Università di Genova | DIPARTIMENTO INFORMATICA, BIOINGEGNERIA, ROBOTICA E INGEGNERIA DEI SISTEMI

Computer Science Workshop
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Attributed Graphettes-based Preterm Infants Motion Analysis

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Introduction

The study of **preterm infants neuro-motor status** can be performed by analyzing infants spontaneous movements [4]. Nowadays, available automatic methods for assessing infants motion patterns are still limited [2]. We present a novel pipeline for the characterization of infants spontaneous movements, which given RGB videos **leverages on network analysis and NLP** [3]. First, we describe a body configuration for each frame considering landmark points on infants bodies as nodes of a network and connecting them depending on their proximity. Each configuration can be described by means of *attributed graphettes* [1]. We identify each attributed graphette by a string, thus allowing to study videos as texts, *i.e.* sequences of strings. This allows us exploiting NLP methods as topic modelling to obtain interpretable representations. We analyze topics to describe both global and local differences in infants with normal and abnormal motion patters. We find encouraging correspondences between our results and evaluations performed by expert physicians.

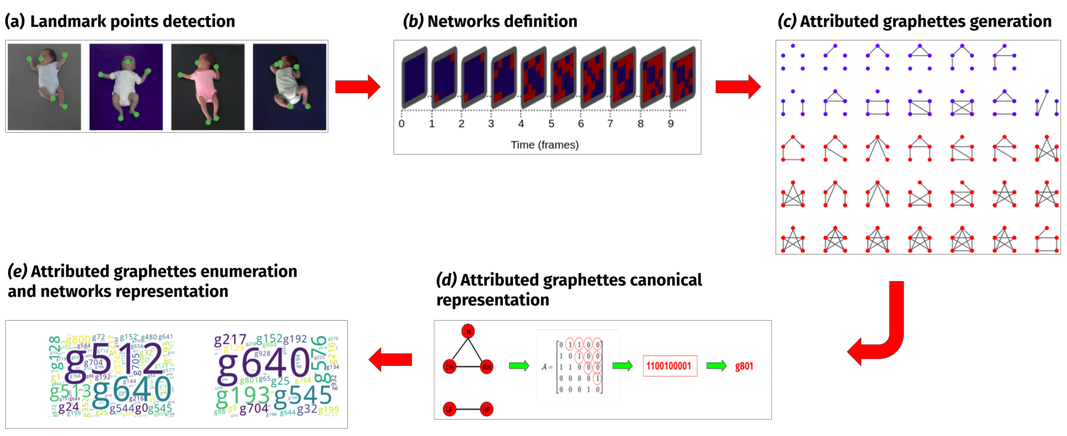

Figure 1: Summary of the pipeline.

Materials and Methods

We approach the problem of representing spontaneous movements sequences of preterm infants by studying it as a temporal network analysis problem. More precisely, we map each frame of a video to a 5-nodes graph whose nodes are landmark points and edges are inserted based on the distance of the landmark points on the image plane. We model the networks as sequences of 5-nodes *attributed graphettes* [1], defined as not necessarily connected, non-isomorphic induced subgraphs of a larger graph, whose nodes are equipped with attributes.
We build topic models upon graphettes occurrences in the network. Such topic models, in which graphettes are actually encoded as words of a text that is the network, allow to overcome the only description of networks through graphettes concentrations by including the distribution on graphettes themselves. This allows us to obtain a representation of the network as a mixture of structural topics which in turn are outlined as a mixture of graphettes. In our problem, we leverage on a Latent Dirichlet Allocation model to identify local motion patterns able to characterize infants spontaneous movements.

Results

Number of Topics Selection

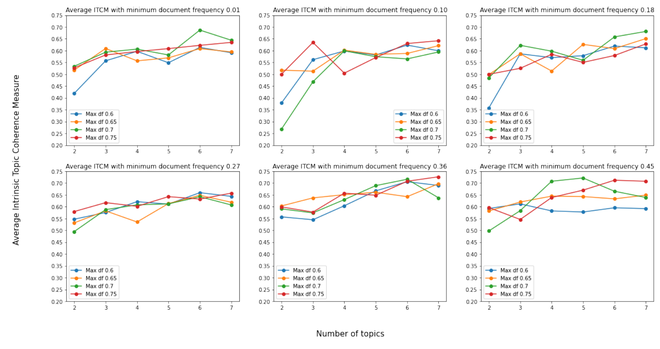

Figure 2: Average ITCM evaluated for number of topics (NoT) ranging in {2; 3; 4; 5; 6; 7}.

Topics Analysis

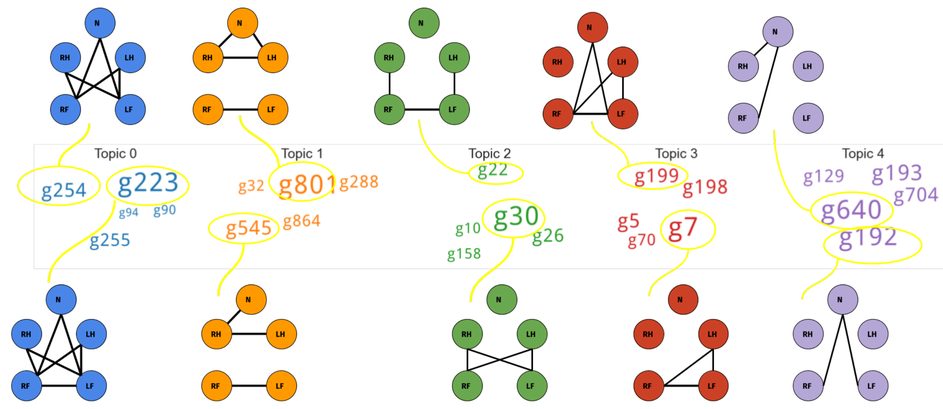

Figure 3: Visual representation of the five obtained topics described by their 5 most probable configurations.

	Intra-class probability								Symmetry			Density
	class N				class Ab							
	Mean	Min	Max	Conc	Mean	Min	Max	Conc	Global	Hands	Feet	
T0	0.59	0.34	0.9	0.15	0.67	0.6	0.91	0.15	0.94	0.95	0.78	0.62
T1	0.8	0.41	1.0	0.28	0.74	0.42	1.0	0.28	0.94	0.87	0.60	0.28
T2	0.73	0.46	1.0	0.17	0.74	0.36	1.0	0.13	0.90	0.80	0.75	0.34
T3	0.6	0.4	0.99	0.23	0.71	0.33	0.93	0.17	0.80	0.50	0.58	0.34
T4	0.7	0.44	0.98	0.17	0.82	0.47	1.0	0.26	0.92	0.20	0.68	0.24

Table 1: For each topic, we report statistics on: Intra-class assignment probability (mean, minimum, maximum, and concentrations), Symmetry(global, hands, and feet), and Density of the 5 most probable configurations.

Conclusions

- We highlighted **higher motor variability** associated with infants with normal motion patterns, a qualitative aspect that it is **usually considered by expert physicians** during their evaluations;
- Topic 0 and Topic 4 are characterized by **dense configurations** and **higher symmetry**. Also in this case we have a correspondence between our results and the visual evaluation of expert physicians.

Forthcoming Research

For future works we plan to **include more videos** in the study and to **refine the network representation**, detecting more landmark points on infants' bodies. By increasing configurations size, we expect to gain enough information to consolidate the analysis and investigate possible discriminative properties of the identified topics.

References

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