Survival Guidelines

Lecturer: Prof. I-Ta Chris Hsieh, PhD. Email: ita.hsieh@mx.nthu.edu.tw

Teaching Assistant: Thanh Viet Cao. Email: caoviet.ussh@gmail.com

1. **How to get the most from the materials?**

- Core materials: Montague's (1970) PTQ and Heim and Kratzer (1998)

- Supplementary readings:
  - Chris Baker's **Lambda Tutorial**: this is a great tutorial on lambda calculus. Browse to "Examples and practice," which has several exercises on lambda calculus. Guess the result of each expression before clicking "Reduce."
    https://cb125.github.io/lambda.html#binding

Concepts and notation from set theory

$x \in A$	x is an *element of* the set A = x is a *member of* A
$x \notin A$	x is not an element of A
$\emptyset$	the *empty set* = the set that has no members
$A \subseteq B$	the set A is a *subset* of the set B = B is a *superset* of A = every element of A is an element of B
$A \not\subseteq B$	A is not a subset of B
$\wp(A)$	the *powerset* of A = the set of all subsets of A. Example: $\wp(\{a, b\}) = \{\emptyset, \{a\}, \{b\}, \{a, b\}\}$
$A \cap B$	the *intersection* of A and B = the set of elements that are in both A and B
$A \cup B$	the *union* of A and B = the set of elements that are in A or B (or both)
$A - B$	the *difference* between A and B = the set of elements in A that are not in B
$\overline{A}$	the *complement* of A (in E) = $E - A$, where E is a given superset of A
$\|A\|$	the *cardinality* of A = for finite sets: the number of elements in A
$\{x \in A : S\}$	the set of elements in A s.t. the statement S holds Example: $\{x \in \{a, b\} : x \in \{b, c\}\} = \{a, b\} \cap \{b, c\} = \{b\}$
$\{A \subseteq B : S\}$	the set of subsets of B s.t. the statement S holds. Example: $\{A \subseteq \{a, b\} : \|A\| = 1\} = \{\{a\}, \{b\}\}$
$\langle x, y \rangle$	an ordered pair of items x and y
$A \times B$	the *cartesian product* of A and B = the set of ordered pairs $\langle x, y \rangle$ s.t. $x \in A$ and $y \in B$ Example: $\{a, b\} \times \{1, 2\} = \{\langle a, 1\rangle, \langle a, 2\rangle, \langle b, 1\rangle, \langle b, 2\rangle\}$

A *binary relation between A and B* is a subset of the cartesian product $A \times B$.

A *function f from A to B* is a binary relation between A and B that satisfies: for every $x \in A$, there is a unique $y \in B$ s.t. $\langle x, y \rangle \in f$. If f is a function where $\langle x, y \rangle \in f$, we say that f *maps x to y*, and write $f : x \mapsto y$ or $f(x) = y$.

Example: the binary relation $f = \{\langle a, 1\rangle, \langle b, 2\rangle\}$ is a function from $\{a, b\}$ to $\{1, 2\}$, which is equivalently specified $[a \mapsto 1, b \mapsto 2]$ or by indicating that $f(a) = 1$ and $f(b) = 2$.

1. *Idempotent Laws*
   (a) $X \cup X = X$ (b) $X \cap X = X$

2. *Commutative Laws*
   (a) $X \cup Y = Y \cup X$ (b) $X \cap Y = Y \cap X$

3. *Associative Laws*
   (a) $(X \cup Y) \cup Z = X \cup (Y \cup Z)$ (b) $(X \cap Y) \cap Z = X \cap (Y \cap Z$

4. *Distributive Laws*
   (a) $X \cup (Y \cap Z) = (X \cup Y) \cap (X \cup Z)$
   (b) $X \cap (Y \cup Z) = (X \cap Y) \cup (X \cap Z)$

5. *Identity Laws*
   (a) $X \cup \emptyset = X$ (c) $X \cap \emptyset = \emptyset$
   (b) $X \cup U = U$ (d) $X \cap U = X$

6. *Complement Laws*
   (a) $X \cup X' = U$ (c) $X \cap X' = \emptyset$
   (b) $(X')' = X$ (d) $X - Y = X \cap Y'$

7. *DeMorgan's Law*
   (a) $(X \cup Y)' = X' \cap Y'$ (b) $(X \cap Y)' = X' \cup Y'$

8. *Consistency Principle*
   (a) $X \subseteq Y$ iff $X \cup Y = Y$ (b) $X \subseteq Y$ iff $X \cap Y = X$

Figure 1–7: Some fundamental set-theoretic equalities.

(14)	a.	$\neg(\varphi \wedge \psi) \equiv \neg\varphi \vee \neg\psi$
	b.	$\neg(\varphi \vee \psi) \equiv \neg\varphi \wedge \neg\psi$ (de Morgan laws)
	c.	$\varphi \wedge (\psi \wedge \chi) \equiv (\varphi \wedge \psi) \wedge \chi$
	d.	$\varphi \vee (\psi \vee \chi) \equiv (\varphi \vee \psi) \vee \chi$ (associativity)
	e.	$\neg\neg\varphi \equiv \varphi$ (double negation)
	f.	$\varphi \wedge \psi \equiv \psi \wedge \varphi$
	g.	$\varphi \vee \psi \equiv \psi \vee \varphi$ (commutativity)
	h.	$\varphi \wedge (\psi \vee \chi) \equiv (\varphi \wedge \psi) \vee (\varphi \wedge \chi)$
	i.	$\varphi \vee (\psi \wedge \chi) \equiv (\varphi \vee \psi) \wedge (\varphi \vee \chi)$ (distributive laws)
	j.	$\varphi \equiv \varphi \wedge \varphi \equiv \varphi \vee \varphi$ (idempotency)
	k.	$\varphi \to \psi \equiv \neg\varphi \vee \psi$
	l.	$\varphi \to \psi \equiv \neg(\varphi \wedge \neg\psi)$
	m.	$\varphi \leftrightarrow \psi \equiv (\varphi \to \psi) \wedge (\psi \to \varphi)$
	n.	$\varphi \to \psi \equiv \neg\psi \to \neg\varphi$
	o.	$\models \varphi \vee \neg\varphi$ (Law of Excluded Middle)
	p.	$\models \neg(\varphi \wedge \neg\varphi)$ (Law of Contradiction)
	q.	$\models \varphi \to \varphi$
	r.	$\models \varphi \to (\psi \to \varphi)$
	s.	$\models (\varphi \to (\psi \to \chi)) \to ((\varphi \to \psi) \to (\varphi \to \chi))$

Just as for functions we can define:

$$dom(R) = \{a \colon \exists b\, aRb\} \text{ and } range(R) = \{b \colon \exists a\, aRb\}$$

A relation R is *functional* if aRb and aRb' implies $b = b'$. So a functional relation R is a function from $dom(R)$ to some set B such that $range(R) \subseteq B$. We also say that (an arbitrary relation) R is *injective* if aRb and $a'Rb$ implies $a = a'$. Examples of 'laws' for binary relations are given in the exercises.

Here are some well-known properties of relations:

(26)	a.	R is *reflexive* if for all $a \in M$, aRa.
	b.	R is *irreflexive* if for all $a \in M$, $\neg aRa$.
	c.	R is *symmetric* if for all $a, b \in M$, $aRb \Rightarrow bRa$.
	d.	R is *asymmetric* if for all $a, b \in M$, $aRb \Rightarrow \neg bRa$.
	e.	R is *antisymmetric* if for all $a, b \in M$, aRb & $bRa \Rightarrow a = b$.
	f.	R is *transitive* if for all $a, b, c \in M$, aRb & $bRc \Rightarrow aRc$.
	g.	R is *intransitive* if for all $a, b, c \in M$, aRb & $bRc \Rightarrow \neg aRc$.

Notes:

- The U symbol is the set-theoretic universe U; X′ means the complement of X (X′ = { x: x ∉ X}
- For a more detailed list of rules of inference, check the following link https://cse.iitk.ac.in/users/cs365/2012/rulesLogic.html

- For those who need to revise basic notions in semantics, check Albert Gatt's lecture notes here http://staff.um.edu.mt/albert.gatt/teaching/semantics.html

2. **On representing semantics notations:**

- Typographical conventions in semantics:

  - Either use '1 iff ' in e.g. '[[Floyd exploded.]] = 1 iff **exploded**(**Floyd**)' or write e.g. f(x) in place of f(x) = 1 and try to be consistant.
  - Constants should be in **boldface**, variables in *italics.*
  - The types of variables for functions should be indicated as subscripts next to the lambdas that introduce them.
  - Outside of examples, the object language should be in *italics,* emphasis is indicated by **boldface.**
  - The conventions about **variable names** are:
    - *P, Q* for **properties of individuals** *<e,t>*
    - *R* for **relations** *<e,et>*
    - *G* for **gradable degree predicates**, any type with both a *<d>* and an *<e>* in it: *<e,d>, <e,dt>, <d,et>*
    - *D* for **properties of degrees**, type *<d,t>*
    - *p, q* for **propositions**, type *<s,t>*
    - *f , g*,… for other functional types
    - *e, e',* … for **events**, type *<v>*
    - *d, d'*,… for **degrees**, type *<d>*
    - *w, w'*,… for **possible worlds**, type *<s>*

- LaTex typing tips:
  - General info: https://research.pomona.edu/mjkd/latex/
  - Essential macros for semantics:
    - Interpretation notation: |newcommand{|interp}[2][]{ |(|left|llbracket|,|text{#2}|,|right|rrbracket^{**#1**} |) }
    - lambda notation: |newcommand{|lam}[2][]{$|lambda {#2} _{#1}$.}

3. Miscellaneous stuff:

- Useful resources:
  - https://guides.nyu.edu/linguistics/semantics
  - https://semanticsarchive.net/
  - http://ling.auf.net/lingbuzz
  - http://journals.linguisticsociety.org/proceedings/index.php/SALT/

(The biggest conference on semantics)

- Guidelines on reading/writing a philosophy paper:
  - http://www.jimpryor.net/teaching/guidelines/reading.html
  - http://www.jimpryor.net/teaching/guidelines/writing.html