

Logical Reasoning

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"*Excellent!*" I cried.

"*Elementary*" said he.

It is one of those instances where the reasoner can produce an effect which seems remarkable to his neighbor, because the latter has missed the one little point which is the basis of the deduction

– Dialog between Sherlock Holmes and Watson

Three Ways of Reasoning

- Given:
 1. A series of **fact** known as **pre-conditions** or **premises**
 2. A **fact** known as **conclusion**
 3. A **rule** that link the two together, such that the pre-conditions **implies** the conclusion

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 2. A **fact** known as **conclusion**
 3. A **rule** that link the two together, such that the pre-conditions **implies** the conclusion
- We can identify three ways of reasoning
 - **Deduction** – determining the conclusion given the premises
 - **Induction** – learning the rule given premises and conclusions
 - **Abduction** – suggest the pre-conditions given the conclusions

The General Schema

	What You Know	What You Observe	Conclusion
Deduction	$A \rightarrow B$	A	

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Abduction	$A \rightarrow B$	B	

The General Schema

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Deduction	$A \rightarrow B$	A	B (certain)
Induction		$A \dots B$ $A \dots B$ $A \dots B$ A	$A \rightarrow B$ B (probable)
Abduction	$A \rightarrow B$	B	A (hypothesis)

Deduction

- Normally associated with **Mathematical Reasoning**
- The truth of the conclusion is a logical consequence of the premises
 - If the argument is valid and the premises are true, the conclusion must be true as well
 - Unfortunately, in real life, it is hard to have absolute rules and fact

*When it rains, the grass gets wet
Today it rained
Therefore the grass must be wet*

Induction

- Normally associated to **Scientific Reasoning**
- Try to determine the relationship between facts by observing multiple examples of premises followed by the same conclusion
 - Make generalization based on single instances
 - How many observations do you need to achieve reasonable certainty?
 - An inductive argument is never true or false, but it can be **strong** or **weak**

*Every times it rains, the grass always gets wet
Therefore, if it rains, the grass will get wet*

Abduction

- Normally associated to medical or **Detective Reasoning**
- The process of formulating hypothesis to explain a given observation
 - There could be other possible explanations as well, so the idea is to find the *best possible* one
 - How can you choose the “best” explanation?

When it rains, the grass gets wet

*The grass is now wet, therefore it ***might*** have rained*

Occam's Razor

“Entities should not be multiplied unnecessarily”

- The best possible explanation is often defined in terms of simplicity, economy, succinctness, and elegance
 - Between many possible hypotheses (all with the same **explanatory power**), choose the one that is more simple and require less assumptions



Putting Everything Together

[Induction] Transforming observations into knowledge

- From multiple events, extract recurring patterns

[Abduction] Forming the Hypothesis

- From an observation, think about the most likely explanations

[Deduction] Using the hypothesis to deduce other events

- By verifying the predictions it is possible to rule out bad hypothesis

Conclusions can be supported by observations but they can be rarely “proved”

Example

A B

A B

A B

B

A → C

Example

A B
A B
A B

B

A → C

→ A → B *Induction*

Example

A B
A B
A B

B

A → C

→ A → B *Induction*



→ A *Abduction*

Example

A B
A B
A B

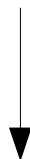
B

A → C

→ A → B *Induction*



→ A *Abduction*



→ C ?? *Hypothesis verification by Deduction*

Example

