Reminder.

- XIth century.
  - Berengar of Tours (c.1000-1088): Linguistic analysis of the Eucharist.
  - Anselm of Canterbury (1033-1109): *sola ratione*.
  - Roscelin of Compiègne (c.1045-c.1120): Radical nominalism.
- XIIth century.
  - Peter Abelard (1079-1142).

Realism & Nominalism.

- Was not a issue in the XIth century (Garland the Computist).

- Roscelin; Abelard (XIIth century).

- Aristotelian distinction:
  - Universal substances: **Animal**, **Human**.
  - Particular substances: **Socrates**, **Plato**, **Aristotle**.

Realists.   Universals exists independent of the particulars.

Problem. What is the ontological status of these universals?

Nominalists.   Universals exist only through the particulars.

Problem. Is it intuitively plausible that the concept 'tree' changes every time a tree is cut down?

Abelard's Logic.

- **The Square of Oppositions.** Discussion of the existential content of universal statements: Does *"Omnis homo est albus"* imply that there is a man?

- **Modal Logic.** Distinction of model statements into *de re* and *de dicto*.

- **Temporal Logic.** Isolation of the concept of "true at a time".

- **Propositional Logic.** Theory of conditionals.

Martin M. **Tweedale**, Abelard and the culmination of the old logic, *in:* N. Kretzmann, A. Kenny, J. Pinborg (*eds.*), The Cambridge History of Later Medieval Philosophy, Cambridge 1982, p. 143-158

Abelard: *quidam non* vs *non omnis*.

Abelard notices that the Aristotelian square of oppositions includes "existential import":

"Every B is A" implies "Some B is A",

so he reads "*omnis homo est albus*" as "there are men and all of them are white".
Therefore, Abelard distinguishes between "*Non omnis homo est albus*" ("either there are no men or there are non-white men") and "*Quidam homo non est albus*" ("there is a non-white man").

Abelard: *de re* vs *de dicto*.

Abelard notices the modal logic distinction *de re* versus *de dicto*. ("*expositio per divisionem*" and "*expositio per compositionem*"), thereby developing a way to understand the Aristotelian "two Barbaras" problem.

However, he claims that *de dicto* modalities are not real modalities.

(This changes in Thomas Aquinas, *De Modalibus*.)

Abelard: true at time t.

Confusion in the Master Argument about tense and time.
Not all statements in past tense are necessarily true:
"Socrates did not talk to Plato."
One attempt of a solution is to introduce a semantics of
tense sentences that allows **truth at a time**.
One step in the direction of modern temporal logics.

Abelard: Conditionals.

A new (intensional) view of propositional logic:
"*Si non est A est B.*" is equivalent to "*Aut est A aut est B.*"

$$\neg A \rightarrow B \leftrightarrow A \vee B?$$

Abelard reads "*Si est A est B*" as "necessarily, A implies B", and thus has a different reading of the disjunction as "necessarily, $\neg A$ implies B".

Rediscovery of Aristotle.

- Until 1100: *Logica vetus*.
  - Aristotle, *Categoriae* (Boëthius).
  - Aristotle, *De interpretatione* (Boëthius).
  - Porphyrios, *Isagoge*.

- c.1120: Rediscovery of Boëthius' translations of
  - Aristotle, *Prior Analytics*.
  - Aristotle, *Topica*.
  - Aristotle, *Sophistici Elenchi*.

- c.1150: James of Venice translates
  - Aristotle, *Posterior Analytics*.
  - Aristotle, *De anima*.
  - Aristotle, *Metaphysica*.

Logica Nova.

Bernard G. **Dod**, Aristoteles Latinus, *in:* N. Kretzmann, A. Kenny, J. Pinborg (*eds.*), The Cambridge History of Later Medieval Philosophy, Cambridge 1982, p. 45-79

The historical situation around 1200.

- **Resources.** Rediscovery of Aristotle leads to a lot of new material.

- **Institutions.** The centres of learning (Paris, Oxford, ...) institutionalise learning in the Universities.

- *Consolidation of the XIIIth century.* Embedding of Aristotelian teaching into the Christian philosophy.

(Saint) **Albert the Great**

Albertus Magnus (c.1200-1280)

Doctor Universalis.

Founder of the *studium generale* in Cologne (1248).

Predecessor of modern concept of sciences:

The aim of natural science is not simply to accept the statements of others, but to investigate the causes that are at work in nature.

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(Saint) **Thomas Aquinas** (1225-1274)
Student of Albert the Great.
Doctor Angelicus.

The birth of the university (1).

- *Pre-universities.*

  - Law School of Bologna since the early XIth century (*"Bononia docet"*).
  - Cloister schools and cathedral schools in Paris (*e.g.,* the cathedral school of Notre Dame).

- *Problems.*

  - Non-citizen students and scholars in the cities.
  - High prestige of the education requires canonical procedures.
  - Intellectual atmosphere is hard to control for the church.

The birth of the university (2).

- **Bologna** (c.1200). Non-Bolognese **students** form interest groups, the so-called *nationes* or *universitates*.
  - *universitas legistarum citramontanorum,*
  - *universitas legistarum ultramontanorum,*
  - *universitas artistarum et medicorum,*
  - *collegium doctorum.*

- **Paris** (c.1200). Parisian educational institutions plan a more systematic way of teaching organisation, forming a *universitas*.
  - *Facultas Artium.*
  - *Facultas Iurisprudentiae.*
  - *Facultas Medicinae.*
  - *Facultas Theologiae.*

The birth of the university (3)

The Bologna model (*modus Bononiensis*).

- Each *universitas* elects their own *rector* (a student).
- No colleges.
- No university-wide structure.

The Paris model (*modus Parisiensis*).

- Each faculty has their own administration (*decanus*, Dean; *quaestor*, financial officer), elected by the *magistri*.
- *Concilium generale*, dominated by the *magistri* of the *Facultas Artium*. Elects *rector*, normally a professor.
- Colleges, offering accommodation for poor students (and sometimes professors).

Early universities.

- **Bologna** (c.1200), **Paris** (c.1200)

- Oxford (1212)

- Salamanca (1218)

- Montpellier (1220)

- Naples (1224)

- Cambridge (1225)

- Toulouse (1229), Orléans (c.1235), Papal Rome (c.1245), Piacenza (1248), Angers (c.1250), Sevilla (1254), Valladolid (c.1290), Lisbon (c.1290), Lerida (c.1300), Avignon (1303), City of Rome (1303), Perugia (1308), Treviso (1318), Cahors (1332), Grenoble (1339), Pisa (1343), Prague (1348), Florence (1349), Perpignan (1350), Huesca (1354), Arezzo (1355), Siena (1357), Pavia (1361), Cracow (1364), Orange (1365), Vienna (1365), Pécs (1367), Lucca (1369), Erfurt (1379), Heidelberg (1385), Cologne (1388), Ferrara (1391), Buda (1395).

- **1400:** 30. **1500:** 60. **1600:** 110. **1700:** 150.

Teaching in the *Trivium*.

- **Grammar.**
  - Aelius Donatus, *Ars minor*, *Ars maior*.
  - Priscianus, *Institutiones grammaticae*.
- **Logic / Dialectic.**
  - *Logica vetus et nova*.
  - Petrus Hispanus, *Summulae logicales*.
  - William of Ockham, *Summa logicae*.
- **Rhetoric.**
  - Cicero.
  - Quintilianus, *Institutio oratoria*.

The academic career.

Nullus sit scholaris Parisius qui certum magistrum non habet.

- *Schola / Familia Scholarum*, headed by a *magister*.

- The *magister* guides the student socially and academically to the baccalaureate.

- After that, the scholar starts an teaching assistantship with his *magister*.

- After two to three years, he becomes "licentiate" after a private *rigorosum*.

- To become *magister*, there is another public ceremonial exam, the *inceptio*, in combination with a public disputation.

Scholasticism.

The XIIIth century: the Golden Age of Scholasticism.

- Reasoning and analysis (involving logic, metaphysics and semantics), based on authorities: philological and logical analysis of original texts.

- Forms: *quaestiones*, *disputationes*.

Logica nova.

- *insolubilia*: fallacies and paradoxes.

- *syncategoremata*: and, or, not, if, every, some, only, except.

- *obligationes*: a game-theoretic approach to logic.

- "Terminist logic": *proprietates terminorum*.

Logic in the XIIth/XIIIth century.

- John of Salisbury (c.1115-1180), *Metalogicon* (1159).

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- William of Shyreswood (1190-1249), teacher of Petrus Hispanus, *Introductiones in Logicam*. Discussions of propositional logic and the Square of Oppositions.

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- **Robert Kilwardby** (c.1215-1279). Proofs of syllogistic conversion rules as syllogisms with two terms.

- **Roger Bacon** (1214-1292).

Logic in the XIIIth/XIVth century.

- Raimundus Lullus (Raymond Lull) (c.1235-c.1315).

Logic in the XIIIth/XIVth century.

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- Johannes Duns Scotus (1266-1308). *Doctor Subtilis*.

Logic in the XIIIth/XIVth century.

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- Johannes Duns Scotus (1266-1308). *Doctor Subtilis*.

- *The pseudo-Scot*. New modalities: *dubium, scitum, opinatum, volitum, dilectum*.

- William Ockham (c.1295-1349). *Entia non sunt multiplicanda praeter necessitatem.*

Preview.

Next time.

- *Insolubilia*.
- Termistic logic.
- *Obligationes*.

Dialogic Logic (1).

Paul Lorenzen (1958): Explaining the meaning of propositional connectives via games and strategies.

- Two players, the **Proponent** and the **Opponent**.

- In the round 0, the Proponent has to assert the formula to be proved and the Opponent can make as many assertions as he wants. After that, the opponent starts the game.

- In all other moves, the players have to do an *announcement* and an *action*.

- An **announcement** is either of the form $\mathbf{attack}(n)$ or of the form $\mathbf{defend}(n)$, interpreted as "I shall attack the assertion made in round n" and "I shall defend myself against the attack made in round n".

Dialogic Logic (2).

- An **action** can be one of the following moves:
  - $\mathbf{assert}(\Phi)$,
  - **which one?**,
  - **left?**,
  - **right?**,
  - **what if?**, $\mathbf{assert}(\Phi)$.

- You can only attack lines in which the other player asserted a formula. Depending on the formula, the following attacks are allowed:
  - $\Phi \lor \Psi$ may be attacked by **which one?**,
  - $\Phi \land \Psi$ may be attacked by **left?** or **right?**,
  - both $\Phi \to \Psi$ and $\neg\Phi$ may be attacked by "**what if?**, $\mathbf{assert}(\Phi)$".

Dialogic Logic (3).

- You can only defend against a line in which the other player attacked. Depending on the attack, the following defenses are allowed:
  - If $\Phi \vee \Psi$ was attacked by $\mathbf{which\ one?}$, you may defend with either $\mathrm{assert}(\Phi)$ or $\mathrm{assert}(\Psi)$.
  - If $\Phi \wedge \Psi$ was attacked by $\mathbf{left?}$, you may defend with $\mathrm{assert}(\Phi)$, if it was attacked by $\mathbf{right?}$, you may defend with $\mathrm{assert}(\Psi)$.
  - If $\Phi \rightarrow \Psi$ was attacked by "$\mathbf{what\ if?}, \mathrm{assert}(\Phi)$", you may defend with $\mathrm{assert}(\Psi)$.
  - You cannot defend an attack on $\neg\Phi$.

Dialogic Logic (4).

The rules of the (constructive) game:

- In each move, the action and the announcement have to fit together, i.e., if the player announces $\mathbf{attack}(n)$ or $\mathbf{defend}(n)$, then the action has to be an attack on move n or a defense against move n.

- In round $n + 1$, the Opponent has to either attack or defend against round n.

- An attack is called open if it has not yet been defended.

- The Proponent may attack any round, but may only defend against the most recent open attack. He may use any defense against an attack at most once.

- The Opponent may assert any atomic formulas.

- The Proponent may assert only atomic formulas that have been asserted by the Opponent before.

Dialogic logic (5).

If one player cannot make any legal moves anymore, the other player has won.

Example 1.

0		—		$\mathbf{assert}(p \wedge q \to q \wedge p)$
1	$\mathbf{attack}(0)$	$\mathbf{what\ if}?\ \mathbf{assert}(p \wedge q)$		
2			$\mathbf{attack}(1)$	$\mathbf{left}?$
3	$\mathbf{defend}(2)$	$\mathbf{assert}(p)$		
4			$\mathbf{attack}(1)$	$\mathbf{right}?$
5	$\mathbf{defend}(4)$	$\mathbf{assert}(q)$		
6			$\mathbf{defend}(1)$	$\mathbf{assert}(q \wedge p)$
7	$\mathbf{attack}(6)$	$\mathbf{left}?$		
8			$\mathbf{defend}(7)$	$\mathbf{assert}(q)$
9	—	—		

Dialogic logic (5).

If one player cannot make any legal moves anymore, the other player has won.

Example 1.

0		—		$\mathbf{assert}(p \wedge q \rightarrow q \wedge p)$
1	$\mathbf{attack}(0)$	$\mathbf{what\ if}?\ \mathbf{assert}(p \wedge q)$		
2			$\mathbf{attack}(1)$	$\mathbf{left}?$
3	$\mathbf{defend}(2)$	$\mathbf{assert}(p)$		
4			$\mathbf{attack}(1)$	$\mathbf{right}?$
5	$\mathbf{defend}(4)$	$\mathbf{assert}(q)$		
6			$\mathbf{defend}(1)$	$\mathbf{assert}(q \wedge p)$
7	$\mathbf{attack}(6)$	$\mathbf{right}?$		
8			$\mathbf{defend}(7)$	$\mathbf{assert}(p)$
9	—	—		

Dialogic logic (6).

We say that Φ is **dialogically valid** if the Proponent has a winning strategy in the game in which he asserts Φ in round 0.

In symbols: $\models_{\mathrm{dialog}} \Phi$.

The dialogically valid formulas are exactly those provable in intuitionistic propositional logic.

Example 2.

0		—		$\mathbf{assert}(\neg\neg p \to p)$
1	$\mathbf{attack}(0)$	$\mathbf{what\ if?}\ \mathbf{assert}(\neg\neg p)$		
2			$\mathbf{attack}(1)$	$\mathbf{what\ if?}\ \mathbf{assert}(\neg p)$
3	$\mathbf{attack}(2)$	$\mathbf{what\ if?}\ \mathbf{assert}(p)$		
4			—	—

Dialogic Logic (7).

The rules of the (classical) game:

- In each move, the action and the announcement have to fi t together, i.e., if the player announces $\mathbf{attack}(n)$ or $\mathbf{defend}(n)$, then the action has to be an attack on move n or a defense against move n.

- In round $n + 1$, the Opponent has to either attack or defend against round n.

- The Proponent may attack and defend against any round.

- The Opponent may assert any atomic formulas.

- The Proponent may assert only atomic formulas that have been asserted by the Opponent before.

Dialogic logic (8).

We say that Φ is **classically valid** if the Proponent has a winning strategy in the (classical) game in which he asserts Φ in round 0.
In symbols: $\models_{\mathrm{class}} \Phi$.
The classically valid formulas are exactly those provable in classical propositional logic.

Example 2a.

0		—		$\mathbf{assert}(\neg\neg p \to p)$
1	$\mathbf{attack}(0)$	**what if?** $\mathbf{assert}(\neg\neg p)$		
2			$\mathbf{attack}(1)$	**what if?** $\mathbf{assert}(\neg p)$
3	$\mathbf{attack}(2)$	**what if?** $\mathbf{assert}(p)$		
4			$\mathbf{defend}(1)$	$\mathbf{assert}(p)$
5	—	—		