Identifying Psychological Bio-markers Computationally with Regulated Activation Networks

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Abstract

This work aims in highlighting the importance of bio-markers in studying psychological conditions of humans. The poster displays bio-marker identification via:

- Data obtained from Internet of Everything (IoE) sources.
- Modeling IoE data computationally using Regulated Activation Networks (RANs).
- Statistically analyzing the outcome of RANs model to deducing psychological conditions.

Introduction

Attention Deficit Hyperactivity Disorder (ADHD), Anxiety, depression etc., are a few problems whose causes are directly related to psychological conditions of humans. Most of such disorder are curable but are, generally, either misunderstood or ignored, because of the inability in understanding human psychological problem by normal people. With this poster it is demonstrated that, how data from IoE sources (Figure 1) can be used to build models related to humans, and further how these models can be used to deduce psychological conditions.

For this work, the data was obtained from ISABELA platform developed for project SOCIALITE. The data utilized in our demonstration was collected by monitoring student activities via smartphone. This data was used to build a model with Regulated Activation Networks (RANs). RANs is an unsupervised computational cognitive modeling approach which is connectionist in topology, and grows dynamically to build a representation of concepts being learned. Later, the model and the data were used in conjunction to carryout statistical analysis of the outcome and deduce psychological state of subjects.

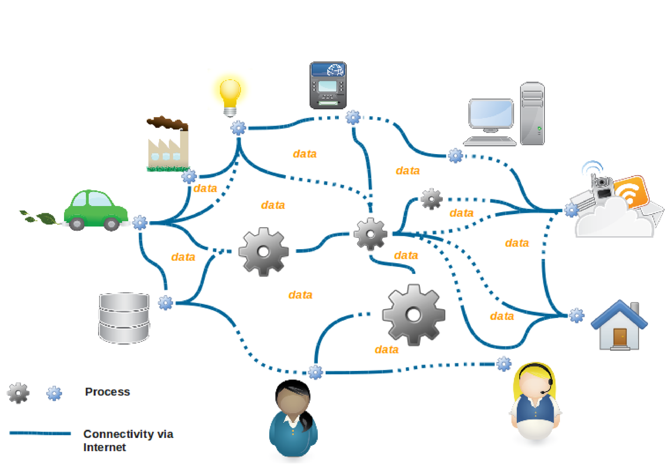

Figure 1: IoE Source Universe

Use Case of Sleep Detection Data

The sleep detection data from ISABELA app of SOCIALITE [1] projects captured attributes Activity, Day-of-Week, Light, Sound, and Phone-Lock-State. The data was labeled based upon conditions:

- If Phone is locked and Activities are Still, Tilt- ing, and Unknown and Light categories are {'Pitch Black', 'Very Dark', 'Dark Indoors', 'Dim Indoors', 'Dim Outdoors', 'Cloudy Outdoors'} and Sound value ⟨=12000. units Then Label instance as an **Inactive - Subject (I-S)**
- Else label instance as an **Active - Subject (A-S)**

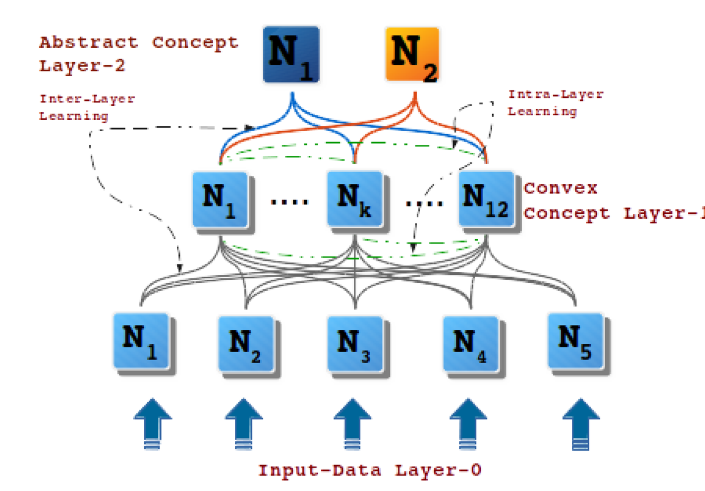

Figure 2: Generated RANs Model

6- **Abstract Concept Identification (ACI)** process determines how many convex concept nodes at *layer*-1 are similar based upon a *similarity - threashold*.

7- **Abstract Concept Creation (ACC)** is the operation to create a new layer 2 with node equal to the number of similar convex concepts identified in ACI process.

8- **Abstract Concept Inter-Layer Learning (ACILL)** is a process to associate *layer*-1 & 2.

Important Remarks and Conclusion

From Tabel 1 we can observe the Student-1 is mostly inactive on all days it and be an indicator of **stress** with the student, whereas the other student shows the normal behavior according to the hypothesis. The statistical analysis of the IoE data from students and its modeling indeed enable as to deduce the psychological conditions of the students.

Table 1: Statistical Analysis of activity and inactivity of 3 Students

		Student-1		Student-2		Student-3	
		A-S (%)	*I-S (%)*	*A-S (%)*	*I-S (%)*	*A-S (%)*	*I-S (%)*
W-D	*E-MH*	0.42	99.57	0.01	99.9	71.39	28.60
	M-H	10.83	89.16	77.43	22.56	91.44	8.55
	AF-H	10.38	89.61	15.35	84.64	50.0	50.0
	E-H	16.38	83.61	73.21	26.78	99.86	0.13
W-E	*E-MH*	1.36	98.63	0.0	100.0	0.0	100.0
	M-H	6.85	93.14	70.90	29.09	94.67	5.32
	AF-H	4.96	95.03	96.94	3.05	42.42	57.57
	E-H	13.05	86.94	65.15	34.84	70.13	29.86

Active-Subject (A-S); Inactive-Subject (I-S); Weekday (W-D); Weekend (W-E); Early-morning-hours (E-MH); Morning-hours (M-H); Afternoon-hours (AF-H); Evening-hours (E-H)

Modeling With RANs

To generate RANs [2] model with sleep detection data, as shown in Figure 2, consecutive 9-steps are followed in their order:

1- **Convex Concept Identification (CCI)** process (at *layer*-0) by clustering and identifying number of groups in the data.

2- **Convex Concept Creation (CCC)** process (at *layer*-1) by creating a new layer based upon number of clusters identified are *layer*-0.

3- **Convex Concept Inter-Layer Learning (CCILL)** process to associate every node at *layer*-1 to all nodes at *layer*-0.

4- **Convex Concept Upward Activation Operation (CCUAP)** is the process to propagate activation from *layer*-0 to *layer*-0.

5- **Similarity Relation Learning (SRL)** is the process to learn the similarity among the convex concepts at *layer*-1, by observing concurrency of activation obtained at each node at *layer*-1 for all training inputs.

9- **Abstract Concept Upward Activation Propagation (ACUAP)** is the process to propagate activation from nodes at *layer*-1 to *layer*-2.

Assumption

It is hypothesized that students are usually *active* during **Morning-Hours** (6am - 11:59am), **Evening-Hours** (5:01pm - 9:59pm), **Afternoon-Hours** (12pm - 5pm) on all days, some exceptions for *inactivity* is possible in **Afternoon-Hours** during weekends. Additionally, in **Early-Morning-Hours** (4am - 6am) most of the students are believed to remain *inactive*.

Experiment and Results

Having generated the models by traversing through all 9-steps of RANs modeling, an experiment is performed by segregating the input data student

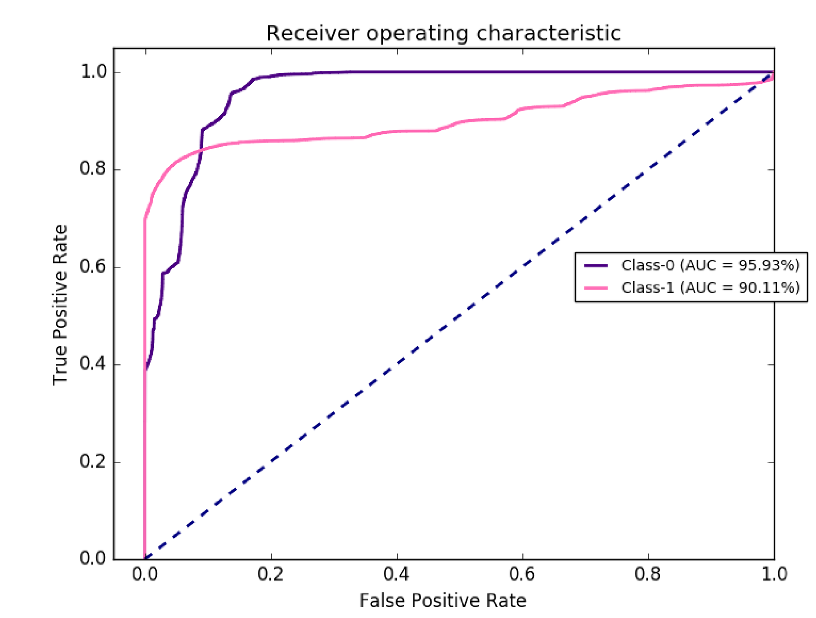

Figure 3: ROC curve for Active (Class-0) and Inactive (Class-1) States

wise along with weekday and weekend, further the data is partitioned into 4 hours slots (mentioned as assumptions). These data is propagated through the model and statistical analysis in made as shown in Table 1.

Table 2: Confusion Matrix of the Model

		Predicted Labels		
		A-S	**I-S**	
True Labels	**A-S**	**100%**	**0%**	23230
	I-S	**36.19%**	**63.81%**	15041
		28674	9597	Total =32827

The generated model was evaluated by building a confusion matrix (Figure 2) depicting the metrics, Precision $= 89.02\%$ (ca.), Recall $= 86.13\%$ (ca.), F1-score $= 85.53\%$ (ca.), and Accuracy $= 86.13\%$ (ca.), along with AUC analysis As shown in Figure 3.

References

[1] Sharma etal.
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