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Directing the Generation of Living Space Descriptions

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Abstract

We have developed a computational model of the process of describing the layout of an apartment or house, a much-studied discourse task first characterized linguistically by Linde (1974). The model is embodied in a program, Apt, that can reproduce segments of actual tape-recorded descriptions, using organizational and discourse strategies derived through analysis of our corpus.

Topic areas: generation, discourse strategies, computational models, living space description.

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Introduction

At this point in research on natural language generation, it is important to select problems that will clarify what is at issue in the larger phenomena under study, while being small enough to yield principled results in a reasonable amount of time. To build on what the field has already accomplished, the problem must involve the generation of motivated discourses, rather than isolated test sentences, and should be based on a corpus of real text. Furthermore, since a computational treatment of a generation problem should include a fully programmed underlying conceptual model to facilitate experiments, and since the representation used in that model will invariably play a crucial role in any theory, part of the research is building the model and designing the representation. This means that to be tractable the problem should not require expert knowledge or be overly large.

Living space descriptions fit these demands neatly. They are single-speaker monologues, allowing us to ignore issues of turn-taking strategies or interpreting an interlocutor's intentions. The task is something everyone seems to be able to do, but it is not such an everyday occurrence that it has become formulaic: it is likely that people are actively constructing what they are saying. Affective and abstract information is minimal and, to a first approximation, can be safely factored out of a corpus, reducing the potential complexity of the conceptual model. This simplicity has allowed us to concentrate on our prime concerns: understanding the relationship between the organization of a conceptual model and descriptive strategies, determining the influence of these strategies on the discourse structure of a text, and (secondarily) to take an initial look at issues in lexical choice in a familiar domain.

At the time this paper is written, we have finished the first phase of our research: We have collected and carefully transcribed a corpus of seven different people's descriptions of the same, single-story house (the residence of one of the authors). A program model

of this house, as these people appear to view it, has been developed, along with a set of strategies and meta-strategies for generating living space descriptions that emerged from our analysis of the corpus. This paper presents our representation, some of the strategies we have identified and their application in mimicking¹ a segment from our corpus, and our treatment of some linguistic issues in choosing words and constructions.

Background and approach

The seminal work in living space descriptions is Charlotte Linde's 1974 dissertation. Linde analyzed 72 descriptions of apartment layouts in New York City. She developed a model in terms of a phrase structure network in which rooms were the nodes and the default strategy was to construct a "tour" through the rooms. Veronika Ullmer-Ehrich (1982) is notable among other researchers studying the structure of living space descriptions. Working in a domain of dormitory room descriptions, she developed the concept of a gaze tour of a single room. (Our own informants tended to give the contents of the rooms as well as their spatial relations to each other.) Another line of research feeding into the current work, especially its architecture, was Jeff Conklin's GENARO program (1983), which described pictures of houses in various settings.

Linde's and Ullmer-Ehrich's models describe their data. Ours is a computational model that allows us to reproduce our data and, further, to produce variations on it. Our implementation, Apt, is composed of a **knowledge base** consisting of interconnected first-class objects, **strategies** which traverse the knowledge base constructing descriptions, **meta-strategies** which choose among the strategies each time a new

¹ Living space descriptions are a small enough subject matter that it is worth trying to develop a treatment with enough articulations in its mechanisms to potentially account for every detail of what people actually say--hence "mimic". There may well be vast amounts of arbitrariness in the decisions people make; but the pressure to explain the fine structure of their utterances, not just to gloss over it by producing something "comparable" but more regular, should lead to stronger, more interesting theories.

strategy is needed, and **mapping rules** between Apt's knowledge structures and the realization component's knowledge structures.

The representation

Practically any familiar representation language that one might "take off the shelf" to use in modeling the information needed for the description of a house will be technically deficient in several ways when one comes to use it as a source for generation: it may not supply first-class objects for the information units a natural language can reference; its taxonomic hierarchy may provide the wrong generalizations, and so on. To avoid these problems, we developed our own representation system, essentially a system for building a classic semantic net.² Every minimal fact and referenceable item is its own first-class object, including the relationships among them. We refer to these objects as **noumena**,³ and presently break them down into three basic types, reflecting differences in how they are mapped to the realization component.

objects, such as *kitchen-window* and *sink*
relations, such as *has-property* and *next-to*
properties, such as *large* and *picture-window-like*

Noumena have links to selected other noumena, which is the basis of the connectivity that (tacitly) makes a given knowledge base into a coherent whole, and is what the descriptive strategies navigate through. Connections are introduced on an empirical basis wherever noumena are related in such a way that they can be combined by a strategy in some description as determined by our analysis of the corpus. The knowledge base for a

² At this point we do not include any sort of part-whole hierarchy such as *house* dominating *room* dominating *furniture*. If such a structure eventually emerges as a generalization that, say, simplifies the statement of our strategies, then this will suggest that it is inherent; on the other hand if we build in a hierarchy *a priori*, we will never know whether the structure is there only because we put it there.

³ Singular: *noumenon*; from the Greek meaning a thing-in-itself, independent of sensuous or intellectual perception of it.

given living space consists of all the noumena that might reasonably be mentioned (given our analysis of the corpus).

While deliberate connections between noumena may seem to be begging the question, it accounts for a phenomenon that cannot be neglected, namely why it is that it never occurs to anyone to say, e.g. *the toilet is next to the stove*: If all aspects of describing a living space are data-directed, i.e. following or choosing among already established connections, then a speaker will never even think about infeasible possibilities. One can easily imagine other architectures, such as simply lumping all objects into a common heap organized by their salience, where one would have to actively search for interesting relations by methods like generate and test. Such a design would make different predictions about resource demands and processing effort than ours would.⁴

Strategies and meta-strategies

A description is a controlled traversal of the knowledge base.⁵ Control is in the hands of **strategies**, which are selected (linked together) by **meta-strategies**. The context these may reference is only the most recently visited noumenon, all the untraversed links emanating from it, and the most recently used strategy, making all of Apt's operations local and data-driven.

We have presently identified approximately 15 strategies in our corpus, each grouping nouema together and ordering their presentation. Typical strategies include moves such as **circular sweep**, in which the speaker picks an anchor point in a room and describes the room's features or contents in an order determined by their placement along

⁴ An arguably equivalent and perhaps preferable representation might be a non-propositional geometrical model after the fashion of an architect's drawing. However, we have never seen any evidence of the precision that such a representation would bring with it (quite the contrary), and have found many conventional aspects to the descriptions in our corpus that would be quite at odds with a model that captured the actual visual appearance of the house.

⁵ Our observations agree with Linde's that a minimal description mentions all of the rooms (except possibly the bathroom) and their spatial relation to each other. Apt keeps track of rooms (and other noumena) mentioned, and simply stops when the rooms have all been mentioned.

the circumference of the room; **look right-look left**, in which the speaker describes features to either side of a mental reference point, optionally adding **look ahead**; or **follow a hallway**, one of the strategies by which a speaker shifts to a new vantage point.

To understand this better let us look at how the strategies and meta-strategies come into play in generating this excerpt from a description by a subject named Lisa. (N.b. this is an implemented example that Apt has actually produced.)

Then, in the kitchen, ⁽¹⁾there's a large window which faces the backyard, with two flanking windows.⁽²⁾ And, if we're facing the backyard,⁽³⁾ on the righthand side is a sliding glass door, and then a small window. If we're again facing the backyard,⁽⁴⁾ on the lefthand side is the stove, then a refridgerator. And, beneath that large window is the sink,⁽⁵⁾ and on the righthand side is the dishwasher.

This segment starts with a preposed adverbial to mark a shift of vantage point.⁽¹⁾ Upon entering a major room a meta-strategy preferring any especially salient objects over object sequences applies, giving us the matrix of the first sentence.⁽²⁾ That window is connected to three sets of objects, each of which is organized by a sweep strategy. This pattern triggers a room-sweep meta-strategy that anchors them all to the same very salient object (the window), expressing the sweeps as displacements from this anchor using deictic terms and reorienting to the salient focal point between sweeps.^(3,4,5) A meta-strategy probably specific to Lisa prefers starting with "righthand" alternatives, thus giving the sweeps their order.

Linguistic choices

Thus far we have been talking about issues of what we would call "orchestration": planning the text structure that provides the order of presentation, segmentation into sentences, and the textual function and salience of a body of information that has been selected for inclusion in an utterance. We must also look at issues in "mapping",

selecting the specific wording and choice of construction that will realize a given noumenon.⁶

Lexical selection is in most respects a non-issue in living space descriptions. Nearly every physical object has an obvious and very over-learned name (e.g. *kitchen, bathroom, sink, refrigerator*), making the process one of simple retrieval rather than judgement and planning. The exceptions are, as one would predict, the objects whose common nouns are ambiguous, such as hallways, closets, or windows, and for these Apt will have to explicitly construct a description (one of the next tasks in our research). In the corpus, constructed descriptions most often involved folding in the same sort of spatial information used in ordinary descriptions. Thus we have references to *a large hallway that leads into the kitchen, the smaller hallway that leads to the bedrooms*. After it has been mentioned a few times, a description will be abbreviated and canonicalized: *that wide hallway, that smaller hallway*, with or without further (non-restrictive) modification.

Choosing syntactic constructions is a constrained problem, since our corpus contains surprisingly few construction types. For example, once affective comments and digressions have been removed, more than half of all clauses fall within the class **locative relation**:

there is <object> <at location>
<at location> *there is* <object>
<at location> *is* <object>
<object> *is* <at location>
<object1> *has* <object2> *at* <location>

⁶ The other principal activities of generation (as we see it) are "selection", which is in most respects trivial in this domain since we stipulate that all of the noumena in the knowledge base are to be mentioned, and "realization", which is carried out by the program Mumble-86 in the fashion described in Meteer et al. 1987.

Which construction is selected is determined by a set of discourse-level heuristics. For example within a sweep the "<at location> *is* <object>" choice is natural because it facilitates chaining; and breaks between discourse segments can be flagged with a marked construction like "there-insertion".

Future Work

A major goal of this work is to construct a library of meta-strategies, strategies, and mapping rules that is comprehensive enough to allow Apt to produce a variety of brand new descriptions (in addition to mimicking the ones actually in the corpus) from the same knowledge base by varying library selections in what appear to be natural ways. Toward the end of establishing and strengthening our theory, we are also planning to collect and model a larger set of descriptions of another living space. In a parallel effort, we are working on a computationally feasible model of deixis (Sibun and Huettner, forthcoming). We would like ultimately to use the architecture we develop to reanalyze prior work in related domains, such as the scene analysis done by Conklin's GENARO.

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