CS 786G *Cognitive Modeling*
Week 7 Discussion Paper
Knowledge as number manipulation

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Kintsch (1988) presents a model of discourse comprehension that combines aspects of *top-down* or expectation-based contextualization and *bottom-up* or context-building behaviour. This work stands opposed in its philosophy to earlier work[1] which suggests that this understanding process is by its very nature primarily top-down and only that one need only "resort" to bottom-up in the extreme cases where context it completely lacking, or a conflict has arisen between accepted guiding contexts.

Kintsch has attempted to design a model which can be smart-enough in its handling of top-down contextualization that it may successfully integrate information into larger scopes while still remaining flexible enough to perform well in situations of high variability such as quick or quirky context changes in textual material. In order to accomplish this Kintsch has proposed a calculated weaking of the "rules" which guide top-down comprehension so as to allow for postulating several possible explanations or interpretations of the current focus, and subsequent manipulation of these postulates via an "integration" process in which the postulates that are contextually appropriate are progressively strengthened, while those which are inappropriate are weakened.

There are two distinct phases to Kintsch's model. First, the construction phase, which is responsible for the initial construction of a "text base" from linguistic input. Input is parsed into propositions and concepts, "associations" are located in the **general knowledge net** and added, new propositions are inferred, and finally, all pairs of identified elements are

[1] Such as that of Schank, cited in the paper, and reflected in the description "people understand correctly because they sort of know what is going to come". An excellent and interesting counter-example cited is that of analysis of the way people read ... with (possibly unconscious) eye movements jumping ahead in the text, presumably recognizing certain key words or phrases which are used to guide integration of the text into a current context. Clearly this type of information processing is far from linear and strictly top-down in that one is "massaging" the current context with "look-ahead" cues in advance of "studied" evaluation of the immediate text.

assigned *connection strengths.* The result of this is a fully-connected associative net (or matrix) which actually consists of numerical values (presumably indicating the degree of "relation" in some abstract, absolute sense that is never defined precisely, and which is difficult to project onto a human-reasoning analog). These values are derived from combining a measure of *proximity* between concepts in the source text (the closer the more "related"), and from (any) pre-existing correlation or "relationship" in the general knowledge net. The second phase of Kintsch model requires an initial "activation vector" which represents the some distributed measure of local-focus. This vector is repeatedly post-multipled with the association matrix giving new activation vectors. Once this process "stabilizes" (i.e. the association matrix values fluctuate little between iterations), the final activation matrix is used to resolve ambiguity amongst propositions in the matrix (essentially some go to zero values and some to higher values, the higher being accepted, the lower rejected), or resolve other issues such as pronoun referents by essentially removing "inadequate" propositions. The explanation of this process is essentially given by Kintsch in relative detail in terms of mathematics, but is only vaguely justified as in terms of knowledge use as indicated by his statement "Just a little knowledge was enough to choose the correct referent.".

As is the case with many connectionist or mathematical/statistical/probabilistic models in AI, justification, explanation or elaboration of the *process* of arriving at a particular decision, inference or resolution can be difficult in non-technical terms, if indeed *any* justification may be constructed or presented at all. It would seem that this type of reasoning falls back on the "intuition" or unconscious level to some extent and is not "reasoned" in the traditional sense. While it might make sense to have an "unconscious" or "non-reasoned" approach to understanding text or speech or other similar *immediate* tasks, it does seem necessary to be able to reflect and reason with and about the products of these other "low-level" tasks. Perhaps this reasoning process is in some way "over and above" the lower level tasks and need not see-into the workings of those tasks in order to justify them after the fact. At any rate, little room is provided in the model for reflection or reasoned retraction of assumptions.

A larger criticism of the mathematical-approach to reasoning and matrix computations is possible by noting that the construction of the general knowledge net is not discussed at all. Necessary to Kintsch's model is that this net embody a large-scale relational associative net which may be inherited to the instance-particular constructed associative net or text base. These relational values must be general enough to embody many different relations among possible propositions and concepts, and yet it seems to me that any general pairwise labeling of a wide range of concepts and propositions is either going to be so specific that it will be easy to construct a textual sample that fails to follow the labelling and consequently the "general knowlege net" values defeat or overwhelm the integration process with initial assignment values, or else the general net assignments will be so general as to capture little real "knowledge" about the world. Some general relationships in the real world (with equally many counter-examples), and other less common relationships require substantial explanation, or contextualization. The point is that a numerical attribution seems woefully lacking and the knowledge structure will have to be much more detailed and contain a great deal of "how-they-may-be-related-and-under-what-conditions" type of information, such as is offered by frames and frame networks and other knowledge structures. While I don't fully understand Kintsch's mathematical "integration" process, I am left feeling that much justification is missing, and that more knowledge correlation is required.

References

Kintsch, W. (1988), 'The role of knowledge in discourse comprehension: A construction-integration model', *Psychological Review* **95**, 163–182.