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Exercise

In an experiment, participants were asked to produce visual scene descriptions while their eye-movements were tracked (Lee, 2012). From this experiment, for each (subject, scene) pair, one obtains the simultaneous recording of two temporal behaviors: eye-movements fixation sequence on the visual side and word/phoneme sequence on the language side.

Here are two examples of such empirical data as displayed by EyeParser (Lee, 2012).

Ex 1: http://victorbarres.github.io/handbook/eyeparser/extemporaneous/
Ex 2: http://victorbarres.github.io/handbook/eyeparser/prepared/

Those are taken from two different subjects describing the same scene, each under a different task conditions. Ex 1 was recorded under the “time-pressure” task conditions in which the subject had to generate extemporaneous descriptions starting as soon as the scene appeared on the display. The second example has been recorded under the “prepared” task conditions in which the subject had 10s to observe the scene before starting her description.

Question 1 to 6 do not require any coding.

Question 1: Describe how the two descriptions differ.

From this point on, you will only consider the extemporaneous case of Ex 1.

Question 2: Following the representational formalism of Template Construction Grammar (TCG), extract a set of constructions (a grammar) that could support the generation of the extemporaneous description. What are the main difficulties you encounter? What are the limitations of the TCG formalism?

Question 3: Turning to the eye-tracking data, under the naïve hypothesis that elements of the image are recognized when they are fixated, propose for the extemporaneous fixation sequence, a potential sequence of SemReps (S1) that would capture the incremental gathering of visual information.

Question 4: Do the same exercise as above but this time propose a sequence of SemReps (S2) that you derive from the unfolding semantic content of the word sequence.

Question 5: Qualitatively compare the two sequences of SemReps you proposed (S1 and S2). Propose a third sequence of SemReps (S3) that forms a compromise between the two previous sequences. What are the type of compromises you have to make?

Question 6: Pick 2 or 3 utterances and show conceptually how the succession of SemRep states S3 would yield the production of the utterances based on the cooperative computation of constructions instantiated from the set of construction you had previously defined. Does this

exercise require you to rethink your set of constructions and/or the succession of SemRep states? If so how?

The following question require the TCG production model that you can find at https://victorbarres.github.io/TCG/

Question 7: After inspecting the TCG_grammar.json files of the predefined TCG grammars, write down your own JSON file defining your TCG grammar, grammar which will only contain the set of constructions you defined in Question 2 (and possibly refined in Question 6).

Update the semantics of the model TCG_semantics.json to account for the concepts you have encountered in your SemReps and that are part of the semantic pole of your constructions.

After inspecting the sem_inputs.json files of the predefined input SemRep sequences, write down a JSON file defining your own semantic input as the sequence of SemReps you defined in Question 5 (and possibly refined in Question 6).

Using the updated TCG semantics file to define the content of the Conceptual_LTM schema, your own TCG grammar to define the content of the Grammatical_LTM schema, and using the sequence of SemRep as input, run the model (you should look at the information on the model's webpage regarding how to run the model).

Are you generating the description? Try and critically analyze the issues you may encounter. What are improvements to the model would you suggest?

The following questions are for the students who want to go further in the exploration of computational construction grammars.

Question 8: After reading the general description of Fluid Construction Grammar (FCG) proposed by Steels (2012), qualitatively assess if and how the FCG framework could handle the type of psycholinguistic data shown above (here consider both Ex1 and Ex2). In particular discuss the challenge of having a semantic representation incrementally built while the production of a description is already under way. Sum up the main points in which FCG is a much more expressive framework (semantically and grammatically) than TCG.

Question 9: Dominey has proposed a radically different approach to computational construction grammar. After reading Hinaut et al. (2015), summarize in a few sentences the main hypothesis the model makes regarding the relation that exists between construction grammar based language production and the cortico-striatal system. Compare and contrast this approach with TCG (and FCG if you have chosen to answer Question 8).

(The online pdf of this problem set can be found at http://victorbarres.github.io/handbook/TCG_exercises.pdf. The online version will be updated if required by the model's developments.)

Hinaut, X., Lance, F., Droin, C., Petit, M., Pointeau, G., & Dominey, P. F. (2015). Corticostriatal response selection in sentence production: Insights from neural network simulation with reservoir computing. *Brain and Language*, *150*, 54–68.

Lee, J. (2012). *Linking eyes to mouth: a schema-based computational model for describing visual scenes*. University of Southern California. Retrieved from http://dl.acm.org.libproxy.usc.edu/citation.cfm?id=2520921

Steels, L. (2012). Design Methods for Fluid Construction Grammar. In L. Steels (Ed.), *Computational Issues in Fluid Construction Grammar* (pp. 3–36). Springer Berlin Heidelberg. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-34120-5_1