Formal Analysis Assignment 1: Logical Thinking

This assignment has two distinct sections, each with multiple parts, which allow you to apply the skills learned in the logical thinking unit in a variety of ways. This is an individual assignment: please do not work with other students on any part of this assignment. Both the logic puzzle that you generate and the speech that you select should be unique.

Section A: Logical Puzzle

In this section of the assignment, you will apply formal logic to solve a puzzle. Read all instructions before beginning. In Part 1, you will generate a complex logic puzzle. In Part 2, the clues of the puzzle will be thoroughly analyzed using formal deductive logic, truth tables, and Python code. After your analysis in part 2, you will actually solve the puzzle in part 3. It's important that you start with a puzzle that allows you to successfully complete parts 2 and 3. If you generate a puzzle that has inadequate clues to complete part 2, or is too difficult to solve in part 3, please start again with a different puzzle. Do not spend too much time solving the logic puzzle itself; focus on HOW you are applying deductive logic to solve the puzzle.

Part A1: Setup

Go to the following website: http://www.logic-puzzles.org/init.php (http://www.logic-puzzles.org/init.php). Select any grid size or difficulty setting. Click "Create Puzzle" to generate a custom logic puzzle. Click "Start this puzzle" to start solving it. It is important that the "Active Clues" listed on the right are suitable for successful completion of part 2. There should be at least two clues containing conjunctions, disjunctions, or conditionals. Later, in part 3, you will actually solve the logic puzzle, so if you are unfamiliar with this type of puzzle, you may want to try solving some small puzzles first to warm up.

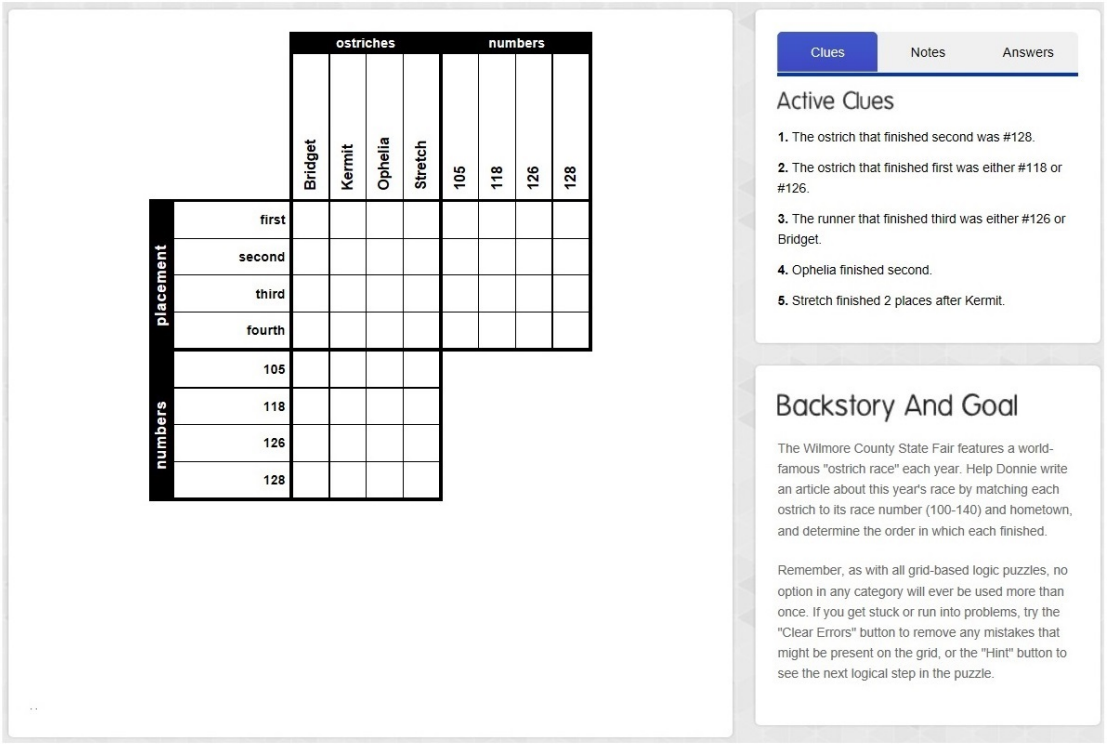
A1.1. Before moving on, put a screenshot of your custom puzzle into your notebook.

To do so, follow these steps:

1. Take a screenshot and save as a .jpeg or .png file. A. mac: command + shift + 4 - saves to desktop B. Windows + Shift + S (Windows 10 only)
2. Upload the file into your Cocalc file folder A. Drag the file from Finder into your files in Cocalc OR B. Use the Cocalc Upload button
3. Copy the file name of the image
4. Paste file name into the Image command: Image("FILE_NAME_HERE") (replace the call for the image in the box below)
5. Run the cell. Your image should print.

In [3]:
```
from IPython.display import Image
Image("AnalysisPuzzle.jpg")
```

Out[3]:



A1.2. Copy-Paste the clues into your notebook.

Active Clues

1. The ostrich that finished second was #128.
2. The ostrich that finished first was either #118 or #126.
3. The runner that finished third was either #126 or Bridget.
4. Ophelia finished second.
5. Stretch finished 2 places after Kermit.

Part A2: Formal Logic and Algorithms [#deduction, #algorithms]

A2.1. Select 2 of the clues from part 1 that contain conjunctions, disjunctions, or conditionals, and translate them into symbolic logic. Be sure to include a symbolization key.

Note: you may need to select high difficulty levels or sizes to obtain clues that are not simple atomic sentences. You also may need to reword the sentence into a logically equivalent form before translating it into symbolic logic; in any case, explain what you are doing.

1. The ostrich that finished first was either #118 or #126.

Rewording it into a logically equivalent form:

- The ostrich that finished first was #118 or #126, but not, #118 and #126.

```
The ostrich that finished first was #118. ---> A
The ostrich that finished first was #126. ---> B
```

(A v B) & ~(A & B)

1. The runner that finished third was either #126 or Bridget.

Rewording it into a logically equivalent form:

- The runner that finished third was #126 or Bridget, but not, #126 and Bridget.

```
The runner that finished third was #126. ----> C
The runner that finished third was Bridget. -> D
```

(C v D) & ~(C & D)

A2.2. Negate the two clues you used in part 2 using DeMorgan's Laws. Then translate them back into English.

1. (A v B) & ~(A & B)

```
~[(A v B) & ~(A & B)]

(~A & ~B) v (A v B)
```

It is not the case that the ostrich that finished first was #118 and #126 or the ostrich that finished first was #118 or #126.

1. (C v D) & ~(C & D)

```
~[(C v D) & ~(C & D)]

(~C & ~D) v (C v D)
```

It is not the case that the runner that finished third was #126 and Bridget or the runner that finished third was #126 or Bridget.

A2.3. Use truth tables to evaluate both of your two clues from A2.1. Briefly explain whether the two clues form a consistent set based on your truth tables. Format your table neatly in google docs or google sheets, then paste in the image(s).

In [10]:
```
Image("TruthTable.jpg")
```

Out[10]:

A	B	C	D	A v B	A & B	~(A & B)	C v D	C & D	~(C & D)	(A v B) & ~(A & B)	(C v D) & ~(C & D)
TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE
TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	TRUE
TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	TRUE
TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE
TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
TRUE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
FALSE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE
FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE
FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE
FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE
FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE

After using a truth table to evaluate both clues, I determined that they form a consistent set. This is becuase my truth table contains all variables which are the atomic sentences and they also contain the clues in their symbolic language form. They are are consistent because there are several cases were both clues can be True at the same time.

A2.4. Write a function in Python that checks the truth value of one of your clues from 2.1 using "if", "and", "or", "not". You may refer to the code in lesson 2.1 and 2.2 for inspiration. The function should:

a. input the truth values of the atomic sentences that make up the statement, represented by boolean variables, and**

b. output the truth value of the full statement (clue).

c. include clearly annotated comments to explain what the code is doing and how it is using logic (read this resource about the importance of comments and this one for further guidance).

In [9]:
```
def xor(a,b): #The first line of code defines the function. It inputs two variab
les representing
                #the atomic sentences a and b.
    return (a or b) and not (a and b) #The second line outputs the truth value o
f the disjunction.
xor(True, True) #The last line calls the defined function.
#For purposes of trying out the code, I evaluated the code when both a and b are
 True.
#It works because it is the same as in the truth table.
```

Out[9]:
```
False
```

Part A3: Logic Puzzle [#deduction]

A3.1. Work through the puzzle. It will be helpful to write notes for yourself explaining what each clue implies. Describe how you used the rules of deductive logic to evaluate the clues by giving at least one example of an implication that you derived using the common rules of deductive logic.

Clue #1 and Clue #4

1. The ostrich that finished second was #128.
2. Ophelia finished second.

These clues help me to put my first green dots on the grid. This is where second and 128 meet. Also, where Ophelia and second meet, and where Ophelia and 128 meet.

Clue #5

1. Stretch finished 2 places after Kermit.

This clue implies Stretch finished third and Kermit first because we already know Ophelia finished second, making other combinations not possible. It also implies Bridget finished fourth because it is the last one to be filled.

Clue #3

1. The runner that finished third was either #126 or Bridget.

Since we already know Bridget finished fourth, then #126 finished third.

Clue #2

1. The ostrich that finished first was either #118 or #126.

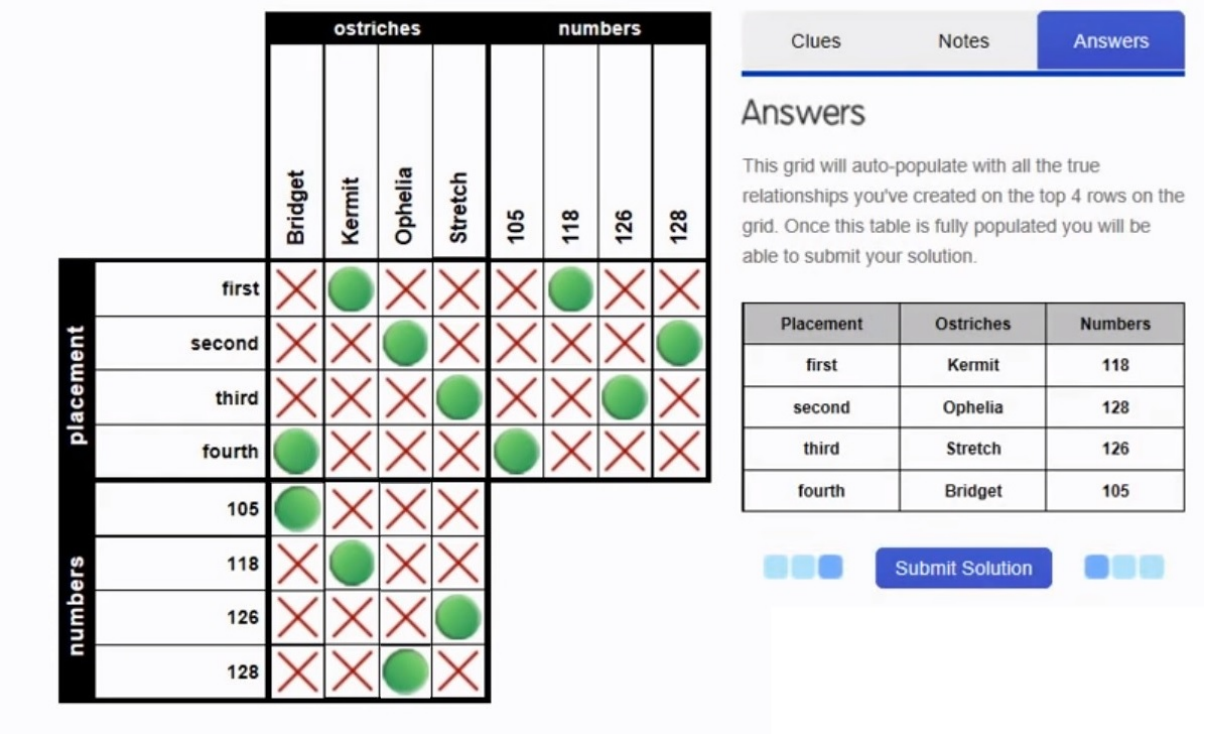
Since we already know #126 finished third then #118 finished first. The last piece missing is that #105 is Bridget, but since that is the only one left then we know that is the case.

I used the rules of deductive logic to evaluate the clues that depended on the truth values of other clues. For example Clues #1, #4, and #5 are atomic sentence with a the same truth value and they allow me to determine which of the atomic senntences in Clues #3 and #2 are True and which are False.

A3.2. Put a screenshot of the answer grid into your notebook before hitting submit. Do this before the next step, because once you hit submit, you lose access to the original puzzle and clues, so be sure that you took the necessary screenshots in parts A1 and A3.

In [11]:
```
Image("solvedpuzzle.jpg")
```

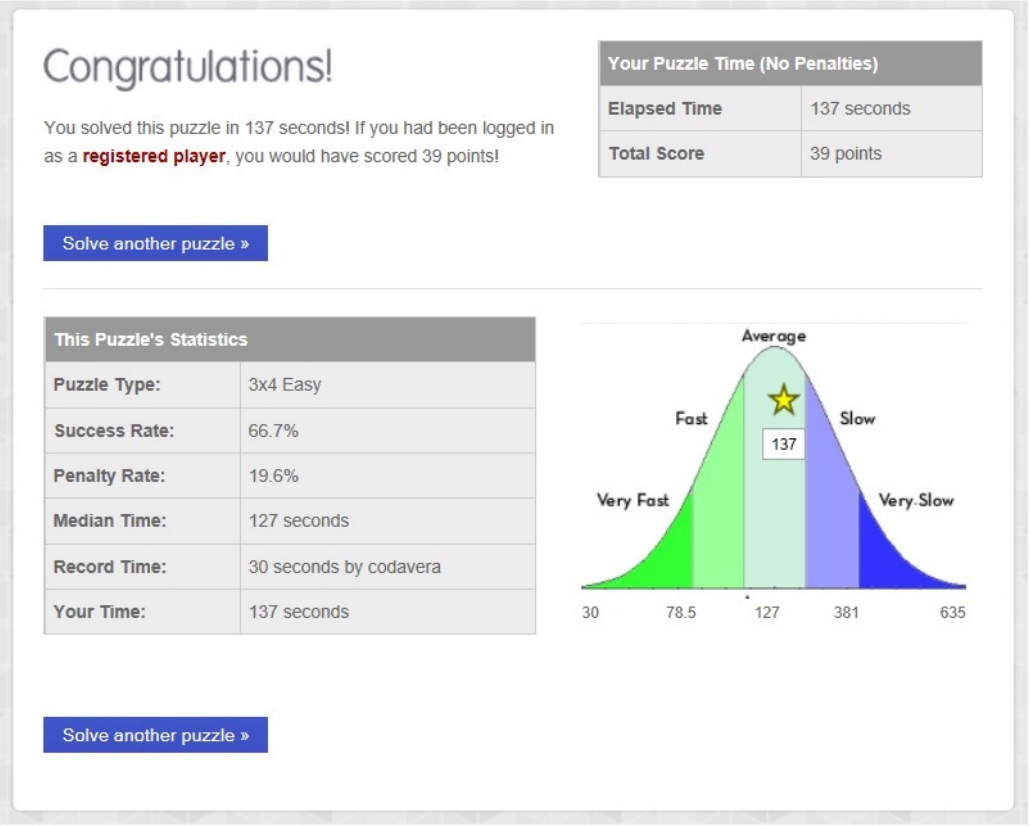
Out[11]:



A3.3. Now you can hit submit. Paste your score into your notebook (don't worry about how long you took).

In [6]:
```
Image("congratulations.jpg")
```

Out[6]:



SECTION B: SPEECH ANALYSIS

For this section of the assignment, select part of a historical speech by a world leader in order to analyze and evaluate its logic. You will translate the part of the speech you select into symbolic logic, and determine where the leader makes inductive arguments, deductive arguments, and fallacies.

Part B1: Speech Selection

B1.1. Find a speech with an argument that is at least ten years old. It may be written by, for example, an elected official, dissident, political leader, or religious leader.

B1.2. Cite the speech in APA format and include a hyperlink to the source of the speech.

7 Famous Speeches that Changed the World. (n.d.). Retrieved October 03, 2018, from Famous Speeches that Changed the World (https://goo.gl/52okYK)

B1.3. Write a short synopsis of the speech in your own words (<100 words). You should not provide a transcript of the speech in full, but should quote the specific parts that you use in the analysis (see below).

Henry talks about how they have been in a struggle for liberty for a long time and he no longer wants that. He strongly believes in their ability to fight for what's theirs. They have been under the British rule. While the British seem to be preparing for war, they are not prepared for any attack. Henry, however, is compelling the whole convention into gathering forces to counterattack. Through this speech, he was able to influence the right people, creating a domino effect of events that led to the independence of the United States of America.

Part B2: Argument Analysis [#deduction, #induction, #fallacies]

B2.1. Identify a deductive argument from the speech. Include a copy of this part of the speech with proper citation. Analyze this argument:

a. Rewrite the argument in natural language in simple terms with clear use of logical connectives and atomic sentences so that it is amenable for analysis with the next steps. Do your best not to change the meaning of the argument. You may add premises that you believe to be implied but please justify your interpretation.

b. Translate the argument into symbolic logic. You should not be translating the whole speech - just the statements that comprise the argument.

c. Why is this argument deductive? Is the argument valid? Support your answer with a truth table and/or a proof.

d. Is the argument sound? Why or why not? (<300 words for the valid/sound analysis)

B2.1. A deductive argument can be found almost at the end of the speech.

> "If we wish to be free if we mean to preserve inviolate those inestimable privileges for which we have been so long contending if we mean not basely to abandon the noble struggle in which we have been so long engaged, and which we have pledged ourselves never to abandon until the glorious object of our contest shall be obtained, we must fight! I repeat it, sir, we must fight!" (Seamons, 2018)

a. If we wish to be free, then we must fight! If we mean to preserve inviolate those inestimable privileges, then we must fight! If we mean not basely to abandon the noble struggle, then we must fight! We wish to be free, and we mean to preserve inviolate those inestimable privileges, and we mean not basely to abandon the noble struggle. We must fight!

b. Translating this into symbolic logic would give us the following:

```
We wish to be free. --> A

We mean to preserve inviolate those inestimable privileges. --> B

We mean not basely to abandon the noble struggle. --> C

We must fight! --> D
```

The argument would go like this:

```
A -> D

B -> D

C -> D

A & B & C

D
```

c. This argument is deductive because it has the form and structure where the premises are given, and the conclusion follows from the premises. I added the last premise that affirms that A, B, and C are true because I believe Henry needed not to repeat himself by doing so because of how compelling his first premise is. Also, Henry uses repetition as a figure of speech to make his idea and his intentions significant in this part of the speech. He even goes as far as to say we must fight with such conviction that there is no need to say the reasons again. If we use Modus Ponens as a proof, we can see that this argument is valid because If A then D. A. Therefore, D. If B then D. B. Therefore, D. If C, then D. C. Therefore, D. we are affirming the antecedent, so the consequent must be true as well. This argument is also valid because all the premises are true, hence making the conclusion true just like we proved with Modus Ponens. We could also apply rules of logical reason to change our first premise to if A & B & C then D and the second premise to A & B & C, the conclusion would directly follow from both these premises to be D.

d. I would say that this argument is indeed sound because it is valid, and its premises are true. The argument presents conditional premises and a conjunction of logical atomic sentences that are true, and those propositions do entail that conclusion. It follows that the argument is valid. Also, we can say that all the premises are true. Thus, the argument is valid and has only true premises. It follows that the argument is sound.

B2.2. Identify an inductive argument from the speech. Include a copy of this part of the speech with proper citation. Analyze this argument:

a. Why is this argument inductive? Can you identify which type/form of induction it is?

b. Is the inductive reasoning weak or strong, and why?

c. Write another inductive conclusion based on the premises you've identified. Compare this conclusion to the one offered in the speech and comment on which argument is stronger. (<250 words for the induction analysis)

An inductive argument can be found at the beginning of the speech.

> "Are fleets and armies necessary to a work of love and reconciliation? Have we shown ourselves so unwilling to be reconciled, that force must be called in to win back our love? Let us not deceive ourselves, sir. These are the implements of war and subjugation; the last arguments to which kings resort. I ask, gentlemen, sir, what means this martial array, if its purpose be not to force us to submission? Can gentlemen assign any other possible motive for it? Has Great Britain any enemy, in this quarter of the world, to call for all this accumulation of navies and armies? No, sir, she has none. They are meant for us; they can be meant for no other." (Seamons, 2018)

This argument is inductive because it seems that the conclusion follows from the premises but the topic at hand isn't as one dimensional as Henry puts it. The type of induction used is casual inference which draws a conclusion about a causal connection based on the conditions of the occurrence of an effect. Premises about the correlation of two things can indicate a causal relationship between them, but additional factors must be confirmed to establish the exact form of the causal relationship. Henry can provide a bit of his rationale on the subject and the premises may help make the conclusion probable, so I'd say it is a strong inductive argument.

Henry presents, through the premises in this argument, a series of conditions present at that time that ensure a war is coming. However, he concludes that Great Britain, who is the one seemingly getting prepared for war, will attack them specifically and no one else. He could have proposed that these war preparations will probably affect them and other parties that decide to participate in it. His conclusion seems strong because of the nature of the speech, but a less affirmative conclusion would help the inductive argument be reliable.

B2.3. Find two fallacies in the speech. Copy the parts of the speech in which the fallacies appear, with proper citation.

a. Name the fallacies and explain why they are fallacies.

b. Explain how one of the fallacies could be corrected. Would correcting the fallacy change the conclusion of the argument, or one or more of the premises? Why or why not? (<400 words for the fallacies analysis)

A logical fallacy can be found at the beginning of the speech.

> "The question before the House is one of awful moment to this country. For my own par t, I consider it as nothing less than a question of freedom or slavery; and in propor tion to the magnitude of the subject ought to be the freedom of the debate. It is onl y in this way that we can hope to arrive at truth, and fulfil the great responsibilit y which we hold to God and our country." (Seamons, 2018)

Another logical fallacy can be found at the end of the speech.

> "I know not what course others may take; but as for me, give me liberty or give me de ath!" (Seamons, 2018)

The first fallacy talks about how Henry sees that they will soon have to fight for their freedom and does this by expressing his thoughts on the topic and among the fallacies that he employs are false dichotomy, false analogy, and slippery slope. However, despite of his use of many fallacies, this argument can be corrected. When he talks about fulfilling the great responsibility he talks about fighting a war for their independence, this is a slippery slope because this an event that might culminate in significantly negative effects. His false analogy is when he compares the question before the House to what he thinks of it, which is a question between freedom or slavery. The false dichotomy is also present here because there are many other options than just the ones he gives.

The way that this argument may be corrected is by rewriting it without it losing its point. I would say that the most important aspect here is the search for a solution to the problem they're facing. The best way to address this, would be to state their problem, their initial and goal state, break down the problem into more feasible ones, consider the constraints and obstacles and bridge the gaps. This is not what Henry proposes, his solution goes directly to counterattacking at war. However, if they would have followed a more ordered method, they could have probably reached the same solution but backed by a lot of thought behind it. As well as a more complete argument as to why follow this course of action.

To address the second logical fallacy, I would say it is a false dichotomy because there are many other options than just liberty or death. Henry only presents two options for what could happen to him, either he gets his so long desired liberty, or he dies in the battlefield fighting for his liberty. He doesn't consider any other option he may have or anyone else may have. In fact, he disregards any other course of action when he begins his sentence.

Section C: REFLECTION

Reflect on what you learned in this assignment. Address the following points: (<200 words) [#scienceoflearning + other HCs per use]

C.1. How did the principles from the science of learning deepen your knowledge of #induction, #deduction, #algorithms, and #fallacies while working on this assignment?

I was able to use different strategies to help me identify the components of deductive arguments, and how the premises and conclusions work together to make an idea comprehendible. Without the use of the proper techniques, we would often make illogical assertions. In the puzzle it was interesting seeing how using deductive reasoning, I was able to obtain a result were many logical sentences played important roles. Also, identifying deductive and inductive arguments, and fallacies in a speech proved to be quite challenging because we must also critique the author on their intentions and purpose.

2. Throughout both sections, what did you learn about the connection between formal logic, language, computer code, and the use of logical thinking in the real world?

I would say that sometimes it may seem easier to understand the implications of logic in natural language but the tools that formal logic and computer code provide us with, help make the process a little bit easier. In the real world, we do not often worry about how logical we are in our day to day speech, but it is important to understand that people may try to use this against us. We could also use them to improve our accuracy when speaking about topics that might be sensible to false information. Therefore, we must be informed and educated to be prepared for anything.

3. *Optional*: Do you think one should believe the selected speech even though it contains errors in reasoning (such as fallacies or errors in deductive or inductive reasoning)? Why or why not? (<200 words)

I think that the speech I selected is a compelling call to action that serves its purpose even though it contains errors in reasoning. It talks about many events that were happening during that time and mostly appeals to the people's direct relationship with these events. The people needed this kind of speech more than a completely logical speech that would end up sounding cold. It is a speech that was very important during that time because Patrick Henry's ability of public speaking left everyone in the room quite speechless. It also proved to break the barriers of time by having a direct relationship with the events that would occur afterwards.

REFERENCES

Seamons, S. (2018). 7 Famous Speeches that Changed the World. [online] Cdn2.hubspot.net. Available at: https://goo.gl/52okYK (https://goo.gl/52okYK) [Accessed 3 Oct. 2018].