Modelling Telephonic Interaction: A Dynamic Approach

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Synopsis: This paper outlines a dynamic formalism for modelling interaction. A *dynamic* formalism models the behaviour potential *at each point* throughout an interaction, rather than trying to present the possible types of completed interaction structures, as in a *synoptic* approach. It is thus more concerned with interaction as *process*, rather than interaction as *product*. We model an interaction as a sequence of *tasks* which together achieve the respective goals of the participants. The dynamic model details which tasks are appropriately performed at each point of the interaction (the interactional context), and how the performance of the selected task changes the interactional context, thus producing a new interactional task potential. To ground our discussions, we will model Telephonic Information Service interactions.

1. Introduction

There are an increasing number of companies offering telephonic information services -- services which allow a caller to ring in and obtain information from the service's databases. In the past, such services may have been limited to train timetables, or telephone numbers, but in recent years the range of such services has been growing.

One limitation on the growth of such services is economic -- the cost of an operator's wages often outweighs the revenue that can be derived from charging for information. Information with infrequent demand cannot be provided economically.

One solution to this problem is to automate the service, replacing the human operator with a computer program. The human somehow communicates their needs to the computerised operator, which then obtains the required information from its database, and speaks this information back to the caller. Such services are starting to appear, but they are limited -- the computer offers a multiple choice option to the caller, who then indicates their choice by pressing a dial-key, or speaking a single word.

With improving voice recognition technology, more natural forms of interaction are becoming possible. There are prototype systems today which can provide answers to spoken questions, although these systems tend to have restricted linguistic models, both in terms of grammar/lexicon, and also in terms of the interactional model. Ideally, such a system should allow people to access information over the phone as in a human-human interaction. To enable the computer to handle a dialogic interaction in a manner approaching that of a human operator, we need to provide a linguistic model of interaction, a formal setting out of the behavioural patterns of human interactants in this genre.

With this goal in mind, the *Dialogue Project* at the University of Sydney was set up, with funding and co-operation from Telecom (Australia) Research Labs (King *et al.* 1991; Eggins *et al.* 1991; Sefton *et al.* 1991). The project, which ran over several years, analysed information-service interactions, and modelled them on several levels. These models were then implemented in a prototype computer system (Rowles *et al.* 1992a, 1992b, 1993a, 1993b).

This paper reports one level of our modelling of telephonic interaction, what we call *Task Structure* -- the modelling of interaction as a series of tasks to be achieved. While the authors are primarily responsible for this model, contributions have also been made by other members of the project, including Christian Matthiessen, Suzanne Eggins, Julie Vonwiller, and Janine Schulz.

We will be dealing with a sub-genre of the information service genre, called a *Yellow Pages* information service (YPIS), which allows callers to ring in and query the commercial telephone directory, for instance, to obtain the location of a particular type of business, e.g., *Where is my closest repair shop?* To obtain data to model this genre, a Yellow Pages service was set up for one day only (see King *et al.* 1991 for details). Associates of the project were asked to ring in and try to elicit information relating to Motor Repair businesses. A professional telephone operator was used to handle calls. Answers were provided from a database made available by Telecom Australia. The resulting dialogues were recorded and transcribed, and have been analysed at various levels.

Most prior Systemic work on generic structure has focused on monologic texts. We are concerned more with the structuring of *interaction*, rather than the structuring of *text*. We wish to model how people interact co-operatively to achieve their goals. We are thus concerned with dialogue rather than monologue. Our focus on modelling interaction does not preclude us from modelling monologic text as well: our approach has been used to model the structure of author biographies, and can be extended to any text which is generically structured.

Our focus on modelling interaction also leads us to consider *non-verbal*, as well as *verbal*, behaviour, particularly where non-verbal action is used as an alternative to verbal interaction, for instance, when we check our own watch rather than ask someone else for the time.

Dynamic *vs.* Synoptic Modelling: Approaches to modelling interaction can be either *dynamic* or *synoptic*:

i) A *synoptic* approach represents what types of interaction-structures we can produce. It models the *products* of interaction, rather than the process itself. For instance, the Generic Structure Potential (GSP) of Hasan (1979) represents the different generic structures which can be produced in an interaction, and Martin (1992, p552) demonstrates a synoptic representation of service encounters, using system networks.

ii) A *dynamic* approach, on the other hand, represents what can come next at each point of the interaction. It is more concerned with modelling the *process* of interaction, rather than the *product*. A dynamic approach represents the choices which can be made at each point throughout the interaction, and how that choice affects future behaviour choices.

For our goal of modelling interaction for a computer operator, a dynamic approach is preferred, since it allows the computer to see, at each point of the interaction, what its behavioural options are, and what the consequences of these choices are in regards to later behavioural options. It can thus choose behavioural options which best move towards its goals (which, for the computer, is to charge the customer for use of the service, and also to leave the customer satisfied so that they will use the service again).

It is difficult to use a synoptic model for this purpose -- the computer cannot just choose an interaction structure and attempt to produce it, since, ideally, the caller has a part in determining the direction and shape of the interaction. The interaction needs to be negotiated dynamically, allowing each participant to plan where the interaction is going, but allowing for these plans to change in response to the needs of the other interactant.

Two formalisms have commonly been used for dynamic modelling of interaction -- *flowcharts* (Ventola 1984, 1987; Martin 1988, 1992), and *transition networks* (Woods 1970; Winograd & Flores 1986; Fischer *et al.* 1994). We propose here a systemic-based alternative to these approaches, relying on system networks to represent behaviour (task) potentials at each point of the interaction, and also to represent the interactional contexts which condition these choices. For this purpose, we have adopted the dynamic formalism of O'Donnell (1986, 1990), which was there used for representing Move (Exchange) Structure. We thus now use this formalism to model interaction on two levels -- the dynamic unfolding of tasks within a genre, and also of moves within an exchange.

This formalism was an outgrowth from Halliday's and Hasan's notion of a contextually-conditioned behaviour-potential (e.g., Halliday 1973, Hasan 1981). Berry (1981) applied this notion to exchange structure, showing the move potential at each point of an exchange (see applications of this approach in Tsui 1989). Ventola's (1984, 1987) use of flowcharts to

represent interaction has also been influential, as has Martin's (1988) discussion of the dynamic *vs.* synoptic distinction.

Framework Overview: To put the Task Structure model in perspective, we will briefly discuss the relation of this component to the rest of the semantic system. We are modelling interaction using a model with three strata (levels) of representation (non-verbal action only requires the first of these two levels of interaction), as shown in figure 1:

- **Task Structure**: Representation of the interaction as a global goal-satisfying activity.
- **Move Structure**: Representation of interaction as physical acts and verbal acts. A series of moves negotiating a single (possibly complex) proposition constitutes an *exchange*. A move is itself composed of participants (Doers, Speakers, Hearers), and other roles (Ideational-Content, Speaking-Time, etc.).
- **Grammatical Structure**: Each verbal move can be re-represented in terms of its grammatical structure, the syntactic form of the utterance.

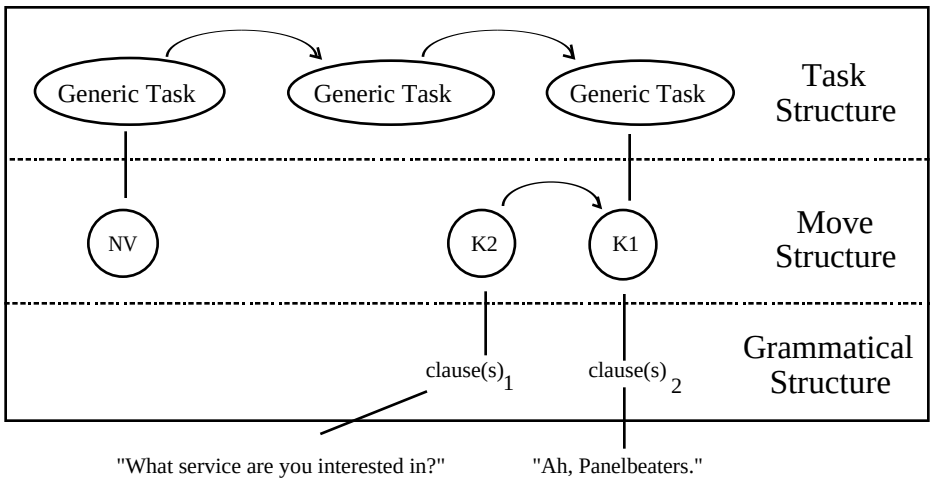

Figure 1: Task Structure in a Model of Interaction

The first two of these strata are most relevant for modelling interaction: Task Structure organises the dialogue as a series of institution-specific tasks which need to be achieved; and Move Structure organises these task in terms of the co-operative contributions from each participant. Each task is realised either as a single move (as is often the case for nonverbally realised tasks), or as a move-complex (e.g., an verbal exchange negotiating some proposition). Both strata are concerned with the joint achievement of goals through interaction.

2. Task Potential

In the rest of this paper, we outline a model of interaction as a sequence of tasks which together work towards the participants' goals. The sequencing of these tasks is organised through use of a dynamic model, which firstly constrains each task to particular interactional contexts, and secondly, shows how the successful completion of the task modifies the interactional context, thus activating further tasks, and moving closer to satisfying the overall goals of the discourse.

Susan Eggins (in King *et al.* 1991) provided the following GSP analysis for the Yellow-Pages Information Service genre:

> Contact ^ Business-Request ^ Location-Nomination ^ (Foreshadowing) ^ Database-Search ^ (Wait-Warning) ^ Report-Negotiation ^ Report-Provision ^ Pre-Closure ^ Closure

We have used these elements as the basic tasks in our model, although some have been changed to better suit a task-based approach, rather than her stage-based approach. In regards

to the sequencing of the tasks, we have also replaced the GSP representation with a dynamic model, as outlined below.

In this section, we will outline the types of tasks which are available in the Yellow-Pages information service. Later sections will show their contextual conditioning, and finally their effect on context. Table 1 below shows a sample dialogue from a Yellow-Pages Information service. The leftmost column shows the breakdown of the interaction in terms of tasks. The dialogue has been structured according to Eggins' scheme (modified for out purposes). The second column shows the speech or action which takes place, with the performer of the (inter-)act shown as either the caller (c), or operator (o). The final column of the table provides a gloss for each of these tasks. The caller's turns have been shaded, to show that turn-taking is organised distinctly from task structure.

These tasks are realised either verbally or non-verbally. Verbally-realised tasks are realised through dialogue -- the goal of the task is to negotiate some information or action, and reach a common agreement (sharing) of the information, or action. Other tasks are realised through a single interactant's non-verbal action (such as *pick-up-phone*, or *initiate-database-search*). Task structure is thus seen as an abstraction over both verbal and non-verbal behaviour. We are more concerned with *what* is done, rather than *how* it is done. The realisation of tasks as verbal and non-verbal acts will be discussed in a later paper.

Task	Text	Gloss
Ring-Information-Service	c: <caller dials>	The caller dials the information service.
Pick-Up-Phone	o: <operator picks up the phone>	The operator responds to a ringing phone by 'picking up the phone' .
Greetings	o: good afternoon ~	The operator greet the caller (callers response is optional).
Identify	o: information service c: Yes ~	The operator informs the user of the service they have reached.
Business-Specification	c: I'd like information on some panel beaters o: ...on some panel beaters? c: Hmmm.	The caller specifies the type of business they require information about.
Location-Specification	o: Where do you live? c: Chippendale.	The caller specifies the location of the business they require information about.
Initiate-Database-Search	o: [typing] c: [silence]	The operator types in the database request (a non-verbal action).
Wait-Warning	o: Just a moment.	The operator informs the user that a period of waiting is necessary.
Return-Database-Search	- <screen activity>	The database search program displays results on the operator's screen.
Information Negotiation	o: There's one in Chippendale Would that be.... ? c: Yep, Great	The operator and caller negotiate whether the result is adequate, or, in the case of multiple results, which results to provide.
Information Provision	o: It's Cleveland motor body repairs c: Hmm o: One five three Cleveland street c: Right o: Telephone number is six nine eight... c: Six nine eight o: Two eight four one. c: Two eight four ONE	The operator provides the information to the caller.
Thank	c: Thanks very much o: Right.	The caller thanks the operator.
Closure	Bye bye! c: Bye!	The participants exchange farewells,
Hang-Up	<Operator Hangs up the phone>	The operator, and the caller, hang-up.

Table 1: A Sample Yellow Pages Dialogue

Our way of modelling task structure fits quite well with Halliday's notion of behaviour potential, as described by Butler (1985):

> "As members of a particular culture, with a particular social structure, each of us has available to him a range of behavioural options (a 'behavioural potential') for use in certain types of social context. The behavioural potential constitutes what we 'can do', and encompasses non-linguistic as well as linguistic behaviour." (p59).

The tasks shown in table 1 form the behaviour potential of the participants -- what they can do at this level of modelling. While a behaviour potential at the move level - the Move Potential - represents what each participant can do *individually*, the Task Potential represents what the participants can do *co-operatively*.

3. Task Context

The next step is to specify the context in which each of these tasks is appropriate. Our dynamic model is thus based on Halliday's notion of contextual constraint on behaviour potential:

> "It is the social context that defines the limits on the options available, the behavioural alternatives are to this extent context-specific" (Halliday 1973, p64).

As a first step, we collect a list of the factors which condition the availability of each task. For instance, we can ask: *when can the operator pick up the phone?* The answer is: *when it is ringing*. We thus build up a list of the relevant contextual states. Some of these states represent real-world conditions, for instance, the state of the phone line (connected, ringing or dead), or whether the database-search program is running or not. The majority of the systems reflect instead the *interaction history* -- what has so far happened in the interaction, e.g., has the Greeting task already taken place. These features thus represent, in a paradigmatic manner, the syntagmatic environment of action. We will see that it is this type of contextual information which most frequently conditions the availability of tasks.

We then organise these factors into a system network, such as in figure 2. This network organises contextual states into *systems* -- mutually incompatible sets of states, e.g., *phone-inactive/phone-ringing/call-connected*. These systems are connected to reflect the logical dependency between the states -- greetings could not have been exchanged unless the call was connected, the database search could not be running unless a valid search-template was established, etc.

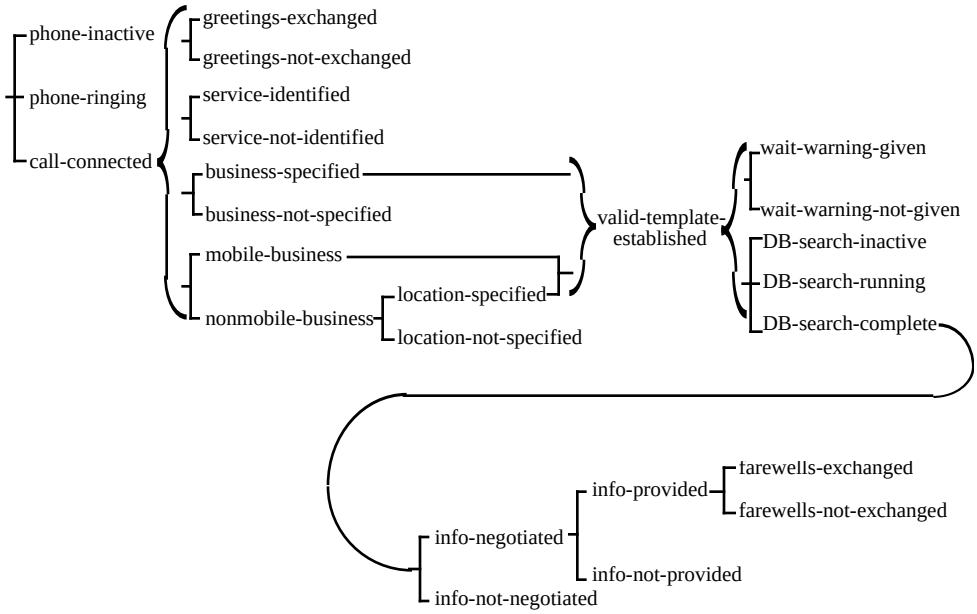

Figure 2: Context Network for Yellow Pages Information Services

Some of these contextual systems apply simultaneously: for instance, the four systems linked by the left-most '{' all become active once *call-connected* is selected. One of the states in each of these systems must be active.

The backward curly-bracket '}' represents a *logical conjunction* of states. In a context network, the state on the right-hand-side of the bracket is established only through the establishment of the states on the left-hand-side of the bracket. For instance, the state *valid-template-established* is not achieved directly by any action, but rather by the achievement of a number of other states, namely *business-specified* (the operator has established a trade-type, e.g., air-conditioning), and either *location-specified* (the operator knows where the caller wants the business), or *mobile-business* (the operator knows the caller wants a business which calls door-to-door, so location is not necessary). For this reason, we call such states *compound-states*. The 'T' linking *location-specified* and *mobile-business* represents a *logical disjunction* of states.

This network should not be interpreted as a flowchart -- it doesn't represent a sequencing of tasks. It is meant to be read as a static representation of the possible states of the interaction -- any one selection expression (the set of features simultaneously selected in the network) is a single possible interaction context. For instance, [phone-inactive] is one possible context. Another is [call-connected: greetings-exchanged: service-identified: business-specified: mobile-business: valid-template-established: wait-warning-not-given: DB-search-running].

If we view a *goal* as *the achievement of some desired context,* then we can re-interpret the context network as a goal network -- a representation of the various goals which can be achieved. People enter into interactions to achieve a particular goal, or in contextual terms, to produce a particular target contextual configuration.[1] Interactants thus choose a series of actions (a task-sequence) which most promises to produce their desired context. Note however, that the existence of pre-packaged genres on the supermarket shelves of our society means that we know longer have to plan a new task structure every time we interact.

[1]Casual conversation is said to be goalless activity. However, we would claim that casual conversation does have goals, but in regards to achieving particular phatic contexts, e.g., reducing social distance.

4. Contextual Constraints on Task Potential

Once we have organised the relevant contextual states, we can then relate each task to the context in which it is appropriate -- its contextual constraint. Table 2 shows the contextual constraints for the tasks of the YPIS genre.

Task Name	Initiator	Activating Context	Contextual Effect
Ring-information-service	Caller	phone-inactive	phone-ringing
Pick-up-phone	Operator	phone-ringing	call-connected & greetings-not-exchanged & service-not-identified & business-not-specified & location-not-specified
Greetings	Operator	greetings-not-exchanged	service-identified
Identify	Operator	service-not-identified	greetings-exchanged
Business-Specification	Either	business-not-specified & service-identified & greetings-exchanged	business-specified
Location-Specification	Either	location-not-specified & service-identified & greetings-exchanged	location-specified
Mobile-Business-Specification	Either	location-not-specified & service-identified & greetings-exchanged	mobile-business
Wait-Warning	Operator	wait-warning-not-given	wait-warning-given & DB-search-inactive
Initiate-Database-Search	Operator	DB-search-inactive	DB-search-running
Information-Negotiation	Either	information-not-negotiated	DB-search-complete & info-not-negotiated
Information-Provision	Either	information-not-provided	info-negotiated & info-not-provided
Thank	Either	information-provided	info-provided & farewells-not-exchanged
Closure	Either	farewells-not-exchanged	farewells-exchanged
Hang-Up	Either	call-connected	phone-inactive

Table 2: The Contextual Conditions of Tasks

The *Initiator* column shows who generally is responsible for initiating the task. Note that the initiator is not the only contributor in a task, nor always the most important: most tasks require contributions from both participants to be successfully completed. Some tasks need to be initiated by a specific participant (e.g., the operator must initiate the *Identify* task). Other tasks can be initiated by either participants, for instance, the *Business-Specification* could be begun by the operator -- *What type of business are you interested in?* -- or by the caller -- *I'm wondering if there are any Panel-Beaters in Glebe?*

In this genre, the operator can initiate any task (except for the act of ringing the service), because it is necessary for them to manage the interaction, ensuring things run smoothly towards the completion of the genre's goal -- the provision of information.

Sometimes an unexpected participant may initiate a task, going against the genre. For instance, imagine a case where a new telephone operator answers the phone with simply "Hello?". It would then be up to the caller to initiate the *Identify* task, by asking a question such as "Is this the Yellow Pages Information Service?".

The column titled *Activating Context* shows the contextual state(s) which must exist before the task can be successfully performed. The constraint may involve a logical combination of the contextual states, including disjunction and conjunction of states, although in this example only conjunction is required.

Sometimes an option is available prosodically throughout the interaction. Our model includes one such case, the option to *Hang-Up,* which can be performed by either participant at any point during the interaction (whenever the state *call-connected* is set). There might be various reasons for the callers to choose this option, for instance, the caller may realise that they don't really need the information, or the caller might notice their house is on fire. For whatever reason, the model needs to allow this action, so that the computer operator can deal with it when it occurs. Synoptic models cannot adequately represent the prosodic availability of options (see O'Donnell 1990).

It is probably more precise to say that it is the *effect* of the task, rather than the availability of the task, that is contextually constrained. It is possible to perform (or at least try to perform) these tasks outside of the activating context. However, it is likely that the action will not be effective outside of these contexts, for instance, picking up the phone and listening will have little effect if the phone is not ringing.

The contextual conditioning represents only the generic activation -- the community-shared notion of what actions are appropriate in what contexts. When we move away from conventionalised behaviour, into the realm of creative behaviour, we may find new contexts for actions which are also functional. If a new action-in-context combination proves to be useful to a number of people, it will tend to become part of the community's shared knowledge, part of an extended generic structure potential.

5. Effect of Tasks on Context

We now need to show how the successful completion of a task modifies the interaction context, thus leading to a change in the available Task Potential. Often, the context changes just by a single state, the selection in one system changing to indicate that some task has been performed, indicating that it does not need to be achieved any more. For instance, the successful completion of the *Greetings* task results in the contextual state *greetings-exchanged* being selected. One effect of this is that the *Greetings* task is no longer activated (it depends on the contextual state *greetings-not-exchanged*). Other contextual changes can be more complex, involving a cluster of contextual systems changing their selection. This may result in substantial changes to the available task potential

The final column of Table 2 shows the contextual effect of each task. This column shows, for each task, the contextual states which result from the successful performance of the task. The context is changed to reflect these new states, and any states not in conflict with these are left unchanged. For instance, changing the context from *greetings-not-exchanged* to *greetings--exchanged* will not effect the system dealing with service-identification.

This component is necessary in a complete dynamic model of interaction. As Martin (1988, p243) points out, some way of relating each action to the change in behaviour potential that follows is needed. Martin, and Ventola, represent this using flowcharts, where the flow-lines link each action to consequent actions or decisions. By explicitly representing the effect of behaviour on context, we have captured this feature in a systemic-based formalism.

The concept is not totally new to Systemics, having been at least pointed to at various times:

> "The social context of any conversation is continually being created and modified, by the course of the conversation itself as well as by other processes that may be taking place" (Halliday, 1984, p8).

> "When the context is co-operatively negotiated, the text and context evolve approximately concurrently, each successive message functioning as an input to the interactants definition of what is being achieved" (Hasan 1981, p118).

The following points are relevant here:

- **Failed tasks do not (usually) modify context**: It is not enough to initiate a task to change the context: a task must be completed successfully to result in a modified

context. For instance, if the operator asks the user where the caller wants the business, and the caller fails to answer, then the context will not be reset. The operator can then retry the task, or try some other task possible from that context.

We might sometimes however desire failed tasks to modify the context -- some tasks can be tried only once, and if they fail, cannot be attempted again. For instance, if the caller answers the question *What trade do you want?* with *I don't know*, then the *Business-Specification* task has failed, but we wouldn't want the operator to repeat the question, but rather to try some alternative task or task sequence to get the interaction back on track, or to terminate it.

- **Contextual changes may be external to participant actions**: Sometimes the context is changed not as the result of an act by a participant, but due to some change in the environment e.g., *Return-Database-Search* (in the Task table above), is an action which is not performed by the operator or by the caller. Rather, after the machine starts a data-base search, the search program will return at some point, resetting the contextual state to *DB-search-complete* automatically. Another externally-initiated event occurs when the phone-line goes dead mid-conversation.

6. Stepping Through an Interaction

To give a better idea of how the model works, we will step part way through an interaction. We have added the task *Do-Nothing* to the participant's behaviour potential, which represents the option not to act. It is always available, and (usually) has no effect on context.

We start with the task-context set to state: *phone-inactive*. Referring to table 2, we see that, apart from *Do-Nothing*, only one task is activated in this context: *Ring-Information-Service*, which needs to be initiated by the caller.

State	Operator Task Potential	Caller Task Potential
phone-inactive	Do-Nothing	Ring-Information-Service Do-Nothing

Lets assume the caller chooses to perform *Ring-Information-Service* rather than *Do-Nothing* (the caller could also choose from some other generic potential. e.g., *Make-Coffee*, *Mow-Lawn*, etc.). This task has an associated contextual-effect: *phone-ringing*. We thus establish a new context, and a new task potential:

State	Operator Task Potential	Caller Task Potential
phone-ringing	Pick-Up-Phone Do-Nothing	Do-Nothing

The operator can choose to ignore the phone, or answer it. Since answering the phone is one step towards its overall goal (to charge customers), it will do so, producing a new context:

State	Operator Task Potential	Caller Task Potential
call-connected & greetings-not-exchanged & service-not-identified & business-not-specified & location-not-specified	Greetings Identify Do-Nothing Hang-Up	Do-Nothing Hang-Up

Both participants now have the options to *Do-Nothing* or *Hang-Up*. The *Hang-Up* option is rarely selected, because it doesn't lead towards the goals of either participant (caller: to get information, operator: to make money).The caller may feel happy to *Do-Nothing* here, waiting for the operator to direct the interaction. The operator is thus likely to select either *Greet* or *Identify* here. Either task can be performed first, I assume the *Greetings* option is chosen.

This *Greetings* Task is the first verbally-realised task of this interaction. For the YPIS genre, it is not essential for the caller to respond to a greeting. We thus consider the task satisfied as soon as it is initiated. In other words, the only obligatory move in the task realisation is the greeting by the operator. The caller can still complete the greeting if they desire, however, and need not do so immediately, but may wait until the operator has finished their turn at speaking. A fuller explanation of this requires discussion of the mapping between tasks and exchange structure, which we will leave to a later paper. For some other types of verbal-exchanges, the task will not be considered satisfactorily completed unless both participants have made a contribution, e.g., when a question is asked by the initiating interactant, the answer is required for a satisfactory completion.

The successful completion of the *Greetings* task changed a single feature of the context, from *greetings-not-exchanged*, to *greetings-exchanged*: This has, in effect, turned off the operator's option to initiate the *Greetings* task again. The interaction continues in this way, each participant choosing from their activated task potential, to initiate new tasks, which may require contributions from the other. Eventually, one or both participants will chose the option to *Hang-Up*, which will end the interaction.

7. Summary

In this paper, we have presented a description of the Yellow-Pages Information Service genre, using what we call a Task Structure representation. This model uses a dynamic formalism to represent Task Structure -- it does not model what types of tasks structures we can produce, but rather, it models the various states of development of the structure, and the task potentials available in each state.

The basic elements of the formalism are:

1. **Task Context Potential**: representing the possible states of an interaction. Each point throughout an interaction is represented by a selection-expression from this network.
2. **Task Behaviour Potential**: representing the range of tasks which can be attempted within the genre. These tasks can be achieved individually or co-operatively, through physical action, or verbal interaction.
3. **Contextual Constraints on Behaviour**: each task states the task context which needs to be achieved before the task can be attempted. Context thus constrains the range of behaviours available at each point of the interaction.
4. **Contextual Effect of Behaviour**: each task also states how its successful completion modifies the context, producing a new context, which activates a new behaviour potential.

Several directions for future work suggest themselves:

- **Relating Tasks to the Moves which Realise Them**: within the Dialog project, we began to specify how each task is realised as moves. We basically associate each task with an ideational template (the information to be negotiated, or the non-verbal action to be performed), and a move-context state to be achieved (e.g., *action-complete*, *proposition-completed-and-supported*). More work in this area is required.
- **Contextual-Conditioning of Contextual Effect**: We are moving away from the notion that context constrains behaviour -- it seems that most actions can be performed in any context, it is only their effectiveness which is dependent on context. To this end, we are tending towards a re-interpretation of table 2 above, where the "Activating Context" does not apply to the task, but to the "Contextual Effect". This would allow any task to be attempted in any context, but allow for its success only in the activating context.

  Following this approach, we could also provide multiple entries for a task, allowing each task to have different effects, depending on the context in which it is attempted.

For instance, the effect of pushing dial-buttons when already connected to a service has different effect than when no connection is in place.

- **Constituency of Task Structure**: it might be desirable to allow a task to be achieved through a series of sub-tasks. For instance, M*ake-Sandwich* can be achieved through *Obtain-Bread*, *Obtain-Filling* and *Assemble-Ingredients*.
- **Forming Interaction Plans**: All we have done in this paper is to provide a set of resources for representing the choices available throughout an interaction. We have not said anything about how individuals decide which choices to make -- how they plan a series of tasks which will eventually realise their goals. More work is required here.

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