BFO 2020 Order Axioms

(1) Precedes is antisymmetric

$$\forall a,b\,(\text{precedes}(a,b) \rightarrow \neg\text{precedes}(b,a))$$

(2) A first instant is either part of an extended region or precedes it

$$\forall l,i\,(\text{instanceOf}(l,\text{temporalInstant},l) \wedge \text{instanceOf}(i,\text{temporalRegion},i) \wedge \neg\text{instanceOf}(i,\text{temporalInstant},i) \wedge \text{hasLastInstant}(i,l) \rightarrow (\neg\text{temporalPartOf}(l,i) \leftrightarrow \text{precedes}(i,l)))$$

(3) Precedes is transitive

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

(4) If two temporal intervals do not overlap then one of them precedes the other

$$\forall t1,t2\,(\text{instanceOf}(t1,\text{temporalInterval},t1) \wedge \text{instanceOf}(t2,\text{temporalInterval},t2) \wedge \neg(\exists\,\text{part}\,(\text{temporalPartOf}(\text{part},t1) \wedge \text{temporalPartOf}(\text{part},t2))) \rightarrow \text{precedes}(t1,t2) \vee \text{precedes}(t2,t1))$$

(5) Temporal instants are totally ordered

$$\forall t1,t2\,(\text{instanceOf}(t1,\text{temporalInstant},t1) \wedge \text{instanceOf}(t2,\text{temporalInstant},t2) \rightarrow \text{precedes}(t1,t2) \vee \text{precedes}(t2,t1) \vee t1{=}t2)$$

(6) If one occurrent precedes another then they do not overlap temporally

$$\forall p,q\,(\text{precedes}(p,q) \vee \text{precedes}(q,p) \rightarrow \neg(\exists\,\text{overlap}\,(\text{temporalPartOf}(\text{overlap},p) \wedge \text{temporalPartOf}(\text{overlap},q))))$$

(7) If the last instant of a temporal region precedes the first instant of another, then the first region precedes the second

$$\forall i1,i2,l1,f2\,(\text{hasLastInstant}(i1,l1) \wedge \text{hasFirstInstant}(i2,f2) \wedge \text{precedes}(l1,f2) \rightarrow \text{precedes}(i1,i2))$$

(8) Precedes and preceded by are inverse relations

$$\forall a,b\,(\text{precedes}(a,b) \leftrightarrow \text{precededBy}(b,a))$$

(9) If two processes that occupy temporal intervals do not overlap, one of them precedes the other

$$\forall o1,o2,t1,t2\,(\text{occupiesTemporalRegion}(o1,t1) \wedge \text{occupiesTemporalRegion}(o2,t2) \wedge \text{instanceOf}(t1,\text{temporalInterval},t1) \wedge \text{instanceOf}(t2,\text{temporalInterval},t2) \wedge \neg(\exists\,\text{part}\,(\text{temporalPartOf}(\text{part},t1) \wedge \text{temporalPartOf}(\text{part},t2))) \rightarrow \text{precedes}(o1,o2) \vee \text{precedes}(o2,o1))$$

(10) If you are part of something that precedes something else, you also precede it

$$\forall o1,o2,o1p,o2p\,(\text{occurrentPartOf}(o1p,o1) \wedge \text{occurrentPartOf}(o2p,o2) \wedge \text{precedes}(o1,o2) \rightarrow \text{precedes}(o1p,o2p))$$

(11) If one temporal region precedes another then the first last time point precedes the second first time point

$$\forall t1,t2,l1,f2\,(\text{precedes}(t1,t2) \wedge \text{hasLastInstant}(t1,l1) \wedge \text{hasFirstInstant}(t2,f2) \wedge l1 \neq f2 \rightarrow \text{precedes}(l1,f2))$$

(12) If you temporally occupy part of something that precedes something else, you also precede it

$$\forall o1,o2\,(\exists\,t1,t2\,((\text{occupiesTemporalRegion}(o1,t1) \vee \text{temporallyProjectsOnto}(o1,t1) \vee t1{=}o1) \wedge (\text{occupiesTemporalRegion}(o2,t2) \vee \text{temporallyProjectsOnto}(o2,t2) \vee t2{=}o2) \wedge \text{precedes}(t1,t2)) \leftrightarrow \text{precedes}(o1,o2))$$

(13) First instant of a temporal region that is not an instant precedes last instant

$$\forall t,ft,lt\,(\neg\text{instanceOf}(t,\text{temporalInstant},t) \wedge \text{hasFirstInstant}(t,ft) \wedge \text{hasLastInstant}(t,lt) \rightarrow \text{precedes}(ft,lt))$$

(14) Precedes has domain occurrent and range occurrent

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

(15) If the last instant of a temporal region precedes the first instant of another, the first region precedes the second

$\forall$i1,i2,l1,f2 ($\neg$instanceOf(i1,temporalInstant,i1) $\wedge$ $\neg$instanceOf(i2,temporalInstant,i2)
$\wedge$ hasLastInstant(i1,l1) $\wedge$ hasFirstInstant(i2,f2) $\wedge$ l1=f2
$\rightarrow$ precedes(i1,i2))

(16) A first instant is either part of an extended region or precedes it

$\forall$f,i (instanceOf(f,temporalInstant,f) $\wedge$ instanceOf(i,temporalRegion,i)
$\wedge$ $\neg$instanceOf(i,temporalInstant,i) $\wedge$ hasFirstInstant(i,f)
$\rightarrow$ ($\neg$temporalPartOf(f,i) $\leftrightarrow$ precedes(f,i)))

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