Roland TD 11 K: No Ghost in the Machine

The Prior Knowledge Review on an Electronic Drum Kit

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Introduction to Cognition

In terms of our evolutionary history, what distinguishes us from other animals is our ability to acquire complex tasks which we required through our constantly developing cognitive skills. Cognitive, derived from the word cognitiō, is the ability to comprehend and translates to the mental process of knowing, including awareness, perception, reasoning and judgment. Cognition is related to our mental abilities and processes such as attention, memory, judgment, problem solving, deduction/induction and language.

There are many powerful, special-purpose peripheral systems for processing perceptual information and coordinating motor performance. However, behind these lies a common cognitive system for higher-level processing. The essence of what it is to be human lies in the principles of this core, higher level system. We may not differ from the many mammalian species to which we are related to in our peripheral perceptual and motor processes, but we assuredly do differ in our complex thought patterns and our intelligence (Anderson, 2013).

Prior Knowledge and Mental Models

Over the years, cognitive scientists have researched on how the mind constructs mental models and how they refer to our perception, imagination and information processing mechanisms. When confronting with new piece of information, we tend to compare it with what we already know. During a cognitive process, we use our existing knowledge, also known as prior knowledge accumulated from previous sensory experience which also influences the processing of incoming information (Waller, 2013). Prior knowledge has roots in learned, previous experiences and is a highly organized and top-down process. A growing number of scientists agree that the brain can solve the problem of obtaining a percept by combining sensory signals and prior knowledge in ways similar to Bayesian decision theory, a fundamental statistical approach to the pattern classficiation (Körding, 2004). Mental models, conceptual models, schemas, scripts and frames are some of the methods used to define the highly organized structure of prior knowledge.

Mental models, first postulated by the Scottish psychologist Kenneth Craik, are psychological representations of real, hypothetical, or imaginary situations. According to Craik, human beings understand the world by constructing working models of it in their minds. Since these models are incomplete, they are simpler than the entitites they represent (Johnson, 1986). The mind constructs these modals of reality in order to use it to anticipate events, to reason and to underlie explanation (Johnson, 1998).

Both the users and the designers have different conceptual models of a system. Conceptual model term relates to how a system is perceived by different users, in other words, the way a user conceptualizes and understands the inner workings of a system and how it differs from person to person. Donald Norman discusses the relationship between these two models, calling them the design model and the user's model. "The problem is to design a system so that, first it follows a consistent, coherent conceptualization -a design model- and, second, so the the user can develop a mental model of the system -a user model- consistent with the design model." (Norman, 1986). The users interact with the design model through an interface, called the system image where he documentation occurs; and the main goal is to develop a system image that maps the design model onto the user model. Thus, a conceptual model helps in forming a framework that enables the designer to create interface metaphors. In order to make an accurate interpretation, we use these metaphors to help us make a better understanding of the new information so that we may predict more efficiently how the new information will relate to our prior experience. Metaphors help us categorize by pairing the existing information with our prior knowledge through forming context relations.

Prior knowledge is also highly interconnected. Semantic networks and propositional networks are used to describe the nature of connections. The depth of learning is determined by the number of connections. The number of connections determine the depth and the quality of learning and there are many variables that may affect the experience. Errors may occur in storing information -if the information is incorrect but stored anyway, processing information -if the receiver is distracted and the information is not processed efficiently-, and retrieving information from long-term store -if the information is retrieved from our long term memory but the reconstruction is flawed (Schiffrin & Schneider, 1977).

While trying to make meaningful connections and generating new knowledge concurrently, there are two processes that we use throughout our life simultaneously: assimilation and accommodation. The former relates to transforming the environment so that it can be placed in pre-existing cognitive structures while the latter refers to the process of changing cognitive structures in order to accept something from the environment.

Cognitive biases also have a negative effect and may lead to systematic deviations on prior knowledge, thus, our judgment. Some of the cognitive biases affect our decision making and behaviours, such as attentional bias where our perception is affected by recurring thoughts (Bar-Haim et al, 2007), or negativity bias where we have a greater recall of unpleasant memories compared to our positive memories (Hazilip, Julie et al, 2012). Some of the cognitive biases are labeled as attributional biases such as halo effect that is defined as the influence of a global evaluation on evaluations of individual attributes of a person (Nisbett, 1977) or projection bias where we assume that others share our current emotional values (Hsee, 2006). And some of the biases are related to memory such as illusory correlation where we

remember an inaccurate relationship between two events (Tversky & Kahneman, 1974) or recency effect where the items we recall depend on the sequence (Martin, 2007).

Another characteristic of prior knowledge is the fact that it constantly evolves and it is related to our long term memory. Memory consists of two parts, short term memory and long term memory. Short term memory, also known as working memory refers to the processes involved in the short-term maintenance, manipulation and rehearsal of information, also serving as a gateway for a long-term retention and retrieval (De Houwer & Hermans, 2010). Short term memory can obtain a limited amount of data for a limited amount of time, whereas long term memory capacity is infinite, yet due to the fact that learning is selective, thus, only what the individual pays attention to is stored in memory. Semantic memory, also called declarative memory, contains generalized information such as concepts, principles, problem-solving skills and learning strategies. Our semantic memory is mentally organized in networks of connected ideas or relationships, which looks like an outline that groups concept and ideas under large categories and help us relate to information we already know (Voss & Wiley, 1995).

Piaget and Cognitive Development Theory

According to Swiss psychologist Jean Piaget, who became a leading theorist in 1930s on cognitive development, children are active learners and they try to construct a better understanding of the world using structures he called schemas. He proposed that the cognitive development occurred in four stages and defined the process as a continuous and gradual process. The first stagesensorimotor, concrete operations and formal operations stages. The first stage, sensorimotor, took place between birth and up to 2 years and consisted of sensing and acting. The second stage, preoperational took place between 2 to 7 years of age and consisted of concept formation and symbolic reasoning. The third stage, concrete operations took place between 7 to 11 years of age and consisted of logical operations on concrete objects and events. The last stage was called formal operations between 12 years and beyond, and consisted of abstracts, analogies, metaphors and hypothetical reasoning (Huitt & Hummel, 2003). Although he was criticized for underestimating the impact of social and cultural environment on cognitive development, especially by Lev Vygotsky, arguing that the development must be understood in terms of the interpenetration of social factors and the child's individual development (Tudge & Winterhoff, 1993), and overestimating the degree to which people achieve formal operational thought by researchers later on, his observations on the fact that early learning is hands-on and interactive is still accepted as widely accurate today.

Roland TD 11 K: An Electronic Drum Kit Review

Acoustic drum kits are hard to carry, difficult to set up, take a lot of time to tune and most important of all, extremely loud to play. These reasons gave rise to many companies to produce electronic drum kits so that users may experience the joy of drumming much more comfortably.

Roland TD 11 K (Fig. 1) is an electronic drum kit with a traditional drum kit set up. It consists of:
- a snare drum (white, front)
- two front toms (upper front)
- one floor tom (right)
- one bass drum with a pedal (middle, with right food bass drum pedal)
- one hi-hat cymbal with a pedal (left, with a left foot hi-hat pedal)
- one ride cymbal (upper right)
- one crash cymbal (upper left)
- one processor (left)

Fig. 1 Roland TD 11 K Electronic Drum Kit

The drum kit successfully simulates an acoustic drum kit. Mounting the parts appropriately for optimum setting is almost intuitive for any user who spent some time with a drumset. Adjusting the toms and the cymbals are easy to accomplish as the design constraints the user to integrate the parts only in one possible way. Besides, the processor has a headphone jack which enables the user to listen to himself/herself while causing minimal external noise.

Although Roland TD 11 K offers practicality in terms of drumming, it also has some design flaws that contradict with the main principles of drums as a music instrument, especially when compared with playing an acoustic drum set. Considering the fact that most of the people who play drums come from acoustic drumming background and their prior knowledge in drumming stems from their experience with acoustic drum sets, these design issues have to be pointed out in order to create a better user experience.

When a drummer plays a rhythmic figure very smoothly to the point of near silence, it is called a ghost note. Ghost notes add a dynamic contrast to a rhythmic piece when applied with regular beats that have higher accents. It may also be described as in a sound palette where smooth touches blend with firm beats. In Roland TD 11 K, no matter how smooth the beat is, the user is unable to experience a ghost note. All accents are heard as regular accents, with the same sound texture, only with varying volumes. Just like in

ghost notes, side sticking (Fig. 2) is also not available. It contradicts with the user's belief system and is not in synonymity with the user's established mental model in terms of how the drums should sound.

Side sticking is a technique where the palm mutes the head and the stick hits the rim so that the player gets a short, snappy sound. This contradicts with the prior knowledge that the dynamics of a beat will change the texture of the sound. Upon playing, the user realizes that ghost notes are not a part of the learned experience.

Fig. 2 Side sticking technique

Another major flaw in terms of dynamics is the lack of high accents. In acoustic drums, all toms are surrounded by a rim. When the player intends to play a high accented note in order to amplify the power of the stroke, the best way to create that sound is through hitting the drum skin and the rim simultaneously, which is called a rimshot (Fig. 3)

Roland TD 11 K does not have a rim around its drumheads, thus, just like the problem with playing low-accented ghost notes, it is again not possible to make a high-accented notes through this technique either. It is another indication of a design flaw as there is a major difference between the user's mental model of how the drum should sound and how it sounds when the stroke is performed on the electronic drum kit. It is a good example of how the designer's conceptual model failed to match up with the user's mental model.

Fig. 3 Rimshot technique

When playing acoustic drums, the tone changes depending on where the drumstick hits on the surface of the drums. When hit right into the middle of the circular area, the sound is a higher pitch compared to a hit placed near the edges of the circle. In Roland TD 11 K, no matter where the user hits with a drum stick, the pitch does not change at all, another major difference when compared with the user's prior knowledge. Although Roland TD 11 K manages to offer many novelties to the user, these design-related aspects that fail to reflect the nature of acoustic drumming in terms of prior knowledge should be reviewed with utmost care in order to offer a flawless user experience in its upcoming model.

Conclusion:

The review on Roland TD11 K drum kit clearly represents why taking prior knowledge into account is so important while designing electronic products in the first place. Learning is a highly connected process and relies on the previous experiences, thus the designer has to enable the user to make meaningful connections while interacting with the product so that the user may process the new information with the prior knowledge at hand, so that once the user fully grasps where she is in the progress of the new process, she may properly situate herself and be completely free to get lost in the rhythm (Maeda, 2006).

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