# BFO 2020 Occurrent Mereology Axioms

Occurrent part of and has occurrent part are inverse relations [yvi-1]

$\forall a,b\,(\text{occurrentPartOf}(a,b) \leftrightarrow \text{hasOccurrentPart}(b,a))$

Proper occurrent part of and has proper occurrent part are inverse relations [wim-1]

$\forall a,b\,(\text{properOccurrentPartOf}(a,b) \leftrightarrow \text{hasProperOccurrentPart}(b,a))$

Occurrent part of is reflexive [hbj-1]

$\forall a\,(\exists t\,\text{instanceOf}(a,\text{occurrent},t) \rightarrow \text{occurrentPartOf}(a,a))$

Occurrent part of is antisymmetric [xlu-1]

$\forall a,b\,(\text{occurrentPartOf}(a,b) \wedge \text{occurrentPartOf}(b,a) \rightarrow a=b)$

A proper occurrent part of b means a is an occurrent part of b and a is not the same as b [okr-1]

$\forall x,y\,(\text{properOccurrentPartOf}(x,y) \leftrightarrow \text{occurrentPartOf}(x,y) \wedge x \neq y)$

Occurrent part of is transitive [kad-1]

$\forall a,b,c\,(\text{occurrentPartOf}(a,b) \wedge \text{occurrentPartOf}(b,c) \rightarrow \text{occurrentPartOf}(a,c))$

If one occurrent is part of another, then the temporal region on which the former projects is a part of the temporal region on which the latter projects [ybr-1]

$\forall o1,o2\,(\text{occurrentPartOf}(o1,o2) \rightarrow \forall t\,(\text{existsAt}(o1,t) \rightarrow \text{existsAt}(o2,t)))$

Occurrent part of has domain occurrent and range occurrent [zmr-1]

$\forall a,b\,(\text{occurrentPartOf}(a,b) \rightarrow \exists t\,\text{instanceOf}(a,\text{occurrent},t) \wedge \exists t\,\text{instanceOf}(b,\text{occurrent},t))$

If a occurrent part of b then if a is an instance of process then b is an instance of process [csk-1]

$\forall p,q\,(\text{occurrentPartOf}(p,q) \rightarrow (\exists t\,\text{instanceOf}(p,\text{process},t) \rightarrow \exists t\,\text{instanceOf}(q,\text{process},t)))$

Proper temporal part of has domain occurrent and range occurrent [ees-1]

$\forall a,b\,(\text{properTemporalPartOf}(a,b) \rightarrow \exists t\,\text{instanceOf}(a,\text{occurrent},t) \wedge \exists t\,\text{instanceOf}(b,\text{occurrent},t))$

Proper occurrent part of has domain occurrent and range occurrent [yhc-1]

$\forall a,b\,(\text{properOccurrentPartOf}(a,b) \rightarrow \exists t\,\text{instanceOf}(a,\text{occurrent},t) \wedge \exists t\,\text{instanceOf}(b,\text{occurrent},t))$

Every process has a process boundary [aff-1]

$\forall p\,(\exists t\,\text{instanceOf}(p,\text{process},t) \rightarrow \exists pb,t\,(\text{instanceOf}(pb,\text{processBoundary},t) \wedge \text{occurrentPartOf}(pb,p)))$

If a occurrent part of b then if a is an instance of temporal region then b is an instance of temporal region, and vice versa [gjl-1]

$\forall p,q\,(\text{occurrentPartOf}(p,q) \rightarrow (\exists t\,\text{instanceOf}(p,\text{temporalRegion},t) \leftrightarrow \exists t\,\text{instanceOf}(q,\text{temporalRegion},t)))$

If a has occurrent part b then if a is an instance of process boundary then b is an instance of process boundary [hdk-1]

$\forall p,q\,(\text{hasOccurrentPart}(p,q) \rightarrow (\exists t\,\text{instanceOf}(p,\text{processBoundary},t) \rightarrow \exists t\,\text{instanceOf}(q,\text{processBoundary},t)))$

If a occurrent part of b then if a is an instance of spatiotemporal region then b is an instance of spatiotemporal region, and vice versa [myl-1]

$\forall p,q\,(\text{occurrentPartOf}(p,q) \rightarrow (\exists t\,\text{instanceOf}(p,\text{spatiotemporalRegion},t) \leftrightarrow \exists t\,\text{instanceOf}(q,\text{spatiotemporalRegion},t)))$

Definition of temporal part for temporal regions [cmy-1]

$\forall b,c\,(\exists t\,\text{instanceOf}(b,\text{temporalRegion},t) \wedge \exists t\,\text{instanceOf}(c,\text{temporalRegion},t) \rightarrow (\text{temporalPartOf}(b,c) \leftrightarrow \text{occurrentPartOf}(b,c)))$

If a has occurrent part b then if a is an instance of process then b is an instance of process or process boundary [ccz-1]

$$\forall p,q\,(\text{hasOccurrentPart}(p,q) \rightarrow (\exists t\,\text{instanceOf}(p,\text{process},t) \rightarrow \exists t\,(\text{instanceOf}(q,\text{process},t) \vee \text{instanceOf}(q,\text{processBoundary},t))))$$

If a occurrent part of b then if a is an instance of process boundary then b is an instance of process or process boundary [ptm-1]

$$\forall p,q\,(\text{occurrentPartOf}(p,q) \rightarrow (\exists t\,\text{instanceOf}(p,\text{processBoundary},t) \rightarrow \exists t\,(\text{instanceOf}(q,\text{process},t) \vee \text{instanceOf}(q,\text{processBoundary},t))))$$

A process boundary is any temporal part of a process that has no proper temporal parts. [esh-1]

$$\forall pb\,(\exists t\,\text{instanceOf}(pb,\text{processBoundary},t) \leftrightarrow (\exists p\,(\text{temporalPartOf}(pb,p) \wedge \exists t\,\text{instanceOf}(p,\text{process},t))) \wedge (\exists t\,(\text{occupiesTemporalRegion}(pb,t) \wedge \text{instanceOf}(t,\text{temporalInstant},t))))$$

Occurrent part of has a unique product [hpc-1]

$$\forall x,y\,(\exists t\,(\text{instanceOf}(x,\text{occurrent},t) \wedge \text{instanceOf}(y,\text{occurrent},t) \wedge \text{instanceOf}(t,\text{temporalRegion},t)) \rightarrow (\exists w\,(\text{occurrentPartOf}(w,x) \wedge \text{occurrentPartOf}(w,y)) \rightarrow \exists z\,(\forall w\,(\text{occurrentPartOf}(w,z) \leftrightarrow \text{occurrentPartOf}(w,x) \wedge \text{occurrentPartOf}(w,y)))))$$

At least one process boundary needs to be at the first or last instant of the process it bounds [qsp-1]

$$\forall p\,(\exists tp\,\text{instanceOf}(p,\text{process},tp) \rightarrow \exists pb,tb,tp\,(\text{occupiesTemporalRegion}(p,tp) \wedge \text{occurrentPartOf}(pb,p) \wedge \text{occupiesTemporalRegion}(pb,tb) \wedge \text{instanceOf}(pb,\text{processBoundary},tb) \wedge (\exists ltp,ftp\,(\text{hasFirstInstant}(tp,ftp) \wedge \text{hasLastInstant}(tp,ltp) \wedge (tb=ftp \vee tb=ltp)))))$$

B is a temporal part of process or process boundary c if b is occurrent part of c and b's spatiotemporal region is temporal part of c's spatiotemporal region [xyn-1]

$$\forall b,c\,((\exists t\,(\text{instanceOf}(b,\text{process},t) \vee \text{instanceOf}(b,\text{processBoundary},t))) \wedge (\exists t\,(\text{instanceOf}(c,\text{process},t) \vee \text{instanceOf}(c,\text{processBoundary},t))) \rightarrow (\text{temporalPartOf}(b,c) \leftrightarrow \exists bs,cs\,(\text{occurrentPartOf}(b,c) \wedge \text{occupiesSpatiotemporalRegion}(b,bs) \wedge \text{occupiesSpatiotemporalRegion}(c,cs) \wedge \text{temporalPartOf}(bs,cs))))$$

B temporal part c (both spatiotemporal regions) iff b temporal projection is part of c's temporal projection, and for all parts of b's existence, if it spatially projects onto s at that time, then so does c [eom-1]

$$\forall b,c\,(\exists t\,\text{instanceOf}(b,\text{spatiotemporalRegion},t) \wedge \exists t\,\text{instanceOf}(c,\text{spatiotemporalRegion},t) \rightarrow (\text{temporalPartOf}(b,c) \leftrightarrow \exists tb,tc\,(\text{temporallyProjectsOnto}(b,tb) \wedge \text{temporallyProjectsOnto}(c,tc) \wedge \text{occurrentPartOf}(tb,tc) \wedge (\forall tp\,(\text{occurrentPartOf}(tp,tb) \wedge \exists s\,\text{spatiallyProjectsOnto}(b,s,tp) \rightarrow \exists s\,(\text{spatiallyProjectsOnto}(b,s,tp) \wedge \text{spatiallyProjectsOnto}(c,s,tp)))))))$$

Two spatiotemporal regions are parts when they are temporal parts and their spatial projects are always parts [txf-1]

$$\forall st1,st2\,(\exists t\,\text{instanceOf}(st1,\text{spatiotemporalRegion},t) \wedge \exists t\,\text{instanceOf}(st2,\text{spatiotemporalRegion},t) \rightarrow (\text{occurrentPartOf}(st1,st2) \leftrightarrow (\exists t1,t2\,(\text{temporallyProjectsOnto}(st1,t1) \wedge \text{temporallyProjectsOnto}(st2,t2) \wedge \text{temporalPartOf}(t1,t2))) \wedge (\forall t\,(\text{existsAt}(st1,t) \rightarrow \exists s1,s2,tp\,(\text{temporalPartOf}(tp,t) \wedge \text{spatiallyProjectsOnto}(st1,s1,tp) \wedge \text{spatiallyProjectsOnto}(st2,s2,tp) \wedge \text{continuantPartOf}(s1,s2,tp))))))$$

Alan Ruttenberg, November 12, 2021. The most recent version of this file will always be in the GitHub repository https://github.com/bfo-ontology/bfo-2020