

### Ground Mereology Axioms

axiom	meaning	defn.
<b>M</b>	Ground Mereology	
Pxy	x is a part of y	
Reflexivity	x is a part of itself	Pxx
Antisymmetry	x and y can't be parts of each other, unless they are actually the same thing	$Pxy \wedge Pyx \rightarrow x=y$
Transitivity	if x is a part of y, and y is a part of z, then x is a part of z	$Pxy \wedge Pyz \rightarrow Pxz$

### Ground Mereology Definitions

sym.	meaning	defn.
PP	Proper Part	$PPxy := Pxy \wedge \neg Pyx$
O	Overlap	$Oxy := \exists z (Pzx \wedge Pzy)$
U	Underlap	$Uxy := \exists z (Pzx \wedge Pzy)$
OX	Over-Crossing	$OXxy := Oxy \wedge \neg Pxy$
UX	Under-Crossing	$UXxy := Uxy \wedge \neg Pyx$
PO	Proper Overlap	$POxy := OXxy \wedge OXyx$
PU	Proper Underlap	$PUxy := UXxy \wedge UXyx$

### Derived Statements

Overlapping is Reflexive	Oxx
Overlapping is Transitive	$Oxy \rightarrow Oyx$
Proper Parts are not Reflexive	$\neg PPxx$

### Extensional Mereology

<b>EM</b>	Extensional Mereology
Supplementation Axiom	$\neg Pxy \rightarrow \exists z (Pzx \wedge \neg Ozy)$
Weak Supplementation	<b>EM</b> $\vdash PPxy \rightarrow \exists z (PPzy \wedge \neg Ozx)$
If all the proper parts of X are proper parts of Y, X is part of Y	
If two objects have the exact same proper parts, they are the same object	

### Closed (Extensional) Mereology

<b>CEM</b>	Closed Extensional Mereology
ι	description operator ιx is "the unique x such that"
x+y	sum (or fusion) $Oxy \rightarrow \exists x \forall w (Pwz \leftrightarrow (Pwx \wedge Pwy))$ defined as: $\iota z \forall w (Owz \leftrightarrow (Owx \vee Owy))$
x×y	product $Uxy \rightarrow \exists z \forall w (Owz \leftrightarrow (Owx \vee Owy))$ defined as: $\iota z \forall w (Pwz \leftrightarrow (Pwx \wedge Pwy))$
x-y	difference $\exists z (Pzx \wedge \neg Ozy) \rightarrow \exists z \forall w (Pwz \leftrightarrow (Pwx \wedge \neg Owy))$ defined as: $\iota z \forall w (Pwz \leftrightarrow (Pwx \wedge \neg Owy))$
U	universe $\exists z \forall x (Pxz)$ defined as: $\iota z \forall x (Pxz)$
~x	compliment U-x

### General (Extensional) Mereology

<b>GEM</b>	General Extensional Mereology
Fusion Axiom	$\exists x \phi \rightarrow \exists z \forall y (Oyz \leftrightarrow \exists x (\phi \wedge Oyx))$

### Ground Topology Axioms

<b>T</b>	Ground Topology	
Cxy	x is connect to y	
Reflexivity	x is connected to itself	Cxx
Symmetry		$Cxy \rightarrow Cyx$
Transitivity		$Pxy \rightarrow \forall z (Czx \rightarrow Czy)$



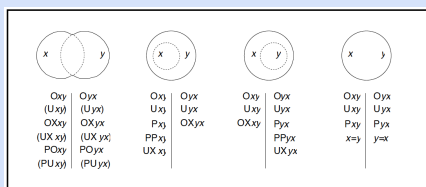
### Ground Topology Definitions

EC	External Connection
TP	Tangential Part
TPP	Tangential Proper Part
IP	Internal Part
IPP	Internal Proper Part
E	Enclosure
IE	Internal Enclosure
TE	Tangential Enclosure
S	Superposition
PS	Proper Superposition
I	Coincidence
A	Abutting

### Predicate Logic

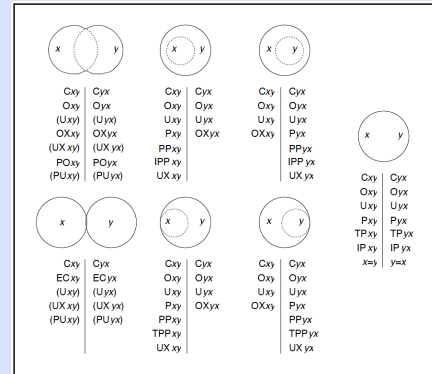
$\neg$	not
$\wedge$	and
$\vee$	or
$\forall$	for every
$\exists$	there exists
$\rightarrow$	implies
$:=$	definition
$\leftrightarrow$	iff
$\vdash$	provable
$\models$	entails
$\top$	tautology
$\perp$	contradiction

### Basic Patterns in Mereology



Credit: Varzi 1996, used without permission. The relations in parenthesis hold if there is a larger z including both x and y.

### Basic Patterns in Mereotopology



Credit: Varzi 1996, used without permission. Seven basic patterns of the connection relationship.

### Examples

Part	Your finger is part of your hand
Reflexivity	Your finger is part of your finger
Antisymmetry	Your finger is part of your hand, but your hand is not part of your finger
Transitivity	Your finger is part of your hand, and your hand is part of your body, so your finger is part of your body
Proper Part	A tail is a proper part of a cat
Overlapping	Two roads overlap at their intersection
Underlapping	Your finger and thumb are underlapping parts of your hand
Supplementation	Road A is not part of Road B, because there is at least some of Road A that doesn't overlap Road B
Weak Supplementation	Road A is not a proper part of Road B, because at least some of Road A is outside Road B

### Alternate Notations

symbol	meaning	from
$\ll$	is a proper part of	Simon 1987
$<$	is an improper part of	Simon 1987
$\circ$	overlaps	Simon 1987
$\#$	is disjoint from	Simon 1987
$Pxx$	is a part of	Smith

### Mereological Operations

$\cdot$	binary product	$x \cdot y$
$+$	binary sum	$x + y$
$-$	difference	$x - y$
$\sigma x \uparrow F x \uparrow$	fusion	
$\pi x \uparrow F x \uparrow$	nucleus	

### Smith (1996) Mereology Definitions

sym.	meaning	ex.	defn.
P	is a part of	$xPy$	
O	overlaps	$xOy$	$\exists z(zPx \wedge zPy)$
D	discrete	$xDy$	$\neg xOy$
Pt()	is a point	$Pt(x)$	$\forall y(yPx \rightarrow y=x)$



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