Definitions

Sentence

- Is grammatically correct

Statement

- Sentence
- Asserts something being true or false
    - Either true or false

Proposition

- The meaning of a statement regardless of syntax or presentation of the sentence

Argument

- Propositions **(Premises + Conclusion)**
    - One claims to be supported by the rest accepted premises
    - ***Premise (Accetped fact) --prove--> Conclusion***
- Hidden premise
    - Assumed premise

Explanation

- Propositions
    - One claims to be shed light on by the rest
    - ***Explanan --explain--> Explanandum (Accepted fact)***

Deductive/Inductive arguments

Deductive arguments

- If all premises are true -> **Impossible** to be false
- Can ***conclusively*** support conclusions

Inductive arguments

- If all premises are true -> **Improbable** to be false
- Can ***strongly*** support conclusions

Possibilities

- **Technological**: Within current technological constraints
- **Physical**: Within physical constraints

- **Logical**: Within logical constraints
    - No logical contradictions
    - Within all possible worlds
- Technological ∈ Physical ∈ Logical

Proposition types

- **Tautological**: Necessarily true
    - Proves itself
- **Self-contradictory**: Necessarily false
    - Disproves itself
- **Contingent**: Neither
    - Requires external knowledge to be proven

Argument evaluation standards

Deductive standard

Validity (valid/invalid?)

- Truth-preserving?
    - **Invalid**: True premise + False conclusion -> Possible
        - ***Conditionally valid*** (!!!)
    - **Valid**: True premise + False conclusion -> Impossible
        - ***Self-contradictory premise*** (Impossible true premise)
        - ***Tautological conclusion*** (Impossible false conclusion)

Soundness (sound/unsound?)

- Valid argument + True premise

Inductive standard

Strength (**strong/weak**?)

- Probable conclusion?
- Not binary/all-or-nothing

Cogency (cogent/uncogent?)

- Strong argument + True premise

Categorical syllogism

Syntax

- *Quantifier - subject term - copula - predicate term*

    - All A are B
- Types:
    - **A**: All *X* are *Y*
    - **E**: No *X* are *Y*
    - **I**: Some *X* are *Y*
    - **O**: Some *X* are not *Y*
    - Affirmative: **A**, **I**; Negative: **E**, **O**
    - Universal: **A**, **E**; Particular:**I**, **O**
- Some = Not zero
- Terms = ***NOUNS***
- "**All** *x* **identical to** *x*" | "**所有與** *x* **等同的** *x*"

Venn diagrams

- /// = Emptiness
- **X** = Existence

Standardisation

Conversion

- *Only* truth-preserving for **E**, **I**
- 1. Switch subject and predicate term

Contraposition

- *Only* truth-preserving for **A**, **O**
- 1. Switch subject with predicate
- 2. Toggle "non-" to both terms

Obversion

- *Always* truth-preserving
- 1. Negate the quality (**No** <-> **All** | **Some** <-> **Some...not**)
- 2. Toggle "non-" to both terms

Syllogism

- Two-premise argument
    - Three terms total
    - Each term appears twice
    - None term appears twice in a single proposition
- **Major term**: Predicate term of conclusion
- **Minor term**: Subject term of conclusion
- **Middle term**: Not present in conclusion

Mood & Figure

Figure

1	2	3	4
M P	P ***M***	***M*** P	P ***M***
S ***M***	S ***M***	***M*** S	***M*** S
S P	S P	S P	S P

Mood

Valid

1	2	3	4
AAA	AEE	AII	AEE
AII	AOO	EIO	EIO
EAE	EAE	IAI	IAI
EIO	EIO	OAO	

Invalid (Conditionally valid)

1	2	3	4
AAI	AEO	AAI	AAI
EAO	EAO	EAO	AEO
			EAO

Venn diagram

- △; circles at vertices

```
        Middle term
             △
Minor term     Major term
```

Opposition

- **Contradictory**
  - Cannot be both true + Cannot be both false
  - **A** <-> **O**
  - **E** <-> **I**
- **Contrary**
  - Cannot be both true + Can be both false
  - **A** <-> **E**

- **Subcontrary**
  - Can be both true + Cannot be both false
  - **I** <-> **O**
- **Subaltern**
  - For *b* is a subaltern of *a* (*b* -> *a*),
    - True *a* -> True *b*
    - False *b* -> False *a*
  - **I** -> **A**
  - **O** -> **E**

Propositional Logic

- **Simple proposition**: Proposition
- **Compound proposition**: Proposition + Logic (not, if, unless, ...)

Logical Operators

Operator	Function	Translation	T/T	T/F	F/T	F/F
~	Negation	not, not the case, ...				
·	Conjunction	and, also, but, ...	**T**	*F*	*F*	*F*
∨	Disjunction ***(Inclusive)***	either...or...	**T**	**T**	**T**	*F*
⊃	Conditional	if...then..., only if...	**T**	*F*	**T**	**T**
≡	Bi-conditional	if and only if...	**T**	*F*	*F*	**T**

Conditional

- P⊃Q:
  - **P**: antecedent
  - **Q**: consequent
- **Sufficient Condition**
  - *A* is *sufficient* for *B* to occur
  - *~A* does not necessitate for *~B*
  - *A⊃B*
- **Necessary Condition**
  - *A* is *necessary* for *B* to occur
  - *A* does not necessitate *B*
  - *B⊃A*
- ***Sufficient* ⊃ *Necessary***

Bi-conditional

- Logically Equivalent
- *P⊃Q* **==** (*P⊃Q*)·(*P⊃Q*)

Well-formed Formulas

1. Capital letters
2. $\sim\alpha$
3. $\alpha \cdot \beta$
4. $\alpha \vee \beta$
5. $\alpha \supset \beta$
6. $\alpha \equiv \beta$
7. Nothing else

Truth table

- **All False**: Self-contradictory
- **All True**: Tautological
- **True + False**: Contingent
- *Premise* **/** *Premise* **/** ... **//** *Conclusion*

Indirect truth table

- Check validity
  - Assume invalid (true premises + false conclusion)
    - Main operators only
  - Backwards deduction
    - Additional assumptions if necessary
    - All cases contradiction -> Contradiction
  - Check contradictions
    - ≥ 1 contradiction:
      - Wrong assumption
      - ∴ Argument is ***valid***
    - 0 contradiction:
      - ∴ Argument is ***invalid***
- Check consistency
  - Assume both true
  - ...

Proposition Relations

- **Logical Equivalent**
  - Always ≡
- **Contradictory**
  - Always ~
- **Consistent**
  - ≥1 both true
- **Inconsistent**
  - 0 both true

Natural Deduction

Rules of Inference

- No Implication + Replacement in one step

Implication

- *e.g.* (1,2 MT)
- $\alpha * \beta \neq \beta * \alpha$

Replacement

- **::** equivalent
- ≤ 3 replacements in one step

Proofs

- Indent deduction steps

Conditional Proof

- Conclusion: $\alpha \supset \beta$
- Assume premise α ***(ACP)***
- Do until β (***show explicitly***)
- Unindent $\alpha \supset \beta$ *(Step numbers, CP)*

Indirect Proof

- Assume ~conclusion $\sim\alpha$ ***(AIP)***
- Do until contradiction (***show explicitly***)
- Unindent $\sim\sim\alpha$ *(Step numbers, IP)*

Fallacies

Formal Fallacy

- Typical errors
- Can be identified from argument structure
- ***Affirming the consequent***
- ***Denying the antecedent***
- ...

Informal Fallacy

- Can only be identified from argument content

Fallacies of Relevance

- Argument irrelevant to conclusion
- ***Appeal to force***

- ***Appeal to people***
- ***Argument against the person***
- ***Straw man***
    - Unreasonable exaggeration
- ***Red herring***
    - Attention diversion

Fallacies of Presumption

- ***Begging the question***
    - Circular argument
- ***Complex question***
    - Merge multiple questions
- ***False dichotomy***
    - Pretend there are only 2 options

Fallacies of Weak Induction

- ***Hasty generalisation***
    - Unrepresentative sample
        - Small sample size
        - Non-random sampling
- ***Appeal to unqualified authority***
    - Forged authority
- ***Weak analogy***
    - Irrelevant similarities
        - **X:** p, q, s
        - **Y:** p, q
        - $\therefore$ **Y:** s
- ***Appeal to ignorance***
    - Not proven false = True
    - Not proven true = false
- ***False cause***
- ***Slippery slope***
    - Unlikely chain reaction