

Reasoning with Inconsistent Knowledge



This material with
Zhisheng Huang &
Annette ten Teije



Knowledge will be inconsistent

Because of:

- mistreatment of defaults
- polysemy
- migration from another formalism
- integration of multiple sources

("Semantic Web as a wake-up call for KR")

New formal notions are needed

■ New notions:

- **Accepted:** $T \approx \phi$ and $T \not\approx \neg\phi$
- **Rejected:** $T \not\approx \phi$ and $T \approx \neg\phi$
- **Overdetermined:** $T \approx \phi$ and $T \approx \neg\phi$
- **Undetermined:** $T \not\approx \phi$ and $T \not\approx \neg\phi$

■ **Soundness:** (only classically justified results)

$$T \approx \phi \Rightarrow (\exists T' \subseteq T)(T' \not\approx \perp \text{ and } T' \models \phi)$$

■ **Meaningful:** (sound & never overdetermined)

$$\text{soundness} + T \approx \phi \Rightarrow T \not\approx \neg\phi$$

General framework

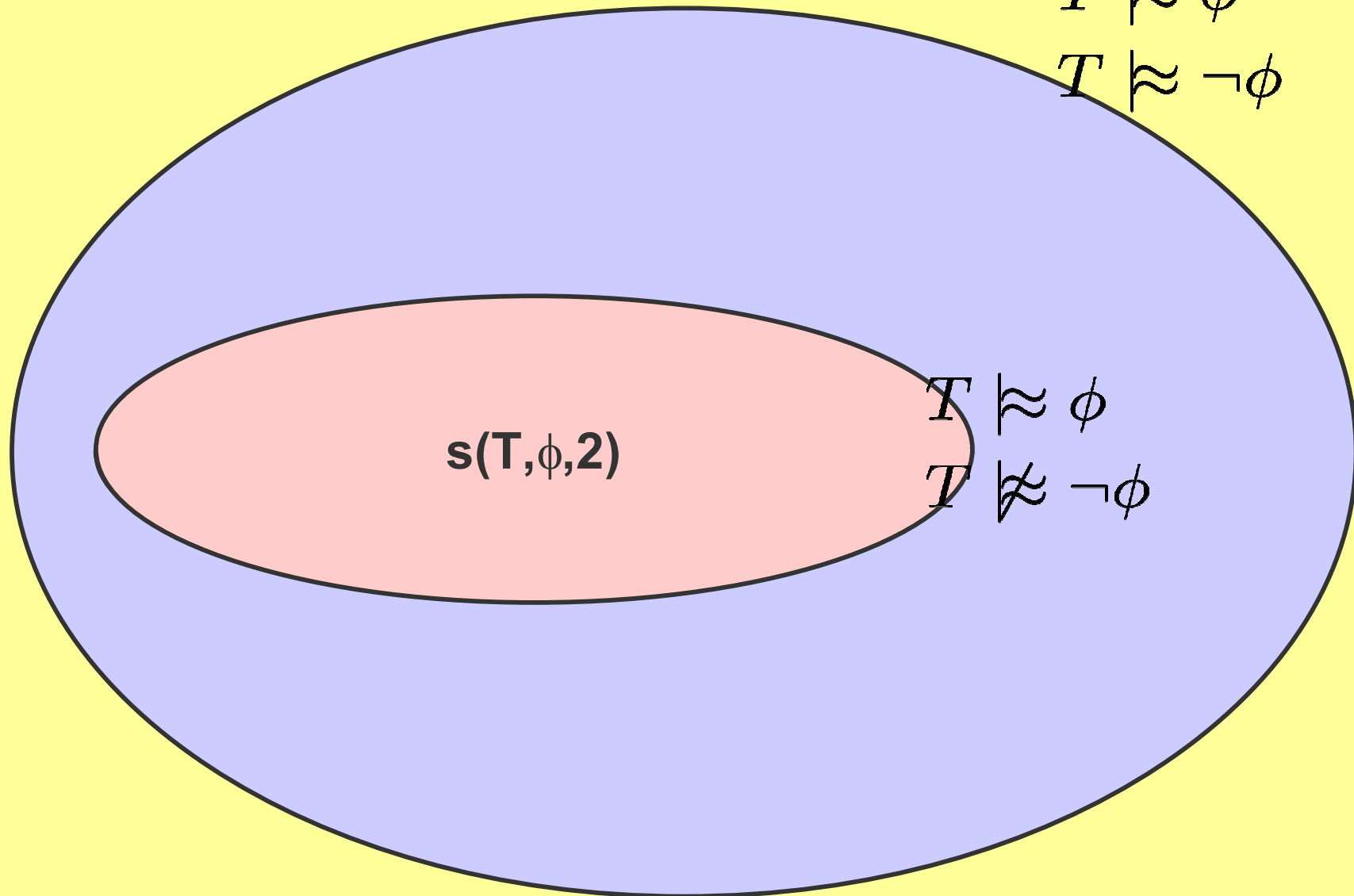
Use selection function $s(T, \phi, k)$,
with $s(T, \phi, k) \subseteq s(T, \phi, k+1)$

1. Start with $k=0$:
 $s(T, \phi, 0) \mid \approx \phi$ or $s(T, \phi, 0) \mid \approx \neg\phi$?
2. Increase k , until
 $s(T, \phi, k) \mid \approx \phi$ or $s(T, \phi, k) \mid \approx \neg\phi$
3. Abort when
 - undetermined at maximal k
 - overdetermined at some k

General Framework

$$T \models \phi$$

$$T \models \neg\phi$$



$s(T, \phi, 2)$

$$T \models \phi$$

$$T \not\models \neg\phi$$

Nice general framework, but...

- which selection function $s(T, \phi, k)$ to use?
- Simple option: **syntactic distance**
 - put all formulae in clausal form:
 $a_1 \wp a_2 \wp \dots \wp a_n$
 - **distance $k=1$** if some clausal letters overlap
 $a_1 \wp X \wp \dots \wp a_n, \quad b_1 \wp \dots \wp X \wp b_n$
 - **distance k** if chain of k overlapping clauses are needed

$a_1 \wp X \wp \dots \wp X_1 \wp a_n$
 $b_1 \wp X_1 \wp \dots \wp X_2 \wp b_n$
 \dots
 $c_1 \wp X_k \wp \dots \wp X \wp c_n$

Works surprisingly well

Allmost all answers are “intuitive”

- Not well understood why
- Hypothesis:
 - due to local structure of knowledge
- Currently experimenting with more informed selection function $s(T, \phi, k)$

Other approaches:

- Debugging a knowledge base
("don't live with it, but find the cause")
 - finding the "cause" of the inconsistency
 - = find the smallest set of axioms that, when removed, fix the inconsistency
- Applying belief revision
("don't' just find the cause, but repair it")