Learning the Statistics of Events

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One of the marvels of neural systems is their ability to latch onto and use the statistical structure of their environment in the service of organizing cognition. After ordering and eating food in a restaurant, we know to order the bill; as the speaker presents her research, we assemble our question for the Q&A period that should follow. In recent years, there has been a resurgence of interest in how this kind of schematic knowledge interacts with new learning (e.g., Gilboa & Marlatte, 2017), but there has been relatively little work on how the schemas are acquired in the first place. Studies of statistical learning have focused on relatively simple statistics (e.g., pairwise transition probabilities) but not the more complex, context-dependent kinds of statistical dependencies that are observed in real-life events (e.g., where the way that a talk unfolds may depend on properties of the particular speaker and the audience).

To address this gap, we have built an engine that algorithmically generates narratives depicting instances of an event type (e.g. dining at a restaurant, watching a poetry reading) from underlying probabilistic graphs, and we are running studies to explore how the statistical regularities (i.e., the event schemas) underlying these narratives are learned. Each event type has a graph associated with it; nodes in the graph represent a particular situation within the event (e.g. waiter is taking order), edges encode the probability of transitioning between two situations (e.g. probability that the customers will tip the waiter before leaving), and these transition probabilities depend on the values of particular parameters (e.g., who is dining; who is the waiter) that can vary from one instance of the narrative to another. Because these parameters are allowed to vary and the transitions are probabilistic, narratives of a given event type will differ in their surface form despite having been generated using the same underlying graph.

As a first step, we have been exposing subjects (both humans and neural network models) to a variety of such event instances, generated from a few sets of underlying graph structures, and probing their ability to construct and use representations for prediction. Here we will present preliminary experimental findings from data collected on Amazon Mechanical Turk subjects. Subjects will read stories generated by our engine a sentence at a time. With a certain probability, they are probed to predict, by adjusting a slider, which one of two possible next situations happens next in the story.

Given that this project is in its early stages, these data will help establish the learning curves for events with different probabilistic structures under different learning regimes. Future studies will use multivariate analysis of fMRI data to track the assembling and use of schemas.

Reference

Gilboa, A. & Marlatte, H., (2017). Neurobiology of Schemas and Schema-Mediated Memory. Trends in Cognitive Science. Vol 21, No. 8.

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