## Masters Thesis

Part 2 of the notes document.

### Defining Traces and Gen. Graph

From all of the considerations before (found in the previous document), it suggests that we should define the traces we get and the generated graphs resulting from analyzing the traces separately.

*Trace = (V, U, T)* as defined before, where V is a set of nodes, U are sets of actions, and T are the transition mappings.

We then define what our generated graph would look like:

*Gen. Graph = (N, L, M, W)*
Where N is a set of traces, represented by nodes.
L is a set of landmarks, represented by nodes.
M is the transition mappings.
W is the mapping function mapping weights to each transition (where the weights represent the length of the trace).

This definition would reflect the image that we have before.
It also suggests to me that the critical-nodes/landmarks are the thing of interest for us in our model. Finding out how to define them, finding out how to think about them in context, finding out how we could derive/calculate/obtain them, how they fit into the graph, etc.

Critical-nodes/landmarks are natural breaks in the conversation, where from our previous definition, no specific player owns the node. The conversation still proceeds normally, and these nodes are likely to be the ones that are densely connected. I guess from a theoretical perspective, the more landmarks an exchange has, the more difficult it will be (landmarks insinuate more opportunities for creation, and creation is not only the defining aspect of learning, it also is the most challenging task). Analyzing and understanding a graph/model based on the

number of landmarks and/or defining a graph based on a certain number of landmarks (maybe with additional properties?) is definitely useful. The paper that introduced the concept of landmarks also suggests that it would logically give us a metric of distance in the graph. Which for us, I am not quite sure how useful it would be? "Distance" in this context would just be the number of utterances/actions before reaching the landmark. I guess we can say that a longer chain of exchanges is more likely to be prone to error/deviation, and therefore we can probably garner some information from that as well.

The notion here being that traces are highly linear, but we can transform the traces into something less linear, and the resulting graph would theoretically provide us with a framework to do something useful. We just have to formally define it I guess.

It also seems like there may not be an algorithmic way (at least not entirely algorithmic) to determine the connections of the nodes (traces to other traces, traces to landmark, etc). It seems like this graph generation comes from taking lots of traces, and running a trained edge detection model. Which makes sense. I guess my worry is that we don't want to spend a lot of effort obtaining this graph only to find that the information we get isn't so useful? So I guess the formal definitions and clear defining inputs/outputs could help us arrive at a conclusion for whether or not the hypothetically obtained graphs would be useful or not.

I guess it would benefit us to draw up an example of this graph -> specifically cases where we determine short/long cycles in the graphs and what that even may mean in context of a conversation, whether or not the graph still becomes linear, etc etc.

There's something to be said about a problem in a conversation of a foreign language, is the issue of the context switching too fast/the flow of logic is not understood (i.e: "I don't understand how one thought connected to the next", "What I expected them to talk about suddenly changed into something else.") Additionally, this may have connections to different modes of expression between individuals, which further complicates this issue.

Can we alleviate this issue by deriving some understanding from the graph, such that we can discuss guarantees such as, you must pass a certain node before you reach this specific node? (LTL variations?, eventually, until, etc…)
Does the existence of landmarks complicate or alleviate this issue?

**Pre Meeting 2 Prep**

Some tasks from last time:

- ~~Fix the graphics~~
- ~~Sample conversation graph~~
- ~~Consider how the graph is generated~~
- Research problem to explore

**Fixing the Graphics**

We'll probably just scrap the graphics from last time and focus on a sample conversation, along with additional drawings for whatever concepts from the papers that we want to expand on.
I think these two graphics would be the most useful right now:

- ~~Sample conversation~~
- ~~Generation of graphs (trace -> graph)~~

**Research Problem**

Not sure if what we have is enough for a research question. But there is something interesting in taking traces of conversation exchanges, and utilizing them to generate a unique graph that grants us some representation of possible exchanges, as well as a framework for analysis (i.e: reachable states, etc, granting certain factors such as vocabulary, etc).

**Some Paper Notes**

"Schema-based conversation modeling for agent-oriented manufacturing systems"

- Seems helpful in confirming some notions that we had, such as it stating that "... communication can be better modeled and more easily implemented when a conversation rather than an isolated message is taken as the primary unit of analysis." This confirms the idea that we were starting to see before

regarding "zooming out" and abstracting over the linear conversations, and instead focusing on small exchanges as a unit with "landmarks" where many edges are possible.

- This paper suggests to me that our set up from our sample conversation will reveal a lot about the schema and possible conversation interactions, which can further shed light on interesting points for analysis.

One of the papers that we stashed introduced the concept of disfluency, which is the notion of making mistakes (repeating words, uncertainty pauses, etc) in normal conversation (that I presume would be otherwise considered correct). This perhaps may be something that could be a side-effect of effectively using a modeled graph? Perhaps something to think about in context of using our generated graph for an analytical purpose. (Considering intent, flow of conversation, reachability of states, can we use all of these notions to minimize disfluency or provide support?)

I guess the theme is that we're trying to apply notions of formal modeling to provide some sort of framework for analysis in order to solve issues that the field traditionally applies language models and machine learning in order to "numerically" solve