

A Computational Theory of Turn-taking

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A Turn-taking Framework

My research is concerned with the problem of turn-taking in discourse, especially as applied to intelligent interfaces, such as advice-giving systems or software help systems. A limitation of many discourse systems is their need for explicit turn-ending signals (e.g. pressing a return key). In such systems, mid-turn interruptions are impossible, although there are practical examples of where mid-turn interruptions are highly desirable. For example, an interface agent should promptly inform the user of important pieces of information, such as a lack of disk space or the loss of a network connection, especially if the user is engaged in some activity that relies on that information.

Interruptions are a particularly useful instance of turn-taking, and we have outlined a general three-part goal-oriented model of turn-taking:

Motivation An agent must first have some motivating reason to take a turn. Motivations include, for example, recognition of an inconsistency in the beliefs of the speaker, or a desire for plan clarification;

Goal Adoption It is often inappropriate to take a turn the moment you have something to say — you should wait until the other person has finished speaking. Thus, motivations trigger the adoption of turn-taking goals;

Turn Execution Conversants typically coordinate turn-taking by giving and receiving various vocal and semantic signals. For example, decreased speaking volume can indicate that a speaker is willing to give up the floor (Oreström 1983).

Time-bounded Persistent Goals

We have designed a goal-based framework for controlling an agent's actions based on the idea of *time-bounded persistent goals*, a time-sensitive variation of Cohen and Levesque's *persistent goals* (Allen 1983;

Cohen & Levesque 1990). In their most general form, time-bounded persistent goals looks like this:

Bounded-persistent-goal(ϕ, T)

While: *simple-goal*(ϕ)

Adopt-when: $B(\text{holds}(B\neg\phi, \text{some-head-of}(T)))$

Drop-when: $B(\text{holds}(B\phi, \text{some-tail-of}(T)))$
 $B(\text{holds}(B\neg\phi, \text{some-tail-of}(T)))$
 $B(\text{after}(T, \text{now}))$

A bounded persistent goal to make ϕ hold over T is adopted when the agent has a simple goal to achieve ϕ , and the agent believes ϕ does not already hold at the start of T . The goal is dropped when the agent believes ϕ holds over some interval that ends T , or that $\neg\phi$ holds over some interval that ends T , or T is in the past. By defining different kinds of simple goals, the bounded persistent goals can be used to help a rational agent decide how to manage its turn-taking activities.

We have considered applying bounded-persistent goals to the problem of the initiation of clarification dialogs in advice-giving settings (for cases of misconceptions and plan ambiguity). While it is typically assumed that, for example, a possible misconception should be dealt with immediately, time-bounded persistent goals allow certain turns to be put aside, and not actually executed until absolutely necessary. Such "lazy" turn-taking thus allows for the possibility that perceived problems may actually be corrected by the speaker, and thus no clarification dialog need be entered into at all.

References

- Allen, J. 1983. Maintaining knowledge about temporal intervals. *Communications of the ACM* 26(11):832–843.
- Cohen, P., and Levesque, H. 1990. Intention is choice with commitment. *Artificial Intelligence* 42:213–261.
- Oreström, B. 1983. *Turn-taking In English Conversation*. CWK Gleerup.