae have a better navigation index when the **steepness** of the gradient and the **intensities** are higher.

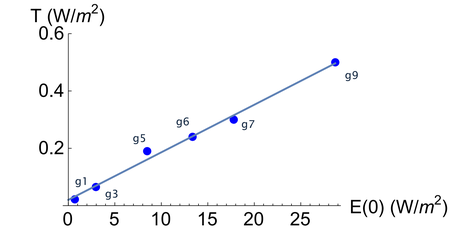


The filters named as **g1-g9** are all **linear** and have increasing intensity and increasing steepness.



Larval internal energy, "temperature"

Larval "**internal energy**" (T) can be estimated from their navigation index using the Metropolis algorithm



Larvae are willing to **take more risks** when the slope and the intensities are higher.

Bibliography

- Elizabeth A. Kane *et al.*, 2013. Sensorimotor structure of drosophila larva phototaxis. *Proceedings of the National Analysis of Sciences* ***110***.
- Alex C. Keene *et al.*, 2011. Seeing the light: photobehaviour in fruit fly larvae. Trends in Neuroscience **35**.

QUEL AIR RESPIRENT LES SUISSES ROMANDS DANS LEURS HABITATIONS ÉCONOMES EN ÉNERGIE ?

Mesqualair, un projet Ra&D collaboratif pour y répondre

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MESQUALAIR 2013-2016

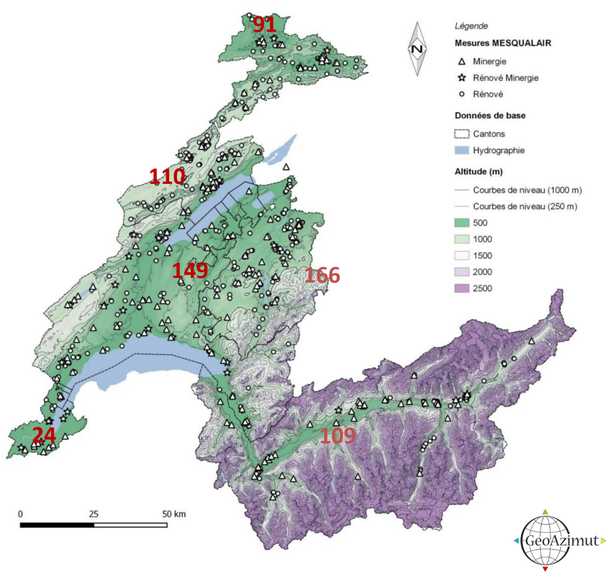
pst-fr pôle scientifique et technologique du canton de fribourg

cluster énergie & bâtiment
Energie & Gebäude Cluster

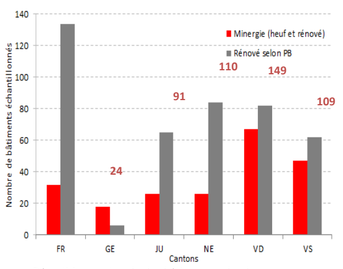
Contexte - Les mesures prises en faveur des économies d'énergie dans le bâtiment ne risquent-t-elles pas d'induire une détérioration du cadre bâti, neuf ou rénové, au détriment de la santé des occupants ?

Méthode - Trois campagnes de mesures accompagnées d'un questionnaire détaillé, se sont succédées entre 2013 et 2016 pour répondre à cette question. Radon, composés organiques volatils (COV) et moisissures ont été quantifiés et identifiés dans un grand nombre de villas. Deux campagnes de mesures ont porté entre 2013 et 2015 sur la mesure officielle du radon effectuée dans une pièce de vie du bâtiment durant 3 mois dans 650 bâtiments. Parmi ceux-ci 214 étaient des bâtiments neufs ou rénovés ayant obtenu le label MINERGIE® et les 436 autres ont bénéficié du Programme Bâtiment dans le cadre d'un assainissement énergétique partiel ou global. Entre septembre 2015 et février 2016, la troisième campagne s'est focalisée sur la mesure des polluants chimiques à savoir les composés organiques volatiles (COV) et les aldéhydes (ALD) et des bio-contaminants dans un peu moins de 200 habitations parmi les bâtiments déjà comptabilisés.

Distribution des habitations sur le territoire Suisse romand selon le type de bâtiment considéré



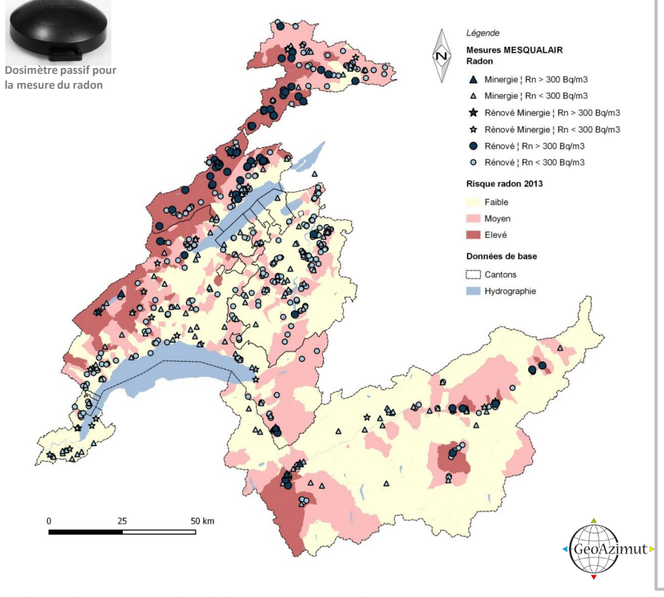
- Contact établis par les Services cantonaux de l'énergie ainsi que l'agence Minergie®
- Mesures effectuées sur une base volontaire après inscription
- Soumission systématique d'un questionnaire détaillé de 120 questions adaptées au type d'habitation et aux usages des occupant-e-s (taux de réponse effectif 95%)
- Un tiers des habitations mesurées ont obtenu le label Minergie



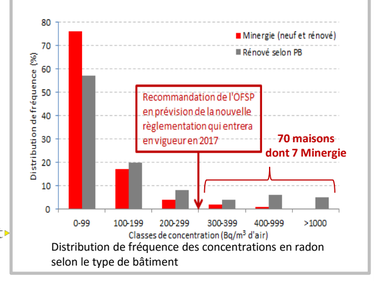
Répartition cantonale des bâtiments selon leur type

Radon - Distribution des concentrations mesurées selon le type de bâtiment et le niveau de risque


Dosimètre passif pour la mesure du radon



- Concentration moyenne de radon mesurée en Suisse romande de 180 Bq/m³ d'air avec médiane à 71, min à 5 et max à 4'284 Bq/m³
- Effet du type de bâtiment hautement significatif ($p < 0.001$)
- Effet hautement significatif de la zone de risque ($p < 0.001$) telle que définie par l'OFSP. Forte empreinte de la géologie
- Effet de l'âge tous types de bâtiments confondus et de la présence d'une cave naturelle hautement significatif ($p < 0.001$)



Distribution de fréquence des concentrations en radon selon le type de bâtiment

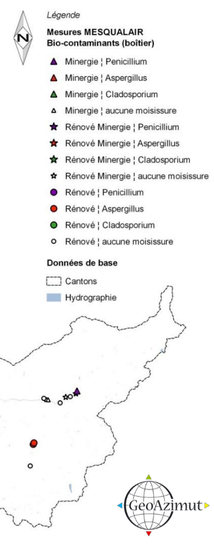
Moisissures - Identification d'espèces dominantes dans la poussière époussetée selon le type de bâtiment et la saison


Lingette pour épousseter après 1 semaine

Fin d'été

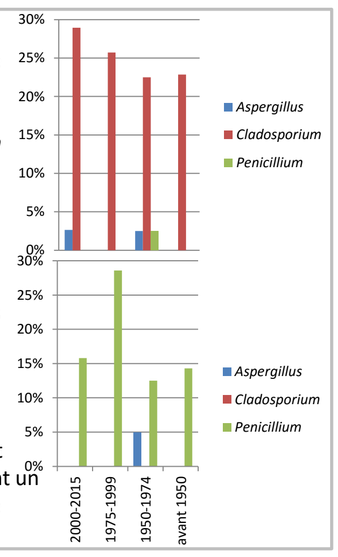

Boitier exposé à la poussière durant 3 mois

Hiver



Situation de fin d'été:
- 157 bâtiments échantillonnés en septembre
  - 25% de bâtiments neufs
  - 75% de bâtiments rénovés
- Esp. dominante (>70%) d'été : *Cladosporium*
- Niveau de contamination similaire entre le neuf et le rénové et d'une tranche d'âge à l'autre. Source extérieure probable.

Situation d'hiver:
- 160 bâtiments échantillonnés durant 3 mois d'octobre à décembre
  - 26% de bâtiments neufs
  - 74% de bâtiments rénovés
- Esp. dominante (>70%) d'hiver: *Pénicillium*
- Parmi les bâtiments construits entre 1975 et 1999, une plus grande proportion présentent un problème de moisissures. Source intérieure cachée?



Moisissures – Présence/absence effective de moisissures prélevées sur lame selon le type de bâtiment


Lame pour prélèvement sur surface

- 73 maisons ont retourné 110 prélèvements de surface – 22 provenant de 15 bâtiments Minergie et 88 venant de 58 logements rénovés
- 32% des prélèvements de surface venant de bâtiments Minergie et 56% de ceux effectués dans les bâtiments rénovés sont positifs pour le développement de moisissures

	Minergie Neuf	Minergie Rénové	Rénové
Salle de bain	Chrysonilia (2), Trichotecium (1)	-	Aspergillus, Cladosporium, Curvularia,
Chambre à coucher	-	-	Aspergillus, Cladosporium, Geomyces, Penicillium, Scopulariopsis, Stachybotris, Trichotecium
Buanderie	Ulocladium (1)	-	Aureobasidium (1), Cladosporium (3)
Cave	Cladosporium (1)	Trichotecium (1)	Aspergillus, Cladosporium, Trichotecium
Chauffage	-	-	Wallemia (1)

- Maisons Minergie moins affectées
- La chambre est contaminée dans les bâtiments rénovés
- La cave est le seul endroit dans lequel tous les types de bâtiments présentent des moisissures

COV totaux – Distribution des concentrations mesurées selon les types de bâtiments


Badge à charbon actif pour la mesure passive des COV

- Identification de 73 substances présentes au moins à une reprise sur les capteurs
- COV totaux (eq toluène) compris entre 25 et 2'292 µg/m³. Environ 92% des cas sont inférieurs à la recommandation de 1'000 µg/m³ de l'OFSP et 12% dépassent le seuil de 750 µg/m³ suggéré par Minergie-Eco
- Toluène attendu dans tous les prélèvements en raison de sa source extérieure. Teneurs usuelles de l'ordre de 20 – 50 µg/m³ dans air urbain pollué par le trafic routier
- Formaldéhyde toujours inférieur à 125 µg/m³ recommandé par l'OFSP
- D-Limonène présent dans 76% des cas. Terpène associé à des parfums et fragrances de produits de nettoyage
- Influence significative du garage intégré sur la qai (COV tot et BTEX: 2 à 3 fois supérieurs mais demeurent inférieures aux seuils recommandés par le label GI)

Conclusion – Il apparait clairement que les bâtiments construits ou rénovés en respectant des prescriptions adéquates de renouvellement d'air telles quelles le sont avec le label Minergie® sont aussi les bâtiments qui présentent *a priori* le moins de pathologies. Une grande attention est donc requise lors de la rénovation énergétique de bâtiments traditionnels. Le fait de les isoler sans intégrer de concept de ventilation/aération rime à les enfermer sous une cloche. Ces nouvelles conditions risquent à moyen terme d'induire une détérioration significative des conditions de vie à l'intérieur ainsi que la dégradation du bâtiment lui-même. Des recommandations de bonnes pratiques sont adressées tant aux professionnels de la construction qu'aux occupants de ces habitations. La rénovation du parc immobilier, enjeux majeur des années à venir, nécessite une extrême vigilance de la part de toutes les parties.

Projet NPR nouvelle politique régionale
TRANSFORM 1 Transform Institute Heritage, Construction and Users
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TOX pro 4
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croqAIR centre romand de la qualité de l'air intérieur et du radon
Hes·so Haute Ecole Spécialisée de Suisse occidentale
Fachhochschule Westschweiz

Characterization of double positive and double negative feedback loop

{ Xavier Richard, Benoît Richard, Christian Mazza, Jan Relof Van der Meer } University of Fribourg

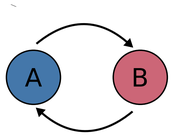
UNIL | Université de Lausanne
Département de microbiologie fondamentale

Introduction

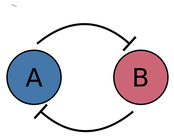
According to [1], a **feedback** "refers to a situation in which two (or more) dynamical systems are connected together such that each system influences the other". A dynamical system is a system whose behavior change over time. A feedback is **positive** when a perturbation of a system increase the response of the other. In contrast, a feedback is **negative** when a perturbation of a system decrease the response of the other. Double positive and double negative feedbacks loops are the simplest systems in which two stable states can arise.

Model

Double positive feedback loop



Double negative feedback loop



A double positive feedback can be expressed by the following differential equation system:

$$\begin{cases} \dfrac{dA}{dt} = \dfrac{c_1 B^2}{1+B^2} - A = f_p(A,B) \\ \dfrac{dB}{dt} = \dfrac{c_2 A^2}{1+A^2} - B = g_p(A,B) \end{cases} \tag{1}$$

A double negative feedback can be expressed by the following differential equation system:

$$\begin{cases} \dfrac{dA}{dt} = \dfrac{c_1}{1+B^2} - A = f_n(A,B) \\ \dfrac{dB}{dt} = \dfrac{c_2}{1+A^2} - B = g_n(A,B) \end{cases} \tag{2}$$

Stable Steady States

The steady states are the solutions of the system when the equilibrium is reached:

$$\begin{cases} f_{p,n}(A,B) = 0 \\ g_{p,n}(A,B) = 0 \end{cases} \tag{3}$$

A steady state $s = (A_s, B_s)$ is a **stable node** if all the eigenvalues of J_s, the Jacobian matrix of the system above evaluated at $s = (A_s, B_s)$ have negative real part. If all the eigenvalues of the Jacobian matrix are positive, the steady state is called an **unstable node**. A system with two stable steady states is called **bistable**.

Phase Plane Analysis

In order to see graphically the dynamic of the system, a phase plane analysis can be perform for given parameters c_1 and c_2 in equations (1) and (2). When the arrows are going in the direction of an intersection point, this point is a **stable node**. When the arrows are going away from an intersection point, this point is an **unstable node**.

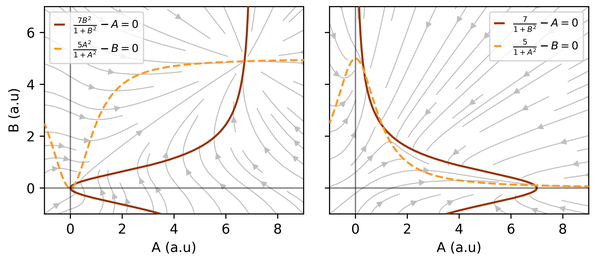


Figure 1: Phase plane analysis of a double positive feedback (left) and of a double negative feedback (right). The parameters are in both cases $c_1 = 7$ and $c_2 = 5$. The two stable curves are defined by eq. (3).

The next step is to determine for which parameter c_1 and c_2 those systems are bistable.

Bistability Range

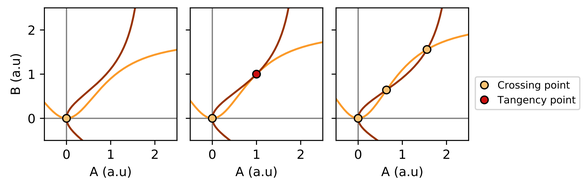


Figure 2: Change of the stable curves when the parameters goes from $c_1 = c_2 = 1.8$ (left, one intersection), to $c_1 = c_2 = 2.2$ (right, three intersections). A tangency point is encountered for $c_1 = c_2 = 2$ (center).

Having two or more intersections is a sufficient condition for bistability. The fact that deforming the stable curves to change the number of intersection entail the creation of a tangency point allows to find the boundary of the bistable region.

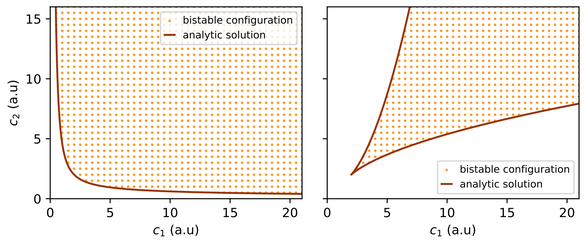


Figure 3: Bistability range of a double positive feedback (left) and a double negative feedback (right). Each dot represents a configuration which has been tested numerically to be bistable and the solid line the analytic solutions corresponding to the boundary between bistable and non bistable area.

The boundary is found as a parametric curve. For a double positive feedback loop it yields

$$\begin{cases} a(\lambda) = \left(1+\lambda^{-2}\right)\sqrt{4\left(1+\lambda^2\right)^{-1} - 1} \\ b(\lambda) = 4\lambda\left(3-\lambda^2\right)^{-1} \end{cases}$$

and for a double negative feedback loop

$$\begin{cases} a(\lambda) = \left(1+\lambda^2\right)\sqrt{\left(1+\lambda^2\right)\left(3\lambda^2-1\right)^{-1}} \\ b(\lambda) = 4\lambda^3\left(3\lambda^2-1\right)^{-1}. \end{cases}$$

Stochastic Simulation

The Gillespie's algorithm was used to perform stochastic simulations in order to confirm the bistability of the system and to see how "deep" each stable node is. A total of 10000 simulations were ran, with A and B ranging from 0 to 100 as initial condition.

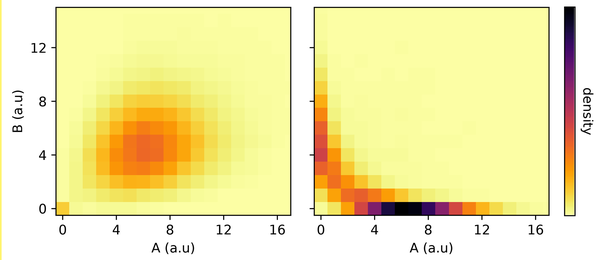


Figure 4: Stochastic simulations of a double positive feedback (left) and a double negative feedback (right). The parameters corresponding to the equations (1) and (2) are $c_1 = 7$ and $c_2 = 5$. In each cases, the values with the higher density are those corresponding to the section "phase plane analysis".

In the case of a double positive feedback loop , the point $p = (0,0)$ is an **absorbing point** i.e. if the simulation is running a certain time, both species A and B will be stuck in $(0,0)$. In the case of a double negative feedback, there is always a probability to switch from one stable node to the other.

Conclusion

Based on this research, the following conclusions arise:

- The two systems can be bistable.
- The analytic solutions match the numerical computations.
- The stochastic simulations show how "deep" is each stable node.

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[1] Karl Johan Aström and Richard M. Murray. *Feedback Systems*. Princeton University Press, 2th edition, 2009.

[2] D. Gonze and M. Kaufman. Theory of non-linear dynamical systems. University Lecture, 2015.

Future Research

The next step of this research is to characterize double positive and double negative feedbacks when an extra feedback (either positive or negative) is added to one of the species. The systems of equations become much more complex and news tools such as interval analysis are needed in order to characterize those systems. An other further work is the characterization of three interacting species.

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Impact of organizational and psychographic variables on perceptions of work-life conflict

Pitch your Research in Statistics 2017, Swiss Statistical Society and FRI SAM workshop, Fribourg, 06.10.2017

Purpose

The objective of this research is to understand what means are available to an organization to prevent the psychosocial risks arising from a conflict between work and personal life (which is a combination of psychosocial risk factors), focusing on different organizational variables (autonomy, job requirements, colleague support, hierarchy and organization), as well as a psychographic variable (the sense of coherence).

Methodology

The quantitative diagnosis was carried out in a representative sample of **60 individuals**. A total of **44 people** participated in this study, with a response rate of 73%. The number of surveys handled statistically remains of the order of 44.

The quantitative survey consisted of **62 questions**: socio-demographic questions (age, gender, presence of children and sector) ; Antonovskys Life Orientation Questionnaire (seven-point semantic differential scale with two terms (or phrases) disposed at the extremes) ; Job Content Questionary (JCQ) of Karasek (four-point Likert scale) ; Eisenberger scale (five-point Likert scales) ; Geurts scale, named SWING (four-point Likert scale).

Main contributions

This study highlighted the impact of certain organizational variables (job requirements, social support and organizational support) and the sense of coherence in the perception of work-life conflict.

It opens up new perspectives for concrete recommendations for organizations.

Hypothesis

General hypothesis: There is a perception of conflict between work and personal life, which is more or less present based on the perception of the work situation.

Specific hypothesis:

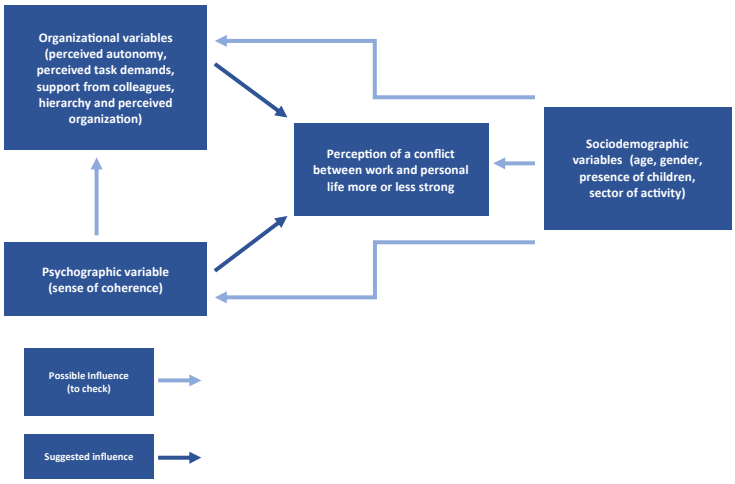
H_1: The higher the level of sense of coherence, the lower the perception of a conflict between work and personal life.

H_2: The higher the level of autonomy within the workplace, the lower the perception of work-life conflict.

H_3: The higher the perception of job requirements, the greater the perception of work-life conflict.

H_4: The higher the perception of support from colleagues and employee's hierarchy, the lower the perceived conflict between work and personal life.

H_5: The higher the perception of organizational support, the lower the perceived conflict between work and personal life.



Results (validation of hypothesis)

Hypothesis	Validation	Statistical tests used
General hypothesis	Accepted	
H_1: level of sense of coherence	Accepted (for negative effect)	- Shapiro-Wilk ; Q-Q-plot
H_2: level of autonomy	Declined	-Test on the average of a starting variable (test on the right)
H_3: perception of job requirements	Accepted (for positive effect)	- Correlation test (Pearson and Spearman)
H_4: perception of social support	Accepted (for negative effect)	- Partial correlation
H_5: perception of organizational support	Accepted (for positive effect)	

Results (socio-demographic variables)

Sociodemographic variables	Significant Trends
Sector *: in this sector the job requirements perceived are higher	> Positive impact of work on privacy (in terms of proportions) Fisher's Exact Test : p-value = 0.066)
Age: over 35 years	<Psychological demand (in terms of proportions) Fisher's Exact Test : p-value = 0.052
Presence of children: no children	> Psychological demand (in terms of proportions) Fisher's Exact Test : p-value = 0.057
Gender: Women	<Social support (in terms of proportions and medians) Fisher's Exact Test : p-value = 0.054 Wilcoxon test : p-value = 0.088

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Main references:

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- VAN WASSENHOVE, Wim, 2014. *Modèle de Karasek*.
- DEBRAY, Caroline, [et al.] 2014. *Le lien entre le sentiment de cohérence, le stress et la santé chez le dirigeant de PME: résultats d'étude*.

Results (validation of hypotheses)

Variables	Descriptive statistics	Test of normality	Principal relations to be verified	Other relationships to verify
Effet_negatif	Average = 7.91 Median = 7.00 Variance = 9.34 Standard deviation = 3.056 Minimum = 3; Maximum = 18 Min. possible = 0 Max. possible = 24 95% confidence interval = [6.98; 8.84]	No Shapiro-Wilk: W = 0.916, p-value = 0.004	Test on the average of a starting variable (negative effect of work on privacy). Test on the right (it is assumed that the average of the police concerning the negative effect of work on privacy is greater than 6). S0 = 4.14 p-value = 0 **The general hypothesis is accepted.**	
Effet_positif	Average = 7.34 Median = 8.00 Variance = 10.509 Standard deviation = 3.242 Minimum = 1; Maximum = 14 Min. possible = 0 Max. possible = 15 95% confidence interval = [6.36; 8.33]	Yes Shapiro-Wilk: W = 0.971, p-value = 0.326	/	
Demande_ psychologique	Average = 23.59 Median = 24.00 Variance = 11.922 Standard deviation = 3.453 Minimum = 17; Maximum = 29 Min. possible = 9 Max. possible = 36 95% confidence interval = [22.54; 24.64]	Yes Shapiro-Wilk: W = 0.959, p-value = 0.114	Correlation with the negative effect of labor (Spearman): correlation coefficient = 0.228 p-value = 0.137 Correlation with the positive effect of labor (Pearson): correlation coefficient = 0.372 p-value = 0.013 **H_3 hypothesis is accepted for the positive effect of labor.**	
Soutien_social	Average = 9.98 Median = 10.00 Variance = 1.325 Standard deviation = 1.151 Minimum = 7; Maximum = 12 Min. possible = 3 Max. possible = 12 95% confidence interval = [9.63; 10.33]	No Shapiro-Wilk: W = 0.925, p-value = 0.007	Correlation with the negative effect of labor (Spearman): correlation coefficient = -0.30 p-value = 0.048 Correlation with the positive effect of labor (Spearman): correlation coefficient = 0.280 p-value = 0.066 **H_4 hypothesis is accepted for the negative effect of labor.**	
Latitude_ decisionnelle	Average = 79.82 Median = 80.00 Variance = 76.245 Standard deviation = 8.732 Minimum = 60; Maximum = 94 Min. possible = 42 Max. possible = 96 95% confidence interval = [77.16; 82.47]	Yes Shapiro-Wilk: W = 0.968, p-value = 0.246	Correlation with the negative effect of labor (Spearman): correlation coefficient = -0.136 p-value = 0.378 Correlation with the positive effect of labor (Pearson): correlation coefficient = 0.214 p-value = 0.163 **H_2 hypothesis is denied.**	Correlation with social support (Spearman): correlation coefficient = 0.411 p-value = 0.006 Decisional latitude and social support = positive linear relationship
Soutien_ organisationnel	Average = 37.30 Median = 38.50 Variance = 39,794 Standard deviation = 6.308 Minimum = 21; Maximum = 52 Min. possible = 11 Max. possible = 55 95% confidence interval = [35.38; 39.21]	Yes Shapiro-Wilk: W = 0.967, p-value = 0.228	Correlation with the negative effect of labor (Spearman): correlation coefficient = -0.041 p-value = 0.793 Correlation with the positive effect of labor (Pearson): correlation coefficient = 0.297 p-value = 0.050 **H_4 hypothesis is accepted for the positive effect of labor.**	
Sentiment_ coherence	Average = 67.75 Median = 67.00 Variance = 39.262 Standard deviation = 6.266 Minimum = 57; Maximum = 87 Min. possible = 13 Max. possible = 91 95% confidence interval = [65.84; 69.66]	Yes Shapiro-Wilk: W = 0.959, p-value = 0.123	Correlation with the negative effect of labor (Spearman): correlation coefficient = -0.347 p-value = 0.021 Correlation with the positive effect of labor (Pearson): correlation coefficient = -0.068 p-value = 0.662 **H_1 hypothesis is accepted for the negative effect of labor.**	Correlation with psychological demand (Pearson): correlation coefficient = -0.297 p-value = 0.050 Sense of coherence and psychological demand = negative linear relationship Partial correlation between sense of coherence, psychological demand and negative effect: none

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)

J. Goyette Pernot, P. Voirin, M. Capitan, Lucy Linder, P. Kuonen, O. Vorlet

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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.

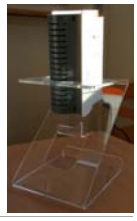
With this in mind, a major step will be to raise awareness and educate the nursery staff on this issue in the future.

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

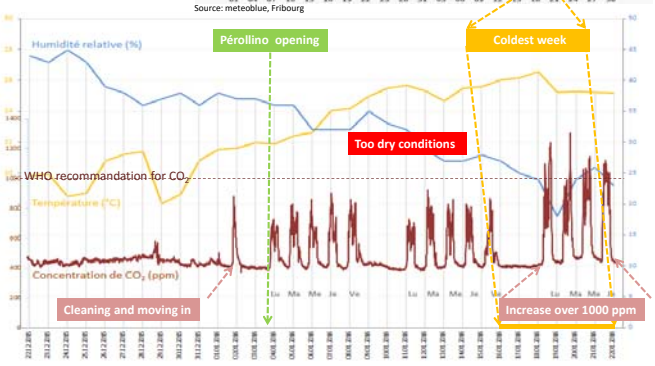
Measurements at Perollino



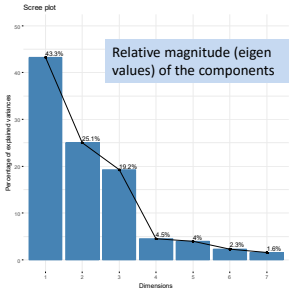
The Amstein&Walthert fireflies device used is a multi-sensor platform that measures :

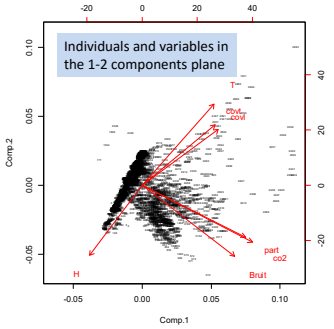
- Temperature (°C)
- Relative humidity (%)
- Carbon dioxide CO_2 (ppm)
- Noise level (dB)
- Light volatile organic compounds (µg/m³)
- Total volatile organic compounds (µg/m³)
- Fine particles, 0.5 to 1.5 µm (Mpart/m³)

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.

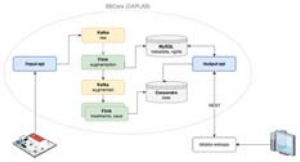
Development of a prototype at HEIA//FR

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.

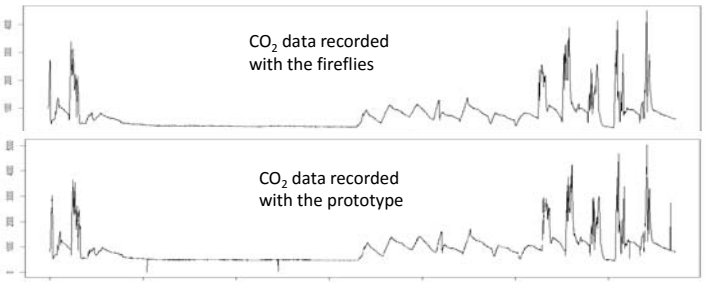
The prototype consists of two sensors boards protected by a box (see picture above) and is connected to a portable computer by USB. The communication architecture relies on POP-C++ objects and can be generic, independently of the actual sensors used; a driver must be available for each sensor.
To get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