BFO 2020 Material Entity Axioms

(1) I is an immaterial entity = Def. i is an independent continuant that has no material entities as parts.

$$\forall i,t\,(\text{instanceOf}(i,\text{immaterialEntity},t) \leftrightarrow \text{instanceOf}(i,\text{independentContinuant},t) \wedge \neg(\exists m\,(\text{instanceOf}(m,\text{materialEntity},t) \wedge \text{continuantPartOf}(m,i,t))))$$

(2) Member part of is dissective on third argument, a temporal region

$$\forall p,q,r,s\,(\text{memberPartOf}(p,q,r) \wedge \text{temporalPartOf}(s,r) \rightarrow \text{memberPartOf}(p,q,s))$$

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

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

(4) Any continuant that doesn't s depend or g depend on something is an independant continuant

$$\forall c1\,(\exists t\,\text{instanceOf}(c1,\text{independentContinuant},t) \leftrightarrow \exists t\,\text{instanceOf}(c1,\text{continuant},t) \wedge \neg(\exists c2,t\,(\text{specificallyDependsOn}(c1,c2) \vee \text{generallyDependsOn}(c1,c2,t))))$$

(5) A fiat object part =def a proper part of an object

$$\forall f,t\,(\text{instanceOf}(f,\text{fiatObjectPart},t) \leftrightarrow \exists o\,(\text{instanceOf}(o,\text{object},t) \wedge \text{properContinuantPartOf}(f,o,t) \wedge \neg\text{instanceOf}(f,\text{immaterialEntity},t)))$$

(6) An object aggregate has more than one member at at least one time

$$\forall ag\,(\exists t\,\text{instanceOf}(ag,\text{objectAggregate},t) \rightarrow \exists o1,o2,t\,(o1 \neq o2 \wedge \text{instanceOf}(o1,\text{object},t) \wedge \text{memberPartOf}(o1,ag,t) \wedge \text{instanceOf}(o2,\text{object},t) \wedge \text{memberPartOf}(o2,ag,t)))$$

(7) Member part of is time indexed and has domain: object and range: object aggregate

$$\forall a,b,t\,(\text{memberPartOf}(a,b,t) \rightarrow \text{instanceOf}(a,\text{object},t) \wedge \text{instanceOf}(b,\text{objectAggregate},t) \wedge \text{instanceOf}(t,\text{temporalRegion},t))$$

(8) Member part of and has member part are inverse relations

$$\forall t,a,b\,(\text{memberPartOf}(a,b,t) \leftrightarrow \text{hasMemberPart}(b,a,t))$$

(9) An object aggregate always has at least one member

$$\forall ag,t\,(\text{instanceOf}(ag,\text{objectAggregate},t) \rightarrow \exists o1\,(\text{instanceOf}(o1,\text{object},t) \wedge \text{memberPartOf}(o1,ag,t)))$$

(10) An object aggregate has member parts only disjoint objects

$$\forall b,c,t\,(\text{memberPartOf}(b,c,t) \leftrightarrow \text{instanceOf}(b,\text{object},t) \wedge \text{instanceOf}(c,\text{objectAggregate},t) \wedge \text{properContinuantPartOf}(b,c,t) \wedge (\forall d\,(\text{memberPartOf}(d,c,t) \rightarrow b=d \vee \neg(\exists z\,(\text{continuantPartOf}(z,b,t) \wedge \text{continuantPartOf}(z,d,t))))))$$

(11) All parts of an aggregate overlap some member

$$\forall t,b,x\,(\text{properContinuantPartOf}(x,b,t) \wedge \text{instanceOf}(b,\text{objectAggregate},t) \rightarrow \exists o\,(\text{memberPartOf}(o,b,t) \wedge (\exists z\,(\text{continuantPartOf}(z,x,t) \wedge \text{continuantPartOf}(z,o,t)))))$$

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