① Theory
② Standards
③ Deployed technology }

$$PLUS(x, y, s)$$

PLUS

0 0 0
...
2 3 5
...
...

Components

Universe: Set of values D with equality $(=)$

Relation: Predicate name R, and arity k of R, (# of columns)

instance: $R \subseteq D^k$

Database: signature: finite set ρ of predicate names

instance: a relation R_i for each R_i

Notation:

Signature: $\rho = (R_1, ..., R_n)$ Instance: DB
$$= (D, =, R_1, ..., R_n)$$

e.g
- $\rho = ($ PLUS, TIMES $)$ DB $= (\mathbb{Z}, =, $ PLUS, TIMES $)$
  integers w/ + and *
- biblio db

$\sim$ ...

relationships between tuples are true $\iff$ present in an instance

$$\varphi ::= R_i(x_{i_1}, ..., x_{i_k}) | x_i = x_j | \varphi \wedge \varphi | \exists x_i . \varphi$$
$$| \varphi \vee \varphi | \neg \varphi$$

Conjunctive queries are the most efficient

$$\theta[x \mapsto v]$$

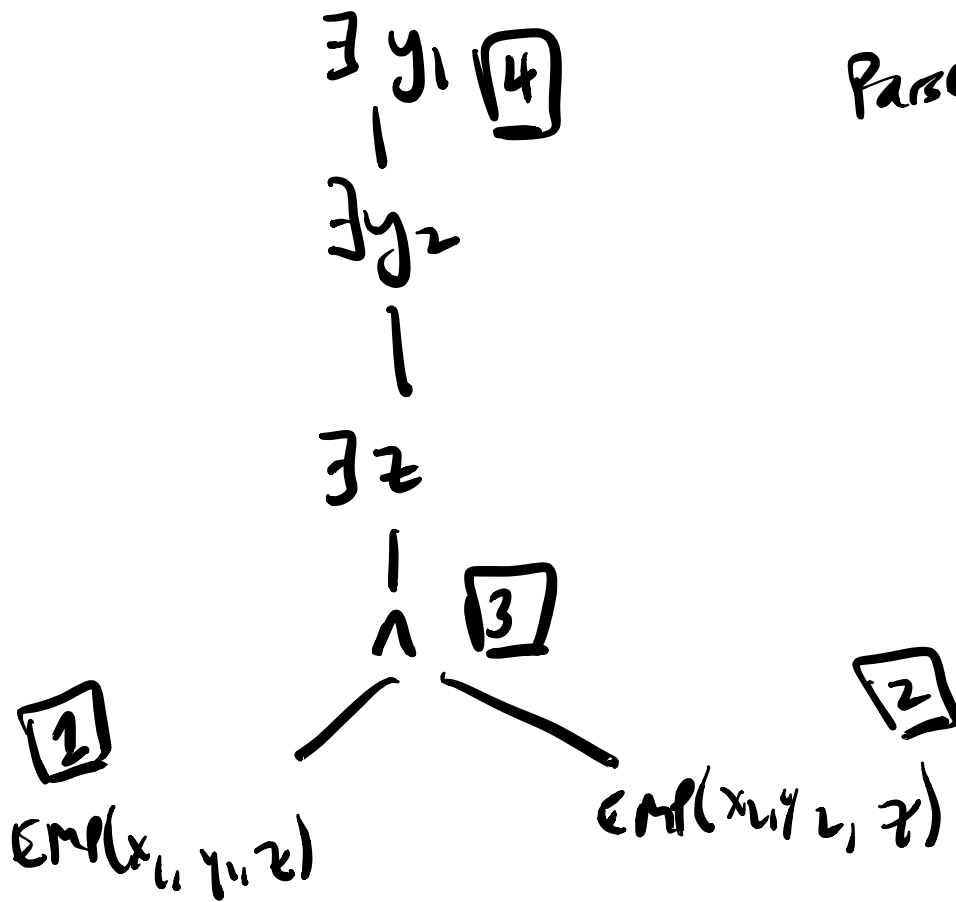$$DB, \theta \models R(x_{i_1}, ..., x_{i_k}) \text{ if } R \in \rho,$$
$$(\theta(x_{i_1}), ..., \theta(x_{i_k})) \in R$$

$$\{(x_1, ..., x_k) | \varphi\} \text{ over } DB$$

$$\{(\theta(x_1), ..., \theta(x_k)) | DB, \theta \models \varphi\}$$

No FV $\rightarrow$ boolean query / sentence

$\exists y_1$ $\boxed{4}$ Parse tree

$\exists y_2$

$\exists z$

$\land$ $\boxed{3}$

$\boxed{1}$

$EMP(x_1, y_1, z)$ $EMP(x_1, y_2, z)$ $\boxed{2}$

List titles of all publications

$$\{ (t) \mid \exists p \cdot PUBLICATION(p, t) \}$$

$\{(an1, an2) \mid \exists a1, a_2 \cdot$ $AUTHOR(a1, an1) \land$

$AUTHOR(a7, an2) \land$

$PUBLICATION(an1, P) \land$

$an2 \land$

$\neg an1 = an2\}$