Evaluation and integration of similarity measures in aphasia rehabilitation – Prediction of difficulty levels based on psychological distances.

Background: Aphasia is the loss or impairment of language functions that occurs due to brain damage. It affects the four linguistic modalities (speaking, understanding, writing and reading) in different combinations and levels of severity. Affected patients undergo face-to-face speech and language therapy (SLT). A key factor for a successful SLT is dose frequency. Tablet-based aphasia tele-rehabilitation increases access to high frequency SLT while reducing cost. Together with the speech and language therapists of the University Hospital Inselspital the Gerontechnology and Rehabilitation group at ARTORG has developed a novel tablet-based tele-rehabilitation application called Bern Aphasia App. The app allows patients to train at home while therapist still have access to the performance and exercises of the patients. This allows the therapist to adjust the exercise type and their difficulty level remotely. At the moment, a clinical trial is running which investigates the effects of high frequency tele-rehabilitation on language skills.

The primary goal of this master thesis is to develop predictive measures for the difficulty of multiple-choice tasks like assignment exercises (relating images to words, words to images, images to images and words to words) and insertions of words into a sentence. The difficulties of exercises are influenced by a lot of factors which should be quantified during the master thesis by using existing databases. The focus will be the following influential factors: characteristics of words, e.g. word frequency, length and syllable sequence, and relations between words, e.g. semantic and phonematic relatedness between alternatives. The measures can later be used to build detailed profiles of patients based on their performances in tasks or to predict their performance in a specific task. Moreover, depending on the results the measures can facilitate the exercise construction for the therapist enormously by implementing an exercise generating algorithm. The algorithm should allow to generate exercises based on difficulty predictive measures, such that the therapist needs to make only minor adjustments.

Aims: 1. Evaluation of measures by assessing the perceived similarity between words in healthy participants
2. Use the measures for prediction/diagnostic purposes within the ongoing clinical trial with aphasia patients

Materials and Methods: There are a growing number of data bases that serves different information about words and their relationships to each other. The main focus of this master thesis lies on semantic relatedness. Mainly two different approaches to measure semantic relatedness are proposed in the literature (lexical resource databases and embedded learning algorithms). Lexical resource based approaches use a network or directed graphs (see figure 1). The semantic relatedness measures are calculated out of the properties of the paths in the graphs. In word embedding approaches continuous vector representations of words are computed based on a model architecture trained with a machine learning algorithm (see figure 2) and the semantic relatedness is calculated as distance between word vectors. We have access to both approaches, a license for the lexical database *GermaNet* and an implementation of *word2vec*, a machine learning algorithm programmed by *Google*.

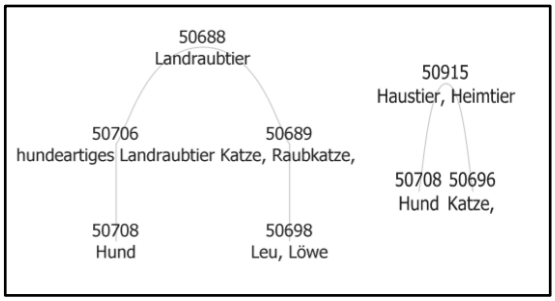

Figure 1: Path between "dog" and "lion" (left) and "dog" and "cat" (right) from GermaNet.

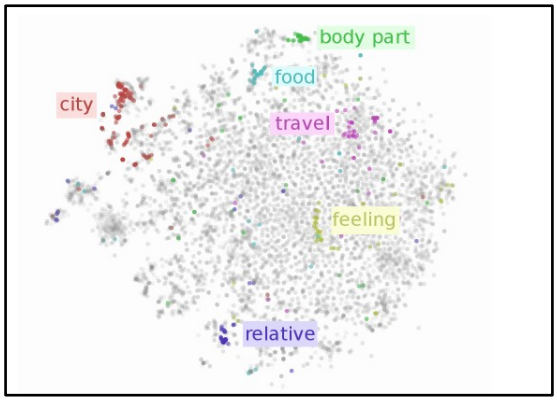

Figure 2: Visualization of high-dimensional word vectors in two-dimensional space (http://colah.github.io/posts/2015-01-Visualizing-Representations/)

Requirements:
Background in cognitive/neuro/clinical psychology or diagnostic
Willingness to learn programming and statistical skills

Supervisors:
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