The Modeling of State-Dependent Memory (SDM) with Artificial Intelligence Approaches

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Introduction:

State-Dependent Memory (SDM) is the term that explains remembering a particular memory occurs most accurately when an individual is in the same state of consciousness as it was at the time of memory formation. The present study was defined to construct an accurate model that predicts drug-induced memory or amnesia based on drug injections. The model assists scientists in the field to appraise their new hypotheses and inspire for further experiment-design without neither animal usage nor colossal amount of time and money consumption.

Method:

The primary dataset for the present modeling was generated by combining the data extracted from five pieces of research that elucidated the influences of various states of consciousness in memory retrieval. Throughout these studies, multiple drugs - including Saline, Morphine, Nicotine, MDMA, Vehicle, Mecamylamine, (S)WAY100135, ACPA, AM251, Dextromethorphan, Ethanol, and WIN 55.212-2 - were injected pre-test or post-train in either Central Amigdala, Basolateral Amygdala, medial Prefrontal Cortext, or Peritoneum, to measure the memory that affected from injections. Each row in the data-set represented a single experiment on a male Wistar rat that a combination of drugs with specific doses was injected through its body. Additionally, the last column of each particular experiment was the latency of the passive avoidance task in the range of 0 and 300 seconds to assess

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memory retrieval based on injections' combination. Trials with detailed information were randomly split into train-set and test-set with a portion of 0.8-0.2. The models were fed with 80% of rows in the dataset; hence, it could be evaluated on both training rows and testing rows separately. Various machine-learning algorithms were applied to establish the most accurate model in the pursuit of predicting the latency of the passive avoidance task based on injection doses. The hyper-parameters of every utilized algorithm, including Linear Regression, Support-Vector Machine, Decision Tree, Random Forrest, K Nearest Neighbor, and Neural Network, were tuned by using grid-search functions.

Result:

The best performance of a model was observed in a compound voting model that returned the mean value of latency output from "Support-Vector Regressor," "Decision Tree Regressor," "Random Forrest Regressor," and "K-Nearest Neighbor Regressor." The voting model attained the R2 score of 0.803 on the train-set and 0.781 on the test-set. Moreover, the model reached the Root-Mean-Squared-Error of 49.36 on the train-set and 55.39 on the test-set for predicting the latency of passive-avoidance task.

Conclusion:

Since the latency numbers can be inferred as a binary conclusion of amnesia or solid memory, and by assuming that latency of 150 seconds or less is referring to amnesia, the model has an accuracy of 93% in predicting amnesia or solid memory based on injections' doses. Even though the data-set included diverse states of consciousness, additional data from other related articles can lead the model to an even more complex model that appreciates the effects and interactions between added states more precisely to assist scientists multifacetedly.