BFO 2020 Continuant Mereology Axioms

(1) If a has continuant part b then if a is an instance of site then b is an instance of site or continuant fiat boundary

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{site},t) \\ \rightarrow \mathrm{instanceOf}(q,\mathrm{site},t) \lor \mathrm{instanceOf}(q,\mathrm{continuantFiatBoundary},t))$$

(2) If at all times that two object aggreates exist each is part of the other, then they are identical

$$\forall a,b\,((\exists t\,(\mathrm{instanceOf}(a,\mathrm{objectAggregate},t) \land \mathrm{continuantPartOf}(a,b,t) \\ \land \mathrm{continuantPartOf}(b,a,t))) \\ \land (\forall t\,(\mathrm{continuantPartOf}(a,b,t) \leftrightarrow \mathrm{continuantPartOf}(b,a,t))) \\ \rightarrow a{=}b)$$

(3) If a has continuant part b then if a is an instance of one dimensional spatial region then b is an instance of one dimensional spatial region or zero dimensional spatial region

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{oneDimensionalSpatialRegion},t) \\ \rightarrow \mathrm{instanceOf}(q,\mathrm{oneDimensionalSpatialRegion},t) \\ \lor \mathrm{instanceOf}(q,\mathrm{zeroDimensionalSpatialRegion},t))$$

(4) If a material entity has a proper part, then at least one of its proper parts is not a material entity

$$\forall m,t\,(\mathrm{instanceOf}(m,\mathrm{materialEntity},t) \land (\exists mp\,(\mathrm{continuantPartOf}(mp,m,t) \land mp{\neq}m)) \\ \rightarrow \exists mp\,(mp{\neq}m \land \mathrm{continuantPartOf}(mp,m,t) \land \neg\mathrm{instanceOf}(mp,\mathrm{immaterialEntity},t)))$$

(5) Continuant part of and has continuant part are inverse relations

$$\forall t,a,b\,(\mathrm{continuantPartOf}(a,b,t) \leftrightarrow \mathrm{hasContinuantPart}(b,a,t))$$

(6) If a has continuant part b then if a is an instance of fiat point then b is an instance of fiat point

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{fiatPoint},t) \rightarrow \mathrm{instanceOf}(q,\mathrm{fiatPoint},t))$$

(7) Proper continuant part of is transitive at a time

$$\forall a,b,c,t,t2\,(\mathrm{properContinuantPartOf}(a,b,t) \land \mathrm{properContinuantPartOf}(b,c,t2) \\ \land \mathrm{temporalPartOf}(t,t2) \\ \rightarrow \mathrm{properContinuantPartOf}(a,c,t))$$

(8) X proper continuant part of y means x is a continuant part of y but y is not continuant part of x

$$\forall x,y,t\,(\mathrm{properContinuantPartOf}(x,y,t) \\ \leftrightarrow \mathrm{continuantPartOf}(x,y,t) \land \neg\mathrm{continuantPartOf}(y,x,t))$$

(9) Continuant part of is time indexed and has domain: continuant and range: continuant

$$\forall a,b,t\,(\mathrm{continuantPartOf}(a,b,t) \\ \rightarrow \mathrm{instanceOf}(a,\mathrm{continuant},t) \land \mathrm{instanceOf}(b,\mathrm{continuant},t) \\ \land \mathrm{instanceOf}(t,\mathrm{temporalRegion},t))$$

(10) Continuant part of is dissective on third argument, a temporal region

$$\forall p,q,r,s\,(\mathrm{continuantPartOf}(p,q,r) \land \mathrm{temporalPartOf}(s,r) \rightarrow \mathrm{continuantPartOf}(p,q,s))$$

(11) Continuant part of has a unique product at a time

$$\forall x,y,t\,(\mathrm{instanceOf}(x,\mathrm{continuant},t) \land \mathrm{instanceOf}(y,\mathrm{continuant},t) \\ \land \mathrm{instanceOf}(t,\mathrm{temporalRegion},t) \\ \rightarrow (\exists overlap\,(\mathrm{instanceOf}(overlap,\mathrm{continuant},t) \land \mathrm{continuantPartOf}(overlap,x,t) \\ \land \mathrm{continuantPartOf}(overlap,y,t)) \\ \rightarrow \exists overlap\,(\mathrm{instanceOf}(overlap,\mathrm{continuant},t) \\ \land (\forall w\,(\mathrm{instanceOf}(w,\mathrm{continuant},t) \\ \rightarrow (\mathrm{continuantPartOf}(w,overlap,t) \\ \leftrightarrow \mathrm{continuantPartOf}(w,x,t) \land \mathrm{continuantPartOf}(w,y,t)))))))$$

(12) If a has continuant part b then if a is an instance of material entity then b is an instance of site or continuant fiat boundary or material entity

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{materialEntity},t) \\ \rightarrow \mathrm{instanceOf}(q,\mathrm{site},t) \lor \mathrm{instanceOf}(q,\mathrm{continuantFiatBoundary},t) \\ \lor \mathrm{instanceOf}(q,\mathrm{materialEntity},t))$$

(13) Exists at is dissective on first argumentwhen it is a continuant

$\forall p,q,r\,(\mathrm{existsAt}(p,q) \land \mathrm{continuantPartOf}(r,p,q) \rightarrow \mathrm{existsAt}(r,q))$

(14) Continuant part of is transitive at a time

$$\forall a,b,c,t,t2\,(\mathrm{continuantPartOf}(a,b,t) \land \mathrm{continuantPartOf}(b,c,t2) \land \mathrm{temporalPartOf}(t,t2) \rightarrow \mathrm{continuantPartOf}(a,c,t))$$

(15) Proper continuant part of and has proper continuant part are inverse relations

$$\forall t,a,b\,(\mathrm{properContinuantPartOf}(a,b,t) \leftrightarrow \mathrm{hasProperContinuantPart}(b,a,t))$$

(16) Proper continuant part of is time indexed and has domain: continuant and range: continuant

$$\forall a,b,t\,(\mathrm{properContinuantPartOf}(a,b,t) \rightarrow \mathrm{instanceOf}(a,\mathrm{continuant},t) \land \mathrm{instanceOf}(b,\mathrm{continuant},t) \land \mathrm{instanceOf}(t,\mathrm{temporalRegion},t))$$

(17) If a has continuant part b then if a is an instance of zero dimensional spatial region then b is an instance of zero dimensional spatial region

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{zeroDimensionalSpatialRegion},t) \rightarrow \mathrm{instanceOf}(q,\mathrm{zeroDimensionalSpatialRegion},t))$$

(18) If at any time that two non object aggreates exist each is part of the other, then they are identical

$$\forall a,b\,(\exists t\,(\mathrm{instanceOf}(a,\mathrm{independentContinuant},t) \land \neg\mathrm{instanceOf}(a,\mathrm{objectAggregate},t) \land \mathrm{instanceOf}(b,\mathrm{independentContinuant},t) \land \neg\mathrm{instanceOf}(b,\mathrm{objectAggregate},t) \land \mathrm{continuantPartOf}(a,b,t) \land \mathrm{continuantPartOf}(b,a,t)) \rightarrow a=b)$$

(19) If a continuant part of b then if a is an instance of spatial region then b is an instance of spatial region, and vice versa

$$\forall p,q,t\,(\mathrm{continuantPartOf}(p,q,t) \rightarrow (\mathrm{instanceOf}(p,\mathrm{spatialRegion},t) \leftrightarrow \mathrm{instanceOf}(q,\mathrm{spatialRegion},t)))$$

(20) If a has continuant part b then if a is an instance of continuant fiat boundary then b is an instance of continuant fiat boundary

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{continuantFiatBoundary},t) \rightarrow \mathrm{instanceOf}(q,\mathrm{continuantFiatBoundary},t))$$

(21) If a continuant part of b then if a is an instance of material entity then b is an instance of material entity

$$\forall p,q,t\,(\mathrm{continuantPartOf}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{materialEntity},t) \rightarrow \mathrm{instanceOf}(q,\mathrm{materialEntity},t))$$

(22) If x,y are both part of a whole w, then if x is located in y it is part of y, if y is located in x it is part of w

$$\forall x,y,t\,(\exists w\,(\mathrm{continuantPartOf}(x,w,t) \land \mathrm{continuantPartOf}(y,w,t)) \rightarrow (\mathrm{locatedIn}(x,y,t) \rightarrow \mathrm{continuantPartOf}(x,y,t)) \land (\mathrm{locatedIn}(y,x,t) \rightarrow \mathrm{continuantPartOf}(y,x,t)))$$

(23) If a continuant part of b then if a is an instance of independent continuant then b is an instance of independent continuant, and vice versa

$$\forall p,q,t\,(\mathrm{continuantPartOf}(p,q,t) \rightarrow (\mathrm{instanceOf}(p,\mathrm{independentContinuant},t) \leftrightarrow \mathrm{instanceOf}(q,\mathrm{independentContinuant},t)))$$

(24) If a has continuant part b then if a is an instance of three dimensional spatial region then b is an instance of spatial region

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{threeDimensionalSpatialRegion},t) \rightarrow \mathrm{instanceOf}(q,\mathrm{spatialRegion},t))$$

(25) Proper continuant part of is dissective on third argument, a temporal region

$$\forall p,q,r,s\,(\mathrm{properContinuantPartOf}(p,q,r) \land \mathrm{temporalPartOf}(s,r) \rightarrow \mathrm{properContinuantPartOf}(p,q,s))$$

(26) If a has continuant part b then if a is an instance of fiat line then b is an instance of fiat line or fiat point

$$\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t) \land \mathrm{instanceOf}(p,\mathrm{fiatLine},t) \rightarrow \mathrm{instanceOf}(q,\mathrm{fiatLine},t) \lor \mathrm{instanceOf}(q,\mathrm{fiatPoint},t))$$

(27) Continuant part of has weak supplementation

$$
\begin{aligned}
&\forall t,x,y\,(\mathrm{instanceOf}(x,\mathrm{continuant},t)\wedge \mathrm{instanceOf}(y,\mathrm{continuant},t)\\
&\quad\wedge \mathrm{instanceOf}(t,\mathrm{temporalRegion},t)\\
&\quad\rightarrow (\mathrm{continuantPartOf}(x,y,t)\wedge x\neq y\\
&\qquad\rightarrow \exists z\,(\mathrm{instanceOf}(z,\mathrm{continuant},t)\wedge \mathrm{continuantPartOf}(z,y,t)\wedge z\neq y\\
&\qquad\quad\wedge \neg(\exists \mathrm{overlap}\,(\mathrm{instanceOf}(\mathrm{overlap},\mathrm{continuant},t)\\
&\qquad\qquad\wedge \mathrm{continuantPartOf}(\mathrm{overlap},x,t)\\
&\qquad\qquad\wedge \mathrm{continuantPartOf}(\mathrm{overlap},z,t))))))
\end{aligned}
$$

(28) If a has continuant part b then if a is an instance of fiat surface then b is an instance of continuant fiat boundary

$$
\begin{aligned}
&\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t)\wedge \mathrm{instanceOf}(p,\mathrm{fiatSurface},t)\\
&\quad\rightarrow \mathrm{instanceOf}(q,\mathrm{continuantFiatBoundary},t))
\end{aligned}
$$

(29) If a has continuant part b then if a is an instance of two dimensional spatial region then b is an instance of two dimensional spatial region or one dimensional spatial region or zero dimensional spatial region

$$
\begin{aligned}
&\forall p,q,t\,(\mathrm{hasContinuantPart}(p,q,t)\wedge \mathrm{instanceOf}(p,\mathrm{twoDimensionalSpatialRegion},t)\\
&\quad\rightarrow \mathrm{instanceOf}(q,\mathrm{twoDimensionalSpatialRegion},t)\\
&\quad\vee \mathrm{instanceOf}(q,\mathrm{oneDimensionalSpatialRegion},t)\\
&\quad\vee \mathrm{instanceOf}(q,\mathrm{zeroDimensionalSpatialRegion},t))
\end{aligned}
$$

(30) If a continuant part of b then if a is an instance of site then b is an instance of site or material entity

$$
\begin{aligned}
&\forall p,q,t\,(\mathrm{continuantPartOf}(p,q,t)\wedge \mathrm{instanceOf}(p,\mathrm{site},t)\\
&\quad\rightarrow \mathrm{instanceOf}(q,\mathrm{site},t)\vee \mathrm{instanceOf}(q,\mathrm{materialEntity},t))
\end{aligned}
$$

(31) Continuant part of is reflexive at a time

$$\forall a,t\,(\mathrm{instanceOf}(a,\mathrm{independentContinuant},t)\rightarrow \mathrm{continuantPartOf}(a,a,t))$$

Alan Ruttenberg, December 5, 2019