

References:

¹C. C. Licon, C. Manesse, M. Dantec, A. Fournel, and M. Bensafi, "Pleasantness and trigeminal sensations as salient dimensions in organizing the semantic and physiological spaces of odors," Sci Rep, vol. 8, no. 1, p. 8444, Dec. 2018, doi: 10.1038/s41598-018-26510-5. ² R. Mathonat, "Rule discovery in labeled sequential data: application to game analytics.," University of Lyon, France, 2020. ³C B. Efron and R. Tibshirani, "Bootstrap Methods for Standard Errors, Confidence Intervals, and Other Measures of Statistical Accuracy," Statistical Science, vol. 1, no. 1, pp. 54–75, 1986.

Exploring the relation between olfaction and affective states using artificial intelligence algorithms

Maëlle Moranges ^{a, b}, Marc Plantevit ^b, Moustafa Bensafi ^a ^a Lyon Neuroscience Research Center, CNRS-INSERM-University of Lyon. ^b Laboratoire d'InfoRmatique en Image et Systèmes d'information-University of Lyon







Maëlle Moranges ^{a, b}, Marc Plantevit ^b, Moustafa Bensafi ^a ^a Lyon Neuroscience Research Center, CNRS-INSERM-University of Lyon. ^b Laboratoire d'InfoRmatique en Image et Systèmes d'information-University of Lyon

Introduction

Aim: To examine the relation between smells and human emotions using an AI approach

Hypothesis: Subgroup discovery (SD) algorithms will enable description and identification of the physiological patterns associated with a specific affective state induced by a particular smell.

Experiment¹:

- 105 odorants were smelled by 22 participants. - Different psychophysiological parameters were recorded: finger pulse frequency (FP), skin conductance (SC), skin surface temperature (ST) and abdominal respiration (AR). - For each odor, participants had to rate five affective dimensions on a scale from 1 (not at all) to 9 (extremely): pleasantness, intensity, relaxation, stress and anxiety.

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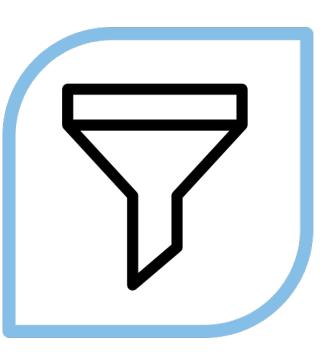






Maëlle Moranges ^{a, b}, Marc Plantevit ^b, Moustafa Bensafi ^a ^a Lyon Neuroscience Research Center, CNRS-INSERM-University of Lyon. ^b Laboratoire d'InfoRmatique en Image et Systèmes d'information-University of Lyon



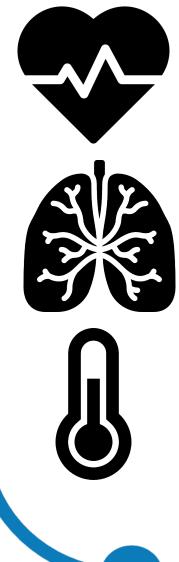




Preprocessing



SC was cut in 4 attributes: latency (ms), rise time (ms), amplitude (µS) and NSSCR (number of events).

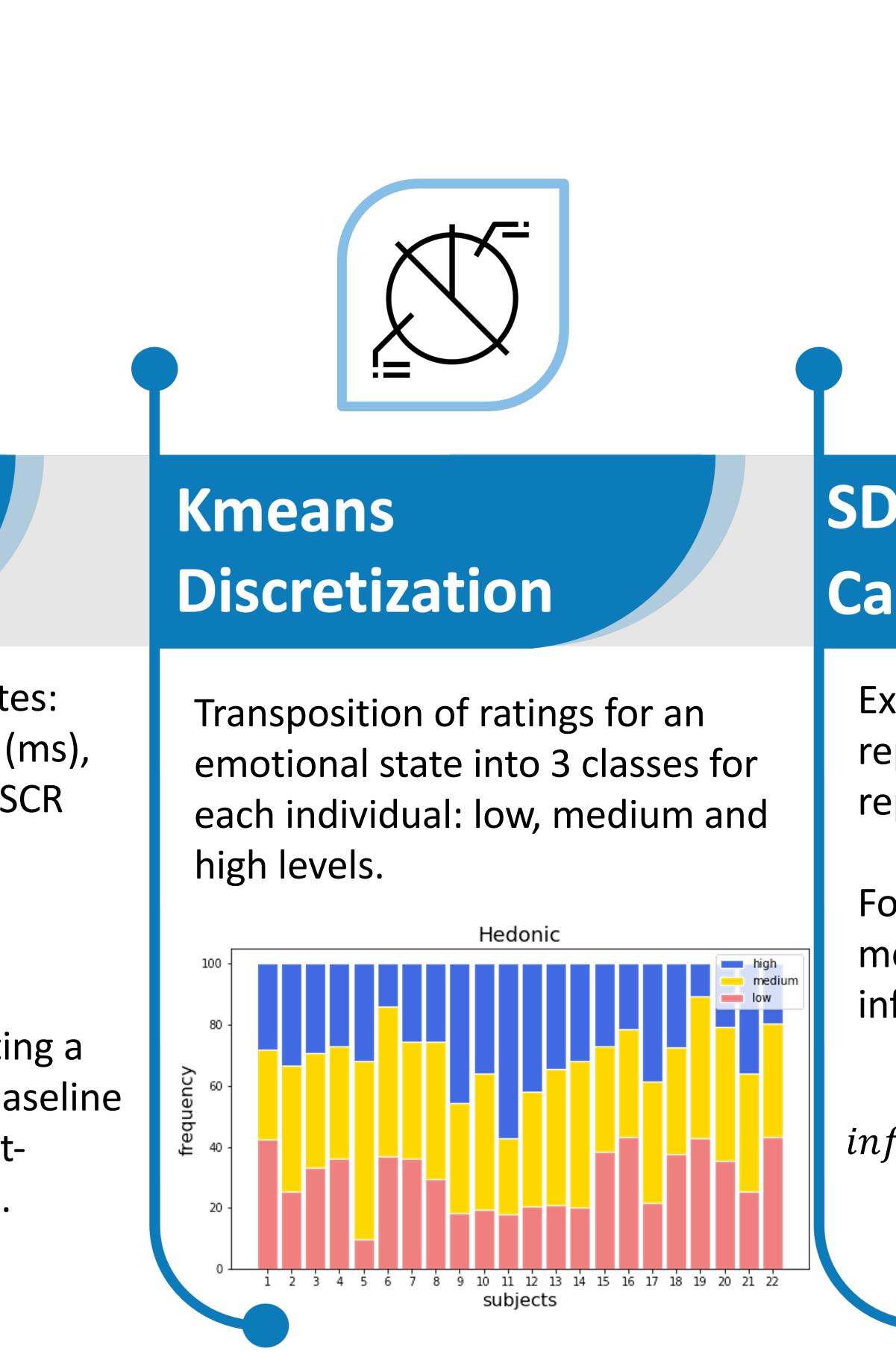


FP, ST, AR and NSSCR: normalized by subtracting a pre-stimulus (10-sec) baseline value from a mean poststimulus (30-sec) value.

References:

² R. Mathonat, "Rule discovery in labeled sequential data: application to game analytics.," University of Lyon, France, 2020. ³ C B. Efron and R. Tibshirani, "Bootstrap Methods for Standard Errors, Confidence Intervals, and Other Measures of Statistical Accuracy," Statistical Science, vol. 1, no. 1, pp. 54–75, 1986.

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SD with Monte Carlo Tree Search

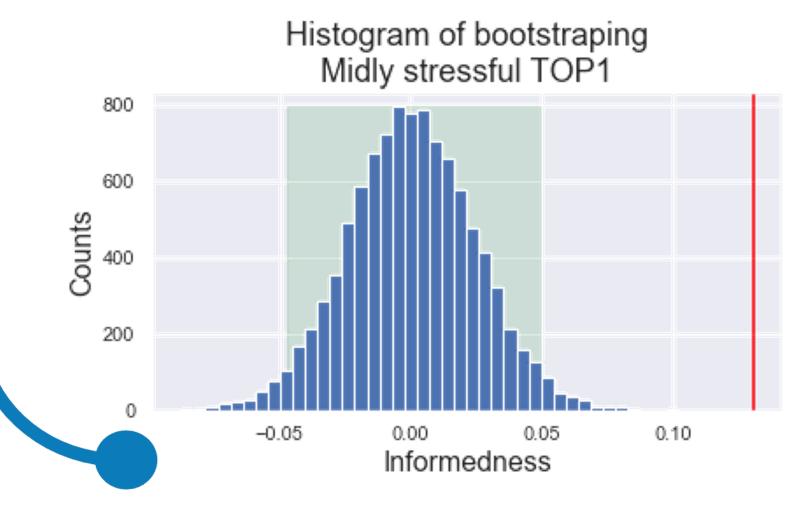
Extraction of descriptive rules (overrepresentation vs. underrepresentation of emotional states).

For that, SD algorithm maximizes a measure of quality named informedness using MCTS algorithm.

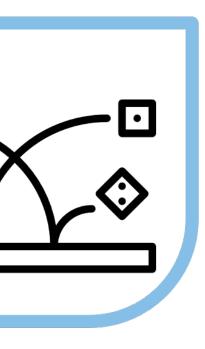
informedness(pattern) = tpr - fpr

Bootstrapping³

Computation of the informedness of 10,000 random groups with same size as the current pattern. The confidence interval of this distribution indicates if the informedness of the found pattern can be observed randomly.









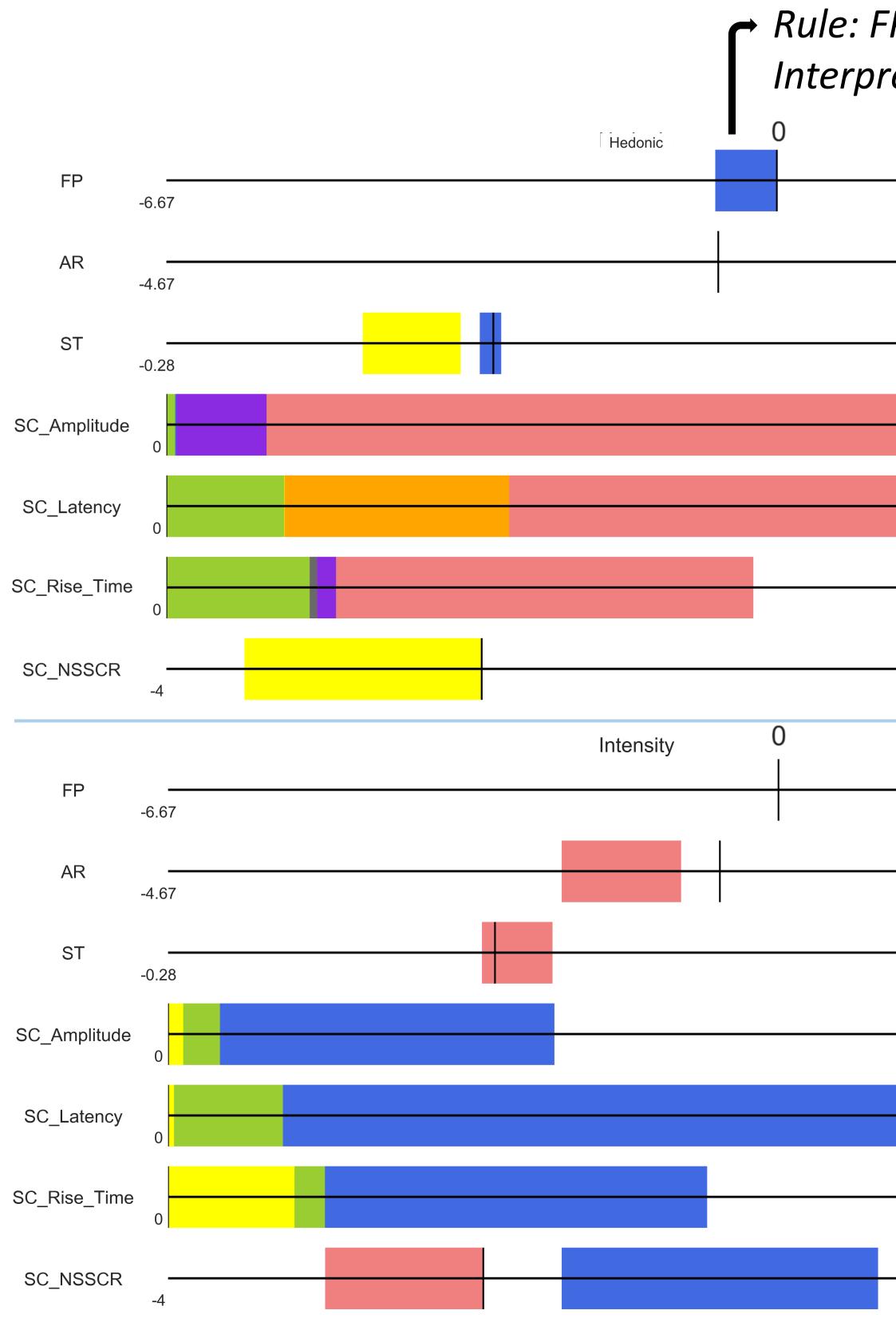








Summary of patterns with only one



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	Relaxation	FP
		AR
Intensity		ST
	Anxiety	SC_Amplit
e interval in the	rule: Stress	SC_Later
₽ <i>∈</i> [-0.67, 0.0]		SC_Rise_7
r c [-0.07, 0.0] retation: FP decrease if od	dorants is pleasant	SC_NSS
3.67		FP
3.33		AR
0.53	Neutral	ST
1.35		SC_Ampli
3.97		SC_Later
14.57	Pleasant	SC_Rise_T
8.0		SC_NSS
3.67		FP
3.33 Not at all	Midly	AR
0.53	intense	ST
1.35		SC_Ampli
3.97		SC_Later
14.57	Very intense	SC_Rise_
8.0		SC_NSS





nemoSim





Results for **intensity** and **pleasantness** confirm what is known in neuroscience: • Strong emotional states (pleasant or unpleasant) induce a skin conductance response greater than neutral states. • Pleasant emotional states decrease pulse frequency. • The more intense the odorant, the higher the peak of skin conductance. • Abdominal respiration decreases when the smell is perceived as weak.

These findings provide new information:

Results for relaxation, stress and anxiety are more difficult to interpret. For instance, past investigations showed that anxiety induces an increase in pulse frequency, abdominal respiration, and electrodermal response which is not in line with the current finding. Note that the 3 classes (low, medium, high) of these 3 affective dimensions were very unbalanced, because the mark "1" (not at all) was used more widely compared to the others. These emotional states were not perceived strongly enough way to carry out this analysis.

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• The higher the latency of the skin conductance, the more unpleasant the odor • The finger temperature is rather stable when the smell is pleasant and decreases when the smell is neutral.





