Basic Concepts of Logic
An argument is just a collection of reasons for believing some claim.
Arguments

- An *argument* is just a collection of reasons for believing some claim.
- We use arguments to *persuade* one another.
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- The thing that the argument is arguing for is called the conclusion of the argument.
Arguments

- An argument is just a collection of reasons for believing some claim.
- We use arguments to persuade one another.
- The thing that the argument is arguing for is called the conclusion of the argument.
- The reasons which are presented in the conclusion’s favor are called the premises of the argument.
A Sample Argument?

- An argument about gay marriage

Russert:

premises

1. Gay marriage is morally tantamount to polygamy
2. Polygamy is wrong.

conclusion

3. So, gay marriage is wrong.
A Sample Argument?

- An argument about gay marriage
- Is Perkins providing an argument?
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- Is Perkins providing an argument?
- If so, what is his argument?

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A Sample Argument?

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\[
\begin{align*}
\text{premises} & \quad \begin{cases} 
1. \text{Gay marriage is morally tantamount to polygamy} \\
2. \text{Polygamy is wrong.}
\end{cases} \\
\text{conclusion} & \quad 3. \text{So, gay marriage is wrong.}
\end{align*}
\]
Some interpreted Perkins as making this argument:

1. Legalizing gay marriage will lead to the legalization of polygamy.
2. We ought not legalize polygamy.
3. So, we ought not legalize gay marriage.
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So understood, Perkins is making a claim about the likely causal consequences of legalizing gay marriage.
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1. Legalizing gay marriage will lead to the legalization of polygamy.
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3. So, we ought not legalize gay marriage.

So understood, Perkins is making a claim about the likely causal consequences of legalizing gay marriage.

This would be (what we will later call) a slippery slope argument.
A Sample Argument?

- But perhaps we should understanding him as making a claim, not about the likely causal consequences, but rather about what we implicitly commit ourselves to by thinking that we ought to legalize gay marriage:

1. If we ought to legalize gay marriage, then we ought to legalize polygamy.
2. We ought not legalize polygamy.
3. So, we ought not legalize gay marriage.
A Sample Argument?

Maybe Perkins is merely providing an objection to a premise in somebody else’s argument, i.e.

1. If all loving relationships deserve the rights of marriage, then loving polygamous relationships deserve the rights of marriage.

2. Loving polygamous relationships don’t deserve the rights of marriage.

3. So, not all loving relationships deserve the rights of marriage.
A Sample Argument?

- good objections to one of these arguments are not necessarily good objections to any of the others.
A Sample Argument?

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- So, what we ought to say about Perkins’ statements will depend upon how we ought understand them.
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So, what we ought to say about Perkins’ statements will depend
upon how we ought understand them.

Lesson: before we get to evaluating arguments, it is important to
figure out whether the person is making an argument, and, if so, what the argument is.
Logic

- Logic is the study of arguments.
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Its goal: to give a theory of which arguments are good and which are bad.
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    - Also, perhaps, to give an explanation of why the good arguments are good, and why the bad arguments are bad.
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- An argument $\overset{\text{def}}{=} \text{a collection of statements, one of which is designated as the } \textit{conclusion}, \text{ the others of which are designated as the } \textit{premises}.$
Logic

- Logic is the study of arguments.
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    - Also, perhaps, to give an explanation of why the good arguments are good, and why the bad arguments are bad.

- An argument $\overset{\text{def}}{=} \text{a collection of statements, one of which is designated as the } conclusion, \text{ the others of which are designated as the } premises.$

- So, this will count as an argument:
  1. Bacon isn’t meat.
  2. Samuel Huntington is spry.
  3. Summer will never come.
  4. So, Elmer Fudd isn’t fictional.
A statement is a sentence which is capable of being true or false.
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Not statements: Questions, commands, suggestions, and exclamations.
Statements

- A *statement* is a sentence which is capable of being true or false.
  - Not statements: Questions, commands, suggestions, and exclamations.

**A Test**

Given some sentence, $P$, if ‘It is true that $P$’ makes sense, then $P$ is a statement. If ‘It is true that $P$’ does not make sense, then $P$ is not a statement.
A statement is a sentence which is capable of being true or false.

Not statements: Questions, commands, suggestions, and exclamations.

A Test

Given some sentence, \( P \), if ‘It is true that \( P \)’ makes sense, then \( P \) is a statement. If ‘It is true that \( P \)’ does not make sense, then \( P \) is not a statement.

‘It is true that I ate my car keys’
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- ‘It is true that I ate my car keys’ ✓
- ‘It is true that try jiggling the handle’
Statements

- A *statement* is a sentence which is capable of being true or false.
  - Not statements: Questions, commands, suggestions, and exclamations.

A Test

*Given some sentence, P, if ‘It is true that P’ makes sense, then P is a statement. If ‘It is true that P’ does not make sense, then P is not a statement.*

- ‘It is true that I ate my car keys’ ✓
- ‘It is true that try jiggling the handle’ ✗
Finding Argumentative Structure

- It is not always obvious whether the passage constitutes an argument or not.
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- It is not always obvious whether the passage constitutes an *argument* or not
- Given that it is an argument, it is not always obvious which sentences are premises, which are conclusions, and which sentences are extraneous
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Indicator Words
Finding Argumentative Structure

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- Indicator Words
- Conclusion indicators
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- Indicator Words
- Conclusion indicators

therefore, hence, so, thus,
this entails that as a result, for this reason, we may conclude
consequently, accordingly, this implies that this entails that
Finding Argumentative Structure

- Premise Indicators
  - since or for
  - because
  - given that
  - owing to
  - in that
  - for the reason that
  - seeing that
  - seeing as
  - as is shown by
  - may be inferred from
Finding Argumentative Structure

- **Premise Indicators**

  - since
  - for
  - as
  - because
  - given that
  - owing to
  - in that
  - for the reason that
  - seeing that
  - seeing as
  - as is shown by
  - may be inferred from
To determine whether an author is making an argument, consider their goals. Do they want to...

- persuade?
- convey information?
- explain why something occurred?
- tell a story?

E.g., Since the moon's gravity is less than that of the earth, astronauts on the moon's surface were able to jump higher than they could on earth. Sabeen is visiting New York because her company was hired to do a workshop there.
To determine whether an author is making an argument, consider their goals. Do they want to...

- persuade? Then they’re making an argument.
Finding Argumentative Structure

- To determine whether an author is making an argument, consider their goals. Do they want to...
  - persuade? Then they’re making an argument.
  - convey information? Then they’re not making an argument.

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Finding Argumentative Structure

- To determine whether an author is making an argument, consider their goals. Do they want to...
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- E.g.,

  Since the moon’s gravity is less than that of the earth, astronauts on the moon’s surface were able to jump higher than they could on earth.
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E.g.,

Since the moon’s gravity is less than that of the earth, Astronauts on the moon’s surface were able to jump higher than they could on earth.

Sabeen is visiting New York because her company was hired to do a workshop there.
Finding Argumentative Structure

The Principle of Charity

When searching for argumentative structure within a passage, attempt to find the argument which is most persuasive.
We must give up some privacy in the name of security. If the homeland is not secure, terrorist attacks orders of magnitudes larger than 9/11 will find their way to our shores. No amount of privacy is worth enduring an attack like this.
1. We must give up some privacy in the name of security.
2. If the homeland is not secure, terrorist attacks orders of magnitude larger than 9/11 will find their way to our shores.
3. So, no amount of privacy is worth enduring an attack like this.
1. We must give up some privacy in the name of security.
2. No amount of privacy is worth enduring an attack orders of magnitude larger than 9/11.
3. So, if the homeland is not secure, terrorist attacks like this will find their way to our shores.
1. If the homeland is not secure, terrorist attacks orders of magnitude larger than 9/11 will find their way to our shores.
2. No amount of privacy is worth enduring an attack like this.
3. So, we must give up some privacy in the name of security.
Conditionals

- Each card below has a letter printed on one side and a number printed on the other side.

```
9  J  U  2
```
Each card below has a letter printed on one side and a number printed on the other side.

- 9
- J
- U
- 2

Claim: every card obeys the following rule
Each card below has a letter printed on one side and a number printed on the other side.

Claim: every card obeys the following rule

**Rule**

*If there is a vowel printed on one side of the card, then there is an even number printed on the other.*
Each card below has a letter printed on one side and a number printed on the other side.

9  J  U  2

Claim: every card obeys the following rule

Rule

If there is a vowel printed on one side of the card, then there is an even number printed on the other.

Which cards do you have to flip over in order to figure out whether the claim is true or false?
Conditionals

Rule

*If there is a vowel printed on one side of the card, then there is an even number printed on the other.*

- Which cards do we have to turn over in order to discover whether the rule is being obeyed?
Conditionals

Rule

*If there is a vowel printed on one side of the card, then there is an even number printed on the other.*

- Which cards do we have to turn over in order to discover whether the rule is being obeyed?
  - All of them?
Conditionals

Rule

If there is a vowel printed on one side of the card, then there is an even number printed on the other.

☐ Which cards do we have to turn over in order to discover whether the rule is being obeyed?
   ☐ All of them?
   ☐ Just ‘U’ and ‘2’?
Conditionals

If there is a vowel printed on one side of the card, then there is an even number printed on the other.

Which cards do we have to turn over in order to discover whether the rule is being obeyed?

- All of them?
- Just ‘U’ and ‘2’?
- Just ‘9’ and ‘U’?
If there is a vowel printed on one side of the card, then there is an even number printed on the other.

- Which cards do we have to turn over in order to discover whether the rule is being obeyed?
  - All of them?
  - Just ‘U’ and ‘2’?
  - Just ‘9’ and ‘U’?
  - Just ‘J’ and ‘U’?
Conditionals

Rule

If there is a vowel printed on one side of the card, then there is an even number printed on the other.

Which cards do we have to turn over in order to discover whether the rule is being obeyed?

- All of them?
- Just ‘U’ and ‘2’?
- Just ‘9’ and ‘U’?
- Just ‘J’ and ‘U’?
Conditionals

If there is a vowel printed on one side of the card, then there is an even number printed on the other.

Which cards do we have to turn over in order to discover whether the rule is being obeyed?

- All of them?
- Just ‘U’ and ‘2’?
- Just ‘9’ and ‘U’?
- Just ‘J’ and ‘U’?
Conditionals

Rule

If there is a vowel printed on one side of the card, then there is an even number printed on the other.

Which cards do we have to turn over in order to discover whether the rule is being obeyed?

- All of them?
- Just ‘U’ and ‘2’?
- Just ‘9’ and ‘U’?
- Just ‘J’ and ‘U’?
Conditionals, again

Each card has an age printed on one side and a beverage printed on the other.

| Beer | 22 | 16 | Coke |

Rule

If the age on one side is less than 21, then the drink on the other side must not be alcoholic.

☐ Which cards do we have to turn over in order to find out whether the rule is being obeyed?
Conditionals

- Claims of the form
  
  If $blah$, then $bleh$.

  are called *conditionals*. 
Conditionals

- Claims of the form If $P$, then $Q$. are called conditionals.
Claims of the form \[\text{If } P, \text{ then } Q.\]
are called *conditionals*.

These claims tell you that, conditional on \(P\) being true, you may infer that \(Q\) is true as well.
Conditionals

- Claims of the form
  
  If $P$, then $Q$. 

  are called conditionals.

- These claims tell you that, conditional on $P$ being true, you may infer that $Q$ is true as well.

- They say that the truth of $P$ is sufficient for the truth of $Q$. 
Claims of the form

If $P$, then $Q$.

are called *conditionals*.

These claims tell you that, conditional on $P$ being true, you may infer that $Q$ is true as well.

They say that the truth of $P$ is *sufficient* for the truth of $Q$.

Alternatively: they say that the truth of $Q$ is *necessary* for the truth of $P$. 
Necessary and Sufficient Conditions

- **X** is sufficient for **Y** if and only if everything which is **X** is also **Y**.

  - Being older than 21 is sufficient for being legally allowed to drink.
  - Being square is sufficient for being rectangular.

- **X** is necessary for **Y** if and only if everything which is **Y** is also **X**.

  - Being European is necessary for being French.
  - Being a triangle is necessary for being an equilateral triangle.

- **X** is sufficient for **Y** if and only if **Y** is necessary for **X**.
Necessary and Sufficient Conditions

- $X$ is sufficient for $Y$ if and only if everything which is $X$ is also $Y$.
  - Being older than 21 is sufficient for being legally allowed to drink.
Necessary and Sufficient Conditions

- \( X \) is sufficient for \( Y \) if and only if everything which is \( X \) is also \( Y \).
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.

- \( X \) is necessary for \( Y \) if and only if everything which is \( Y \) is also \( X \).
Necessary and Sufficient Conditions

- $X$ is sufficient for $Y$ if and only if everything which is $X$ is also $Y$.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
  - Being square is sufficient for being rectangular.

- $X$ is necessary for $Y$ if and only if everything which is $Y$ is also $X$. 
  - Being European is necessary for being French.
    - Everyone who is French is also European.
  - Being a triangle is necessary for being an equilateral triangle.
    - Every equilateral triangle is also a triangle.
Necessary and Sufficient Conditions

- $X$ is sufficient for $Y$ if and only if everything which is $X$ is also $Y$.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
  - Being square is sufficient for being rectangular.
    - Everything which is square is also rectangular.
Necessary and Sufficient Conditions

- **X** is sufficient for **Y** if and only if everything which is **X** is also **Y**.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
    - Being square is sufficient for being rectangular.
      - Everything which is square is also rectangular.

- **X** is necessary for **Y** if and only if everything which is **Y** is also **X**.
Necessary and Sufficient Conditions

- **X** is sufficient for **Y** if and only if everything which is **X** is also **Y**.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
    - Being square is sufficient for being rectangular.
      - Everything which is square is also rectangular.
- **X** is necessary for **Y** if and only if everything which is **Y** is also **X**.
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Necessary and Sufficient Conditions

- **X is sufficient for Y** if and only if everything which is X is also Y.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
  - Being square is sufficient for being rectangular.
    - Everything which is square is also rectangular.

- **X is necessary for Y** if and only if everything which is Y is also X.
  - Being European is necessary for being French.
    - Everyone who is French is also European.
Necessary and Sufficient Conditions

- **X** is sufficient for **Y** if and only if everything which is **X** is also **Y**.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
  - Being square is sufficient for being rectangular.
    - Everything which is square is also rectangular.

- **X** is necessary for **Y** if and only if everything which is **Y** is also **X**.
  - Being European is necessary for being French.
    - Everyone who is French is also European.
  - Being a triangle is necessary for being an equilateral triangle.
Necessary and Sufficient Conditions

- $X$ is sufficient for $Y$ if and only if everything which is $X$ is also $Y$.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
  - Being square is sufficient for being rectangular.
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- $X$ is necessary for $Y$ if and only if everything which is $Y$ is also $X$.
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Necessary and Sufficient Conditions

- X is sufficient for Y if and only if everything which is X is also Y.
  - Being older than 21 is sufficient for being legally allowed to drink.
    - Everyone who is older than 21 is also legally allowed to drink.
  - Being square is sufficient for being rectangular.
    - Everything which is square is also rectangular.

- X is necessary for Y if and only if everything which is Y is also X.
  - Being European is necessary for being French.
    - Everyone who is French is also European.
  - Being a triangle is necessary for being an equilateral triangle.
    - Every equilateral triangle is also a triangle.

- X is sufficient for Y if and only if Y is necessary for X.
- $N$ is necessary for $S$. 
Necessary and Sufficient Conditions

- $N$ is necessary for $S$.
- $S$ is sufficient for $N$. 
'If $P$, then $Q$' says that $P$ is sufficient for $Q$. 
If $P$, then $Q$' says that $P$ is sufficient for $Q$.
The only way this could be false is if $P$ isn't sufficient for $Q$. 
‘If $P$, then $Q$’ says that $P$ is sufficient for $Q$.

The only way this could be false is if $P$ isn’t sufficient for $Q$

that is, if there is something which is $P$ but not $Q$. 
Rule

If there is a vowel printed on one side of the card, then there is an even number printed on the other.
Conditionals

9
J
U
2

The card has a vowel
The card has an even number
x
Here’s one way for an argument to be good: the truth of all of its premises could guarantee the truth of its conclusion.
Here’s one way for an argument to be *good*: the truth of all of its premises could guarantee the truth of its conclusion.

- If all of the argument’s premises are true, then its conclusion will be true as well.
Here’s one way for an argument to be good: the truth of all of its premises could guarantee the truth of its conclusion.

If all of the argument’s premises are true, then its conclusion will be true as well.

An argument is **deductively valid** if and only if the truth of all of its premises is sufficient for the truth of its conclusion.
Deductive Validity

- Here’s one way for an argument to be good: the truth of all of its premises could guarantee the truth of its conclusion.
  - If all of the argument’s premises are true, then its conclusion will be true as well.

Deductive Validity

An argument is **deductively valid** if and only if the truth of all of its premises is sufficient for the truth of its conclusion.

Deductive Validity

An argument is **deductively valid** if and only if it is impossible for all of its premises to be true while its conclusion is simultaneously false.
Some deductively valid arguments:

1. If Obama is president, then he is the commander in chief.
2. Obama is president.
3. So, Obama is the commander in chief.

1. Gerald is either in Barcelona or in New York.
2. Gerald is not in New York.
3. So, Gerald is in Barcelona.

1. Sabeen is younger than 30.
2. So, Sabeen is younger than 40.
Some deductively valid arguments:

1. If Obama is president, then he is the commander in chief.
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1. Sabeen is younger than 30.
2. So, Sabeen is younger than 40.
Deductive Validity

- Deductively valid arguments can have false premises.
Deductive Validity

- *Deductively valid arguments can have false premises.*
Deductive Validity

- Deductively valid arguments can have false premises.
- Deductively valid arguments can have false conclusions.
- What matters is just the connection between the premises and the conclusion.
- If the truth of the premises is enough to guarantee the truth of the conclusion, then the argument is valid, whether or not the premises actually are true.
- If all of the premises of a deductively valid argument are all true, then we say that the argument is sound.

Deductive Soundness

An argument is deductively sound if and only if it is deductively valid and it has all true premises.
Deductive Validity

- Deductively valid arguments can have false premises.
- Deductively valid arguments can have false conclusions.

Deductive Soundness

An argument is deductively sound if and only if it is deductively valid and it has all true premises.
Deductive Validity

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Deductive Validity

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- *Deductively valid arguments can have false premises.*
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Deductive Validity

- Deductively valid arguments can have false premises.
- Deductively valid arguments can have false conclusions.
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- If the truth of the premises is enough to guarantee the truth of the conclusion, then the argument is valid, *whether or not the premises actually are true*.
- If all of the premises of a deductively valid argument are all true, then we say that the argument is *sound*.
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- Deductively valid arguments can have false conclusions.
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- If all of the premises of a deductively valid argument are all true, then we say that the argument is sound.

Deductive Soundness

An argument is **deductively sound** if and only if it is deductively valid and it has all true premises.
In Class Exercise!!!
Deductive Validity

An argument is **deductively valid** if and only if it is impossible for all of its premises to be true while its conclusion is simultaneously false.

- If it is impossible for an argument’s premises to all be true, then it is impossible for all of an argument’s premises to be true while its conclusion is false.
Special Cases of Validity

**Deductive Validity**

An argument is **deductively valid** if and only if it is impossible for all of its premises to be true while its conclusion is simultaneously false.

- If it is impossible for an argument's premises to all be true, then it is impossible for all of an arguments premises to be true while its conclusion is false.
- So this is a deductively valid argument:
  1. It is raining.
  2. It is not raining.
  3. So, chocolate falls from the sky every Thursday.
Special Cases of Validity

Deductive Validity

An argument is **deductively valid** if and only if it is impossible for all of its premises to be true while its conclusion is simultaneously false.

- If it is impossible for an argument’s conclusion to be false, then it is impossible for all of the argument’s premises to be true while its conclusion is false.
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- If it is impossible for an argument’s conclusion to be false, then it is impossible for all of the argument’s premises to be true while its conclusion is false.
- So this is a deductively valid argument:
  1. Barack Obama is a space alien.
  2. Sunday follows Friday.
  3. So, if it’s raining, then it’s raining.
Inductive Strength

- Not every persuasive argument is *deductively valid*. 

  - Every morning, the sun has risen in the east.
  - So, tomorrow, the sun will rise in the east.

  Is this argument deductively valid?
  No, but it is still very persuasive. It's still a very good argument.
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Consider, for instance,

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If \( \Pr(\text{conclusion} \mid \text{premises}) = x \), then the strength of the argument from premises to conclusion is \( x \).

- Say that an argument is *strong*, as opposed to *not strong*, iff \( x > 0.5 \).
Inductive Cogency

- If an inductively strong argument has all true premises, then it is inductively cogent.
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An argument is inductively cogent if and only if it is inductively strong and it has all true premises.