

Basics of Knowledge Representation

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Knowledge Representation

- Semantic web standards, in particular ontologies, rely heavily on knowledge representation
- **Knowledge representation** (KR) is the process of
 - ① identifying the implicit knowledge, semantics or structure in raw data (from a given domain)
 - ② encoding it symbolically or formally into a (formal) KR language
 - ③ reasoning over this encoded knowledge, to automatically derive new knowledge by inference
- KR is what allows semantic-web powered software to unambiguously understand knowledge shared or processed by those systems
- KR languages have a precise syntax and interpretation

Identify Knowledge

William Shakespeare was an English poet and playwright. Shakespeare was born and brought up in Stratford-upon-Avon. At the age of 18, he married Anne Hathaway, with whom he had three children: Susanna, and twins Hamnet and Judith. ... [Wikipedia]

Identify Knowledge

William Shakespeare was an English **poet** and playwright. **Shakespeare** was **born** and brought up in **Stratford-upon-Avon**. At the age of 18, **he married Anne Hathaway**, with whom he had three children: Susanna, and twins Hamnet and Judith. ... [Wikipedia]

1 Identify

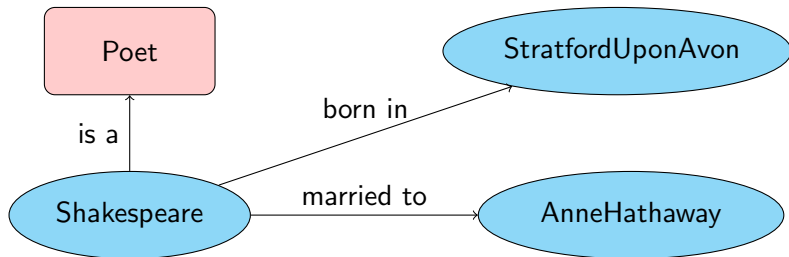
- **entities**: William Shakespeare, ...
- **concepts**: poet, ...
- **relations**: was, ...

2 Identify

- **states of affairs** in which they participate: William Shakespeare is (or was) a poet
- **constraints** (perhaps from other sources, e.g., no poets are chimpanzees)

Identify Knowledge

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Encode it in a KR Language (1)

- Two main components:
 - ① **vocabulary** (= specify names for):
 - **entities** e : *Shakespeare, AnneHathaway, ...*
 - **concepts** c : *Poet, ...*
 - **relations** r : *married to, ...*
 - ② **statements**:
 - **facts** (states of affairs, entity typing) $(e_1, r, e_2), (e, r, c)$:
(Shakespeare, married to, AnneHathaway), (Shakespeare, is a, Poet), ...
 - **constraints** (concept-to-concept relations) (c_1, r, c_2) :
(Poet, is a, Person), ...
- Many KR languages exist (e.g., frame logic), but one key feature is that they can be depicted and manipulated as **graphs**
- The resulting representation is known as a **conceptual model** or **ontology**

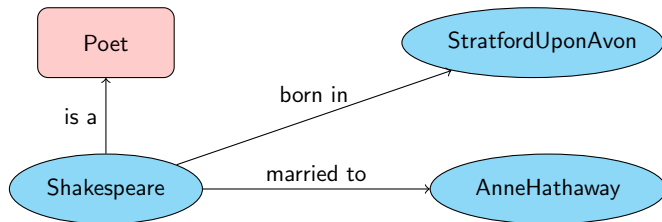
Encode it in a KR Language (2)

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[Wikipedia]

raw data

▷ text



implicit semantics, knowledge

▷ **ontology**

Reason over Knowledge

Once knowledge from raw data has been made explicit, and explicitly represented in a KR language

- further information can be gathered via **inference**:
e.g., if (e_1, r, e_2) and (e_2, r, e_3) , we can conclude, if r is transitive, that (e_1, r, e_3) also holds

if we represent or extract the facts that John is an ancestor of Joe, and Joe is an ancestor of Jane, we can derive –via relational inference– that John is an ancestor of Jane

- information can be queried with formal queries, to extract an exact answer