Logic, Reasoning, and Persuasion, Week 3 Supplement

This week we talked about *truth-preserving logic machines*: structures where if you have *true premises*, you get a *true conclusion*:

1. true premise
2. true premise

⋮

→ true conclusion

The three main ones we talked about were the **implication machine**, the **implication chain machine**, and the **gluestick machine**. I think the naming of "implication machine" and "implication chain machine" may have been confusing. So I will just call the second one the "chain machine."

In this handout I'll review these the implication machine and the gluestick machine and give more detailed examples of each. Our goal for the first half of the course is to be able to analyze and critically evaluate the logical structure of complex arguments, like the arguments given in the Aylsworth and Castro paper assigned. So we want to be able to *translate* sentences of natural language (the languages that humans speak; in our case American English) into the format of one of the logic machines. In particular, we're going to be looking at examples of sentences that link premises and conclusions using words like "because" and "since" (or no linking words at all!) rather than "if...then." This will help us better understand the structure of everyday arguments.

If we can translate a line of reasoning into the format of a sequence of logic machines, then we know that the entire argument is truth-preserving: if the premises we begin with are true, then the premises we end up with are true. When we run into *problems* translating an argument into the format of a logic machine, we have reason to be worried about whether we should accept some piece of reasoning.

1 | The Implication Machine

1. (statement 1)
2. **if** (statement 1) **then** (statement 2)

→ (statement 2).

Standardly, we write this more compactly by using uppercase letters P, Q, R, etc, to stand in for statements. Here is the implication machine written this way:

1. P
2. **if** P **then** Q

→ Q.

I said above that it will be important to translate sentences into the format of a logic machine. This means that, given some statement, like "Ann went to the party because Bob went," which doesn't have an "if" anywhere, we try to find premises and conclusions that translate the claims that are made.

In the case "Ann went to the party because Emily went," what are the claims? Even though it's only one sentence, we can identify three things being claimed.

1. Emily went to the party.
2. Ann went to the party.
3. Ann went to the party *because* Emily went to the party.

In this example, the "because" indicates that Emily going to the party is supposed to somehow *explain* Ann going to the party (maybe Ann is coming as Emily's +1). Since Ann going to the party is the thing to be explained, we'll put it as the conclusion. And since Emily going to the party does some explaining, we'll put it in as a premise.

1. Emily went to the party.
2.

$\rightarrow$ Ann went to the party.

Is there a way we can translate the original "because" explanation for why Ann went to the party in terms of an "if...then" or an "only if" sentence? How about this:

1. Emily went to the party.
2. **If** Emily went to the party, **then** Ann would go to the party.

$\rightarrow$ Ann went to the party.

General Strategy for the Implication Machine

Suppose we come across a sentence that has a "because" or a "since", and we want to see if it can be analyzed with the implication machine. We can follow the following steps:

1. Turn the sentence into a question and answer. For instance: "Ann went to the party because Emily went to the party" turns into
   Question: Why did Ann go to the party?
   Answer: Because Emily went to the party.
2. Take the question part and put it as the conclusion statement (Q).
3. Take the answer part and put it as the first statement (P)

1. P = Answer Part (Emily went to the party)
2.

$\rightarrow$ Q = Question Part (Ann went to the party).

continued...

General Strategy for Implication Machine, Continued

4. Write out **If** P **then** Q as the second statement. Reword if needed.

> 1. P = Answer Part (Emily went to the party).
> 2. **If** P **then** Q (If Emily went to the party, then Ann went to the party).
> → Q = Question Part (Ann went to the party).

Exercise: Translate the following sentences into instances of the implication machine: determine what the (statement 1) and (statement 2) are, then write it in the form

> 1. (statement 1)
> 2. **if** (statement 1) **then**
> → (statement 2).

1. Because I didn't set my alarm clock, I didn't wake up in time.
2. You have a duty to cultivate your capacity to choose and pursue your own ends, because your capacity to choose and pursue your own ends has final value.
3. Using generative AI is tantamount to plagiarism, since you are falsely representing the chatbot's paper as your own work.[a]

a. Actually the full sentence is "Your professor might think [using generative AI] is tantamount to plagiarism, since you are falsely representing the chatbot's paper as your own work." Bonus question: why did I delete the first part?

2 | The Chain Machine

Given two or more "if...then" statements, each of which link two statements, the chain machine allows us to link directly from the first statement in the chain to the last one.

> 1. **if** (statement 1) **then** (statement 2)
> 2. **if** (statement 2) **then** (statement 3)
> →
> 3. **if** (statement 1) **then** (statement 3)

In $P, Q, R, \ldots$ notation:

> 1. **if** P **then** M
> 2. **if** M **then** Q
> →
> 3. **if** P **then** Q.

Here's a way to visualize how the chain machine works:

1. **if** P **then** M
2. **if** M **then** Q

→ **if** P **then** Q

The example in class:

1. If Gabrielle gets ice cream, then Lorenzo will get ice cream.
2. And if Lorenzo gets ice cream, then Brett will get ice cream.

→ So if Gabrielle gets ice cream, then Brett will get ice cream.

Often to analyze a conclusion of the form "if (some statement) then (some other statement)", we'll see if there is an "intermediate" statement that we can put in the middle of the chain. That is, we'll see if we can put something in for the question marks below so that sentences 1 and 2 (the first two "if...then" statements) are more convincing than the conclusion (sentence 3), and can help to argue for it.

1. **if** (statement 1) **then** (_____)
2. **if** (_____) **then** (statement 3)

→ **if** (statement 1) **then** (statement 3)

For instance, suppose that Gabrielle and Lorenzo are good friends, and Lorenzo and Brett are roommates, but Gabrielle and Brett don't know each other very well. And suppose someone tells us that Brett will get ice cream because Gabrielle will get ice cream. First, using the implication machine, we can translate this "because" sentence into an "if...then" format:

1. Gabrielle will get ice cream
2. **If** Gabrielle gets ice cream **then** Brett will get ice cream.

→ Brett will get ice cream.

This is a fine explanation, but it seems incomplete. After all, if Gabrielle and Brett don't know each other that well, why will Brett get ice cream if Gabrielle gets it?

Perhaps there is some missing link in the chain that explains this curious occurence:

1. **if** Gabrielle gets ice cream **then** (_____)
2. **if** (_____) **then** Brett will get ice cream

→ **if** Gabrielle gets ice cream **then** Brett will get ice cream

Well, one possibility is that Gabrielle convinced her friend Lorenzo to get ice cream, and Lorenzo in turn got his roommate Brett to come along. And filling in the blank with "Lorenzo will get ice cream" gets us the original chain from the example:

1. **If** Gabrielle gets ice cream, **then** Lorenzo will get ice cream.
2. And **if** Lorenzo gets ice cream, **then** Brett will get ice cream.

→ So **if** Gabrielle gets ice cream, **then** Brett will get ice cream.

And this provides us with a better explanation of why Brett got ice cream because Gabrielle got ice cream.

General Strategy for the Chain Machine

In general, suppose we come across a sentence that has a "because" or a "since," where we feel like we need some additional reasoning in the middle. Then we can try these two steps:

1. Put the statement into the format of the implication machine (see general strategy above).
2. Take the "if..then" statement from the implication machine, and treat it as the *conclusion* of a chain machine: "if P then Q".
3. Try to find some middle statement M that can fit in the middle.

Original Statement:
Q because P.
1: Translate into Implication Machine:
1. P
2. **If** P **then** Q.

→ Q
*2: Take "**If** P **then** Q" as conclusion of Chain Machine.*
1. **If** P **then** _____
2. **If** _____, **then** Q

→ **If** P, **then** Q
3: Find a middle sentence M that further explains.

Exercise: I've taken the sentence "I don't care about privacy because I have nothing to hide" and implemented the strategy above. Fill in the blanks in the last step by finding a middle sentence M that further explains.

1: Translate into Implication Machine:
1. I have nothing to hide
2. **If** I have nothing to hide, **then** I don't care about privacy.

→ I don't care about privacy.
*2: Take "**If** P **then** Q" as conclusion of Chain Machine.*
1. **If** P **then** _____
2. **If** _____, **then** Q

→ **If** I have nothing to hide, **then** I don't care about privacy
3: Find a middle sentence M that further explains.

Exercise: I've taken the sentence "Our students are tempted to use ChatGPT because we have not successfully shown them why their education matters" and partially implemented the strategy above.[a] Do steps 2 and 3.

> *1: Translate into Implication Machine*:
>
> 1. we have not successfully shown [our students] why their education matters.[a]
> 2. **If** we do not successfully show our students why their education matters, **then** they will be tempted to use ChatGPT.
>
> → Our students are tempted to use ChatGPT.
>
> *2: Take "**If** P **then** Q" as conclusion of Chain Machine.*
>
> 1.
> 2.
>
> →
>
> *3: Find a middle sentence M that further explains.*

a. Note: the brackets around [our students] means that I've replaced the word "them" with the noun that it refers to.

a. Note: the original sentence from Aylsworth and Castro is "Our students are tempted to use ChatGPT, at least in part, because we have not successfully shown them why their education matters." I've deleted "at least in part" because it makes the task more complicated. Is this okay to delete? Why or why not?

Exercise: Do all steps for the following sentence: "Because we're still in the early days, we can expect AI to become more capable over time."[a]

a. Note: the original sentence from A&C is: "Because we're still in the early days—ChatGPT was unleashed upon the world only in November 2022—we can expect AI to become more capable over time, even if progress isn't always a straight line."

3 | More Exercises

3.1 | Implication Machine Exercises

Exercise 1: One of the arguments Aylsworth and Castro consider and reject is (approximately) the following:

> It is wrong to use ChatGPT to write your college papers, because doing so would be cheating.

Implement the general strategy for the implication machine to put this argument in terms of the implication machine.

Solution:
1. Write the statement as question and answer:
1. **Q**: Why is it wrong to use ChatGPT to write your college papers?
2. **A**: because doing so would be cheating.

2. Take question part and put as conclusion statement.
3. Take answer part and put as first statement.
1. Using ChatGPT to write your college papers is cheating.
2.

→ It is wrong to use ChatGPT to write your college papers.

*4. Write out **If** [first statement] **then** [conclusion statement].*
1. Using ChatGPT to write your college papers is cheating.
2. **If** using ChatGPT to write your college papers is cheating, **then** it is wrong to use ChatGPT to write your college papers.

→ It is wrong to use ChatGPT to write your college papers.

Exercise 2: Use the general strategy for the implication machine to put these statements into the form of the implication machine:
1. Clem texted me because I missed her call.
2. I don't know anyone going to the get-together at the park. So there's no reason for me to go.
3. Since everyone is here, we can get started!
4. She'd rather not go to the restaurant. There's nothing there she can eat.
5. Because of the ubiquity of AI technology, students will likely be using it persistently outside the classroom in their personal lives.[a]

a. Megan Fritts, "A Matter of Words", https://thepointmag.com/examined-life/a-matter-of-words/.

Answers:
2.1:
1. I missed Clem's call.
2. **If** I missed Clem's call, **then** she would text me.[a]

→ Clem texted me.

2.2:
1. I don't know anyone going to the get-together at the park.
2. **If** I don't know anyone going to the get-together at the park, **then** there's no reason for me to go.

→ there's no reason for me to go.

2.3:
1. Everyone is here.
2. **If** everyone is here, **then** we can get started

→ we can get started.

a. Or: If I missed Clem's call, then she texted me.

Answers, continued:

2.4:

1. There's nothing there she can eat (at the restaurant).
2. **If** there's nothing there she can eat, **then** she'd rather not go to the restaurant.

→ She'd rather not go to the restaurant.

2.5:

1. AI technology is ubiquitous.
2. **If** AI technology is ubiquitous, **then** students will likely be using it persistently outside the classroom in their personal lives.

→ students will likely be using it persistently outside the classroom in their personal lives.

Exercise 3: Use the general strategy for the implication machine to put these passages into the form of the implication machine:

1. "New jobs are still emerging at a rapid rate and old ones are disappearing, so whatever job the university is training you for might disappear at some point."[a]
2. "With the accumulated knowledge of the world now at their fingertips, students need their teachers more, not less. Why? Because students need teachers to get them to do hard things now that are good for them later."[b]

a. Lin, "Why We're Not Using AI In this Course."
b. Angela Duckworth, Penn GSE Commencement.

Hint: here are the questions and answers for the two passages:

3.1:

- Q: Why is it that whatever job the university is training you for might disappear at some point?
- A: Because new jobs are still emerging at a rapid rate and old ones are disappearing.

3.2:

- Q: Why is it that, with the accumulated knowledge of the world now at their fingertips, students need their teachers more, not less?
- A: Because students need teachers to get them to do hard things now that are good for them later.

Challenge Exercise: the following passage can (approximately) be analyzed in terms of the implication machine and the chain machine. Describe how.

> *[AI] could be a true game-changer and upend how education, jobs, and many other things work in our world.... If it's a game-changer that will be regularly used in future jobs, then students will need to know how to use it expertly; thus it may be premature and potentially a disservice to students to ban AI in the classroom.*[a]

a. from lin, "Why We're not Using AI in this Classroom.

Remark: The "could be" and "may", among other things, make this exercise harder. Suppose you replaced the "could be" with "is" and the "may be" with "is"? Does this make things easier? What do the "could be" and "may be" add here?

3.2 | Chain Machine Exercises

Exercise: Given the following pairs of "if...then" sentences and intermediate claims, put them in the form of a chain machine:

1. If the cafe doesn't have a restroom, I won't go. **Intermediate statement:** I won't be able to pee while we're there.
2. If AI cannot generate convincing prose, then students won't use it to cheat on their papers. **Intermediate statement:** students won't be able to pass off AI-generated work as their own.

Solution to (1.):

1. **If** the cafe doesn't have a restroom, **then** I won't be able to pee while we're there.
2. **If** I won't be able to pee while we're there, **then** I won't go.

$\rightarrow$ If the cafe doesn't have a restroom, then I won't go.

Exercise: Given the following pairs of sentences (which are not in "if...then" form) and intermediate claims, put them in the form of a chain machine:

1. Since the cafe doesn't have a restroom, I won't go. **Intermediate statement:** I won't be able to pee while we're there.
2. Students are now using AI to cheat on their papers, because AI can generate convincing prose. **Intermediate statement:** students are able to pass off AI-generated work as their own.
3. People no longer run in the park, because many lights are broken. **Intermediate statement**: people don't feel safe.

Solution to (1.) (Note: this is the same as the previous exercise!):

1. **If** the cafe doesn't have a restroom, **then** I won't be able to pee while we're there.
2. **If** I won't be able to pee while we're there, **then** I won't go.

→ If the cafe doesn't have a restroom, then I won't go.

Exercise: suppose you're trying to argue the following:

> If you're not a humanities major, then you don't need to write your own papers in humanities classes.

You start off with the following claim:

> If you're not a humanities major, then you don't need to practice how to write humanities papers.

How do you complete the argument using the Chain Machine?

Challenge Exercise: Consider Exercise 3.2. Analyzed in terms of the implication machine, the sentence from Duckworth gives us this statement:

> **If** students need teachers to get them to do hard things now that are good for them later, **then** with the accumulated knowledge of the world now at their fingertips, students need their teachers more, not less.

This argument needs more explanation. If students need teachers to get them to hard things, why does easy access to accumulated knowledge means students need their teachers more? What relates easy access to knowledge and "doing the hard things that are good for you later"?

We can see if it makes sense to put this "if... then" statement into the chain machine and find an intermediate claim M:

1. **If** students need teachers to get them to do hard things now that are good for them later, **then** _____.
2. **If** _____, **then** with the accumulated knowledge of the world now at their fingertips, students need their teachers more, not less.

→ **If** students need teachers to get them to do hard things now that are good for them later, **then** with the accumulated knowledge of the world now at their fingertips, students need their teachers more, not less.

What things could fit in the blank? Do we have to use the chain machine more than once? Here are other things that Duckworth writes afterward:

1. AI can be a crutch if students use it mindlessly, carelessly, and without the objective to develop their own capabilities.
2. Teachers are role models for what genuine intellectual engagement looks like, both online and in real life.

Solution: What's the connection between easy information access and doing hard things that are good for you later? Plausibly (and in line with Duckworth talking about genuine intellectual engagement and developing one's own capabilities, the connection is something like this. If having accumulated knowledge becomes really easy, then it becomes harder to develop your own thinking capabilities. So developing these capabilities becomes a good thing that is harder, and thus something that students need teachers to help with.
So perhaps in the blank we can put:

> When accumulated knowledge becomes easily accessible and makes developing thinking capabilities harder, students need their teachers' help developing their own thinking capabilities.

This fits reasonably well in the second sentence:

2. **If** [when accumulated knowledge becomes easily accessible and makes developing thinking capabilities harder, students need their teachers' help developing their own thinking capabilities], **then** with the accumulated knowledge of the world now at their fingertips, students need their teachers more, not less.

How does it work in the first sentence?

1. **If** students need teachers to get them to do hard things now that are good for them later, **then** [when accumulated knowledge becomes easily accessible and makes developing thinking capabilities harder, students need their teachers' help developing their own thinking capabilities].

Notice that the format here is not more complicated than in the other examples. But the sentences between the "if"s and the "then"s are longer and more complicated.

(There are more ways to split this argument into even smaller bits. Extra Challenge: do some of this extra splitting.)