

Introduction to the Scientific Method
Writing Research or
'How to make people believe you'

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Overview

- Defining research scope
- Forming arguments
- Clear writing
- Proper citation and plagiarism

ICDF2C and STS Security Essay Contest and Panel Discussion

- **You can already start practicing publishing scientific research**
- **How civilians can improve cyber security**
- **Submissions**
 - Should be in English
 - No longer than 3 pages
 - Submitted by September 21
- **If accepted, panel discussion October 6 in Seoul**

Ask some questions

- **Let's think of some research questions that are interesting and useful.**
- **Tag Joshua James in the BoB 4 facebook group**

Everyday Experimentation

Have you used the scientific method today?

Steps of the scientific method:

- Ask a question
- Research
- Construct hypothesis
- Test hypothesis
- Analyze data
- Make conclusions
- Present results

Repeat!



From Dr. Horrible's sing-along blog: <http://drhorrible.com/>

Creating Knowledge

What do we hope to achieve from this process?

Rules! [How and Why]

- **If our hypothesis holds with every test, what happens?**
- **The hypothesis becomes a THEORY**

Theory: a supposition or a system of ideas intended to explain something, especially one based on general principles independent of the thing to be explained.

Creating Knowledge

What happens after we have a theory?

- **Present results**
- **If our theory holds after worldwide testing, it might become accepted as a *LAW***

A **scientific law** is a statement based on repeated experimental observations that describes some aspects of the universe. A scientific law always applies under the same conditions, and implies that there is a causal relationship involving its elements.

Hypothesis, Theory or Law

- Darwin's theory of evolution
- Freud's theory of personality development
- $F = G \frac{m_1 \times m_2}{d^2}$ (Gravitational force)
- IQ score measuring intelligence
- It will rain tomorrow
- The Big Bang

Knowledge

- **Not only how and why – what is missing?**

$$F = G \frac{m_1 \times m_2}{d^2}$$

- **What does this formula tell us?**

Constraint

- We need to know the rule (how)
- We need to know about causation (why)
- We need to know *constraints*
 - *When does this particular rule apply?*

$$F = G \frac{m_1 \times m_2}{d^2}$$

Classes of Knowledge

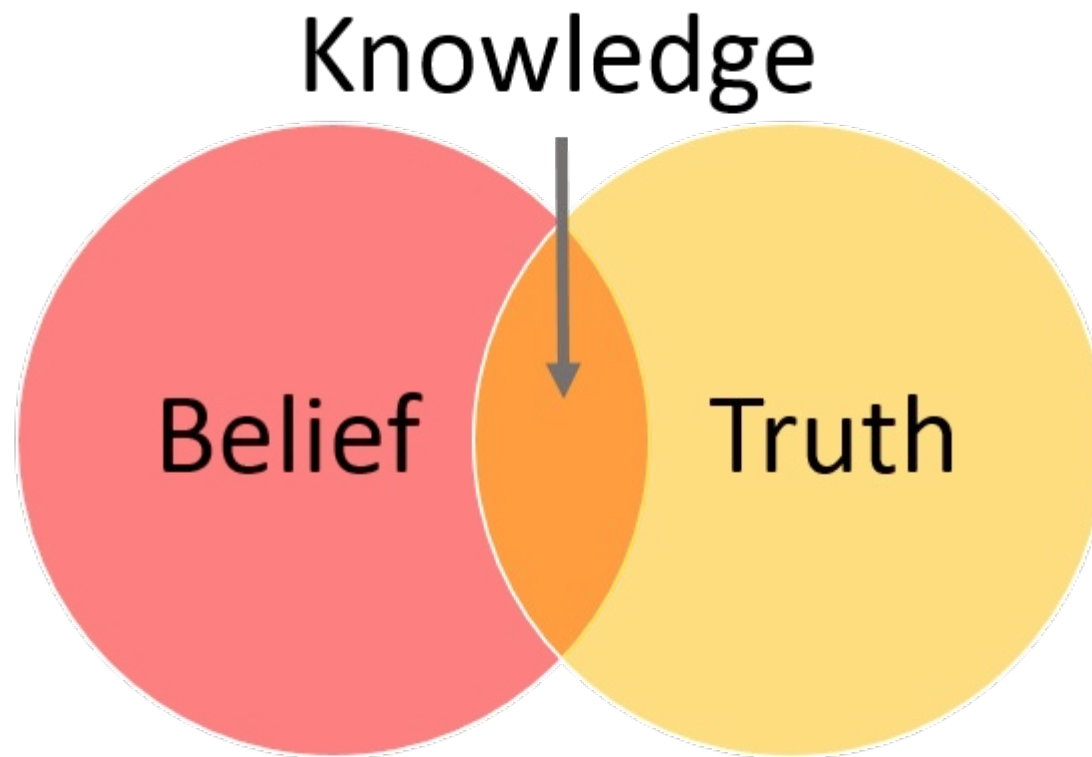
- **What is a belief?**

Belief: an acceptance that a statement is true or that something exists.

- **What is knowledge?**

Knowledge: facts, information, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject.

Belief and Knowledge

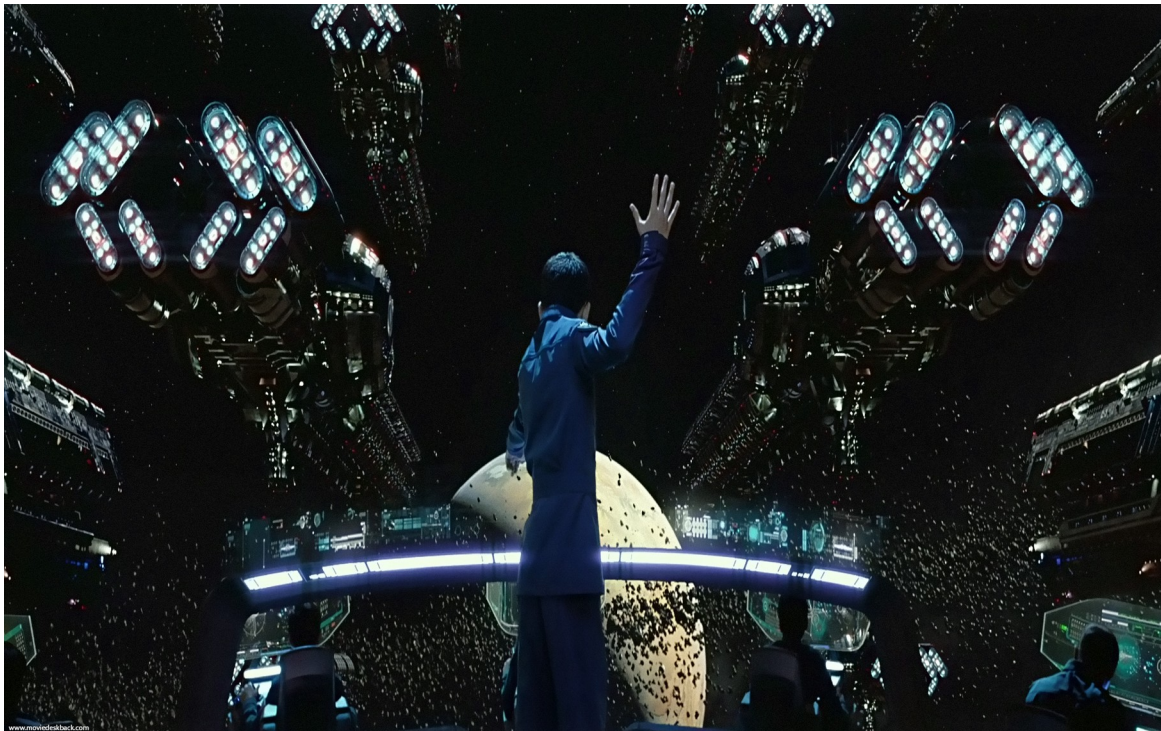


Knowledge [1]

- **What makes knowledge?**
 - **Certainty** – it's hard if not impossible to deny
 - **Evidence** – it has to be based on something
 - **Practicality** – it has to actually work in the real world
 - **Broad agreement** – lots of people have to agree it's true
- **But these have problems!**
- **Result: Belief and knowledge *feel* like the same thing**

Thought Exercise

- Do you believe the sky is up?
- Atmosphere all around us
- Other side of the world is technically “down”
- “Up” in relation to *what*? We need to be specific



Scene from the movie “Enders Game”

Reasoning

- “Reasoning” is the most powerful tool that humans possess
- It is *hard* to do correctly
- It is *easy* to fake or get very wrong



Reasoning Tools

- **Two main tools for human reasoning:**
 - Deduction
 - Induction

- **Arguments are normally written as:**
 - P1: First premise
 - P2: Second premise
 - C1: Conclusion

Deduction [6]

- **Deductive arguments provide a guarantee of the truth of the conclusion if the premises are true**
- **If the premises are true, it is impossible for the conclusion to be false**
 - If the premises guarantee the conclusion, the argument is **“valid”**
 - If the premises are true, the argument is **“sound”**

Deduction [6]

- ***Valid* deductive argument:**
 - P1: It's sunny in Singapore
 - P2: If it's sunny in Singapore, he won't be carrying an umbrella.
 - C1: So, he won't be carrying an umbrella.
- **Why is this argument valid?**
- **Is this argument “sound”?**

Deduction [7]

- **Deductive argument:**
 - P1: All Frenchmen like red wine
 - P2: Pierre is a Frenchman
 - C1: Therefore, Pierre likes red wine
- **Is this argument valid?**
- **Is this argument sound?**

Induction [6]

- Inductive arguments attempt to increase the probability of its conclusion
- If the premises are true, it is *unlikely* that the conclusion is false
- Arguments:
 - Deductive: Valid or Invalid
 - Inductive: Weak or Strong

Induction [6]

- ***Strong* inductive argument**
 - *P1*: Every time I've walked by that dog, he hasn't tried to bite me.
 - *C1*: So, the next time I walk by that dog he won't try to bite me.

Induction [7]

- **Inductive argument**
 - *P1*: The first five eggs in the box were rotten
 - *P2*: All the eggs have the same expiration date stamped on them
 - *C1*: Therefore, the sixth egg will be rotten too

Induction [6]

- ***P1***: The police said John committed the murder. ***C1***: So, John committed the murder.
- ***P2***: The witness said John committed the murder. ***C1***: So, John committed the murder.
- ***P3***: Two independent witnesses claimed John committed the murder. ***P4***: John's fingerprints are the only ones on the murder weapon. ***P5***: John confessed to the crime. ***C1***: So, John committed the murder.
- None of these arguments are deductively *valid*

Reasoning

- **Deductive reasoning is much safer**
 - If our premises are true, we should reach a true conclusion
- **Inductive reasoning**
 - Can take us from true premises to false conclusions
- **Everyday life: Inductive reasoning**
- **Science: (mostly) deductive reasoning**
 - Social sciences mostly use induction

Deductive argument against the big bang [3]

- ***P1:*** The Law of the conservation of angular momentum states that angular momentum is conserved where there is no net external torque. (Spinning things keep spinning in the same direction unless acted upon.)
- ***P2:*** A spinning dot containing all the matter in the universe spins so fast that it explodes.
- ***C1:*** All of the matter being expelled from the spinning dot would be spinning in the same direction as the dot they exploded from.
- **Is this valid/sound?**

Deductive argument against the big bang [3]

- ***P1*: The Law of the conservation of angular momentum**
- ***P2*: Spinning dot**
- ***P3*: All matter out of dot will spin same direction**
- ***C2*: Therefore, all of the planets should be spinning in the same direction.**
- **Is this argument valid / sound?**

Deductive argument against the big bang [3]

- **P4: All of the planets should be spinning in the same direction.**
- **P5: Venus and Uranus spin opposite directions from other planets**
- **C3: The Big Bang must be false**
- **Is this argument valid / sound?**

Hacking people's arguments

- https://www.koreatimes.co.kr/www/news/nation/2015/08/618_183447.html
- https://www.koreatimes.co.kr/www/news/opinon/2015/08/164_185179.html
- https://www.koreatimes.co.kr/www/news/opinon/2015/08/164_183768.html
- https://www.koreatimes.co.kr/www/news/opinon/2015/08/202_185183.html
- https://www.koreatimes.co.kr/www/news/nation/2015/08/614_183664.html

Clear Writing

- **Research Paper**

- Introduction
- Background
- Research question
- Logical Proof (argument)
- Experimentation
- Results
- Conclusions

- **Argument essay**

- Introduction
 - What you want to argue (thesis statement)
- Body
 - Evidence
- Conclusion
 - Based on the evidence why is the argument correct?

Clear Writing

- **Don't use big, complicated words**
 - Easier is better to read and understand
 - More likely you will use the word incorrectly
 - More likely your reader will **lose interest**
- **The best writing was re-written many times**
 - No one can write perfectly the first time
- **Form your argument before you start writing**
 - Make sure the argument is supported by evidence and is convincing
- **If you don't have anything to say, why are you writing?**
- **I highly recommend the book “On Writing Well” by Zinsser**
 - <http://www.amazon.com/Writing-Well-30th-Anniversary-Edition/dp/0060891548>

Citations

- **If you want to be taken seriously (respected as an expert) you *must* use proper citation of sources**
- **Software does it for you:**
 - **Mendeley**
 - <https://www.mendeley.com/>
 - **Zotero**
 - <https://www.zotero.org/>

Plagiarism

- **The fastest way to ruin your reputation is to steal ideas or content from other people**

Plagiarism: the practice of taking someone else's work or ideas and passing them off as one's own

References

- 1) <http://www.philosophynews.com/post/2011/09/22/What-is-Knowledge.aspx>
- 2) <http://www.arachnoid.com/psychology/>
- 3) [A really bad example of deduction] <http://www.angelfire.com/mi/dinosaurs/bigbang.html>
- 4) <http://www.amazon.com/Korea-Impossible-Country-Daniel-Tudor/dp/0804842523>
- 5) https://en.wikipedia.org/wiki/List_of_Christian_denominations
- 6) <http://www.iep.utm.edu/ded-ind/>
- 7) Samir Okasha. *Philosophy of Science: A very short Introduction*. Oxford University Press.
- 8) <http://uk.reuters.com/article/2015/03/17/uk-nuclear-southkorea-northkorea-idUKKBN0MD1F420150317>
- 9) https://en.wikipedia.org/wiki/Bayesian_inference

Thank you
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