Here we will explore the traditional model of communication, and a simple generalization of it. We will then see what is required of the listener in order to communicate in such a model and we will explore how these requirements may be met using inference about the speaker through contingency observations.

Perhaps using this I will be able to build a PAC model of communication.

**Section 2: Formalization**

The success of a listener’s action  is given bywhere  iff  and otherwise. This describes a coordination scenario where the success of a listener’s action is dependent on the accuracy of his knowledge of some part of the speaker’s beliefs.

 is a partial state of the speaker’s beliefs or internal state.

is as inferred by the listener.

 is a message.

 describes how the speaker’s beliefs are translated into a message.

 describes for the listener’s beliefs about the speaker’s beliefs are extracted from a message.

We can see that  iff X’=X iff  which holds for all x in X iff 

We define ideal communication as communication where X’=X always holds. We have shown that ideal communication is only guaranteed in the case that . That is, it is only guaranteed when the speaker’s translation function of a belief to a message is the inverse of the listener’s translation function from a message to a belief.

The information theoretic model of communication makes this assumption.

We can further loosen these requirements if we wish communication to be successful is the listener’s action dependent on the speaker’s beliefs is successful and if we claim that this action is successful if the listener’s belief about the speaker’s belief is within a certain “distance” of the speaker’s actual belief.

To accommodate this new scenario, we redefine  such that  iff  and otherwise.

 will be known as the precision requirement and may vary from action to action.

If we use this imprecision model, then our success criteria for communication change. Instead of requiring that , we now only require that, ,  . We can see that the requirements do not lie in the listener’s of the speaker’s translation functions alone, but in their composition. We will quantify this error as, which will be known as the alignment with respect to. We will also quantify the *total alignment* between the listener and the speaker as.

Similarly, we can define the accuracy with respect to  as and the total accuracy between the speaker and the listener as . If the accuracy is less than 1, then the communication is successful. (Note that this does not hold for the total accuracy. If the communication is successful, then the total accuracy must be less than |X|, but the converse does not hold.)

We have seen that coordination or communication (as we have defined them) are successful if and only if the alignment between the speaker and the listener is less than the precision requirement for each relevant speaker belief. As a listener, how can I be sure that my beliefs about the speaker’s beliefs are accurate? In the information theoretic model, this question does not come up, since we know that the listener and the speaker’s translation functions are symmetric. But what happens when, like we do in natural situations, do not have this guarantee?

We can view this problem as a problem of the listener making inferences about the alignment. Prima facie, there are a couple of ways this might occur:

1. We could assume that the speaker is similar to the listener and therefore that the alignment will be within tolerance
2. We could try to make other inferences about the speaker’s beliefs
3. We could try to make inferences about the speaker’s translation function

Let us briefly explore the consequences of each of these possible strategies.

3:

In order to make inferences about the nature of S, the listener might observe some contingencies between what the speaker says and what the state of the world is.

We can capture these contingencies as M=C(state) which stands for the contingency between the observable state of the world and the message produced by S. We assume for the purposes of the model that M=C(state) is a fixed probability distribution. Though contingencies are generated deterministically, the variables that determine their generation are not all visible to the listener and therefore the contingency function (which captures the listener’s observations), is probabilistic. So far these contingencies do not capture the speaker’s translation function, because they do not capture the belief state of the speaker.

Contingencies are learned through observation, and, as we will explore later, generalization.

What happens if we posit a function x=B(world state, internal state, speaker) that determines the belief state of the speaker based on the state of the world and the prior internal state of the speaker?

We can model this in full, but for now, let us simplify the model and claim that the beliefs of the speaker are dependent solely on the state of the world. In this case, x=B(world state, speaker).

Even with this, the listener does not have access either to S or to x. However, the listener does know M=C(state) and since x=B(world state, speaker) is fully determined by the observable components of the state in this case, the contingency becomes a deterministic function.

~~The listener can now perform an inference on S based on:~~

~~M=S(x)~~

~~M=C(state)~~

~~S(x)=C(state)~~

~~S(B(state))=C(state)~~

~~L(S(B(state))=L(C(state))~~

~~state=C~~~~-1~~~~(M)~~

~~x=B(C~~~~-1~~~~(M))~~

~~B~~~~-1~~~~(x)=C~~~~-1~~~~(M)~~

However, this is still not a sufficient amount of information for the listener to infer x. [Need to prove this. Would be interesting.] There is no way for the listener to infer x from the state of the world and the message.

Instead, let us temporarily change the problem from a communication problem to a coordination problem. Now the listener is not interested in x, but in AS(x), which is the speaker’s action based on their belief state x. [argue for why this is sufficient.] Now we can show that the speaker and the listener can coordinate effectively.

Because AS is observable to the listener, the listener can observe contingencies of the form: AS=C(state). Using these observations, the listener can coordinate with the speaker simply by observing the state and calculating the speaker’s action for state-action contingencies that have already been observed.

However, there are still some difficulties. First, since world-states are highly complex, the exact state-action contingency is not likely to have been observed before by the listener. In the current model, without this prior experience with the contingency, the listener cannot predict the speaker’s action and therefore cannot coordinate.

Second, the speaker’s action does not depend only on the jointly observable state of the world, but also on the hidden state of the speaker’s mental faculties. In this case, AS=C(state) is not a deterministic relation, but a probabilistic approximation to AS=BS(world state, mental state). Moreover, it is not clear yet how the probabilistic approximation would be constructed by the listener.

We will see that both of these difficulties can be accounted for by some degree by the listener and we will use the next section to explore how. We begin with the first difficulty.

The first difficulty essentially amounts to a problem of generalization. Without a means of generalizing beyond what has been observed, the listener has no means by which to predict the speaker’s outcome in states that are not exactly the same as those that have been previously encountered. Generalization, however, is not simple to do correctly. There are infinite ways to generalize beyond a given set of data and no one way is objectively more right than any of the others. In the case of communication, however, we can come up with ways by which to produce effective generalizations. This is because we have additional knowledge about the party we are communicating with.