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Identifying engineering interest in children through Machine Learning using biometric signals

Gustavo Olivas-Martinez, Luis Acosta-Soto, Juan Ocampo-Alvarado, Diego Botín-Sanabria, Milton Osiel Candela-Leal, Gladys Guadalupe Díaz-Armas, Jorge Murrieta-González, Aleyka García-Briseño, Myriam Alanis-Espinosa, Mauricio Adolfo Ramírez-Moreno, Jorge de Jesús Lozoya-Santos

***Abstract*—There is a need for tools that objectively measure professional interest. Evidence supports personality prediction through physiological signals. Given that professional interests have a close relation with personality, it may be predicted using the same means. The objective of this study is to develop a Machine Learning algorithm that estimates engineering interest in children. It can be used to guide education policy, study interest in other professional fields, improve vocational counseling services in educational institutions.**

I. INTRODUCTION

Promoting Science, Technology, Engineering, and Mathematics (STEM) education is a priority in many countries as it is related to technological innovation and economic development. There have been public and privately funded initiatives to foster STEM interest in youngsters. Psychometric testing is the habitual way to measure vocational interest. Nonetheless, it is vulnerable to response and cultural biases.

Therefore, the objective of this study is to generate a machine learning algorithm based on physiological data from children doing STEM-related activities that will estimate their interest in specific professional subfields.

II. METHODS

The sample consists of 13 participants aged 6 to 15 years. During four educational extracurricular 2-hour lectures on Programming, Robotics, and 3D Design, we collected electroencephalographic signals, electrodermal activity, blood volume pulse, facial gestures, and body temperature. These signals were contrasted with the results of STEM-CIS, an adapted psychometric test on STEM interest for children, taken digitally before and after each thematic module.

III. RESULTS

To include all the collected signals, the median from 5-minute windows with overlap was extracted.

All physiological signals were normalized using Z-Score. Then, using the sigmoid function, their domains were transformed so that they lied between 0 and 1. As for discrete data, which was the emotions (happy, surprise, angry, sad, disgust, fear, neutral) drawn from the Computer Vision (CV), the prevalence of each emotion was computed on the same window size. As a result, a high-dimensional data frame that included all the data from the devices in an equal domain was created. Finally, a Principal Component Analysis (PCA) reduced the dimensionality from 104 to 2.

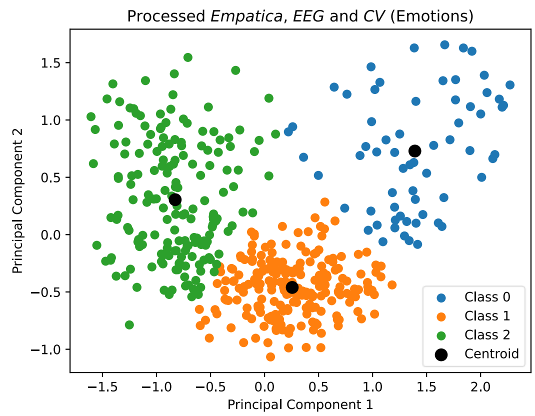

Figure 1. Interest-related classes, created by K-Means algorithm

Since the psychometric test was done at a different time than the signals collected, it was treated as a reference rather than a prediction. Without a predicted class, *K-Means* algorithm was used. Based on the Silhouette Coefficient, the optimal number of classes was selected, which are centroids in Fig. 1. These classes are related to vocational interest, although a deeper contrast analysis must be done with the psychometric test classes to determine the grade of interest.

IV. DISCUSSION & CONCLUSION

These findings support the idea of leveraging neuroscientific instruments to obtain accurate measures of professional interests that are not susceptible to psychometric tests' bias. The proposed methodology may be useful for future research developing next-generation objective measures of related psychological variables too. Moreover, the generated algorithm may be useful for educational institutions, vocational counselors, entrepreneurs, parents, and youngsters. It can also be used by researchers to better inform educational public policy and public resources allocation strategies in countries like Mexico that are heavily investing in STEM education for future economic development.

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[1]M. Alanis-Espinosa is with Tecnológico de Monterrey, NL, Mexico, phone: +52 1 443 164 5461; e-mail: myriam.alanis@tec.mx.