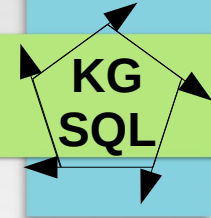


# KGS SQL Semantics

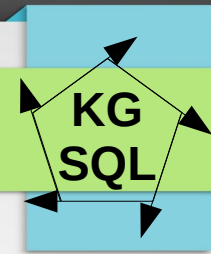
Ken Baclawski

# Outline



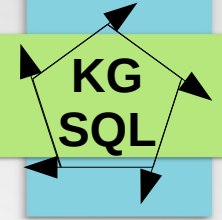
- Ask Queries
- Goguen-Burstall Institutions
- Denotational Semantics

# Ask Queries



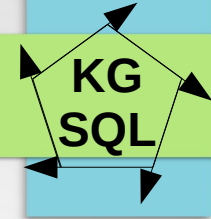
- Same as SELECT except that it only returns whether there were any results
  - Corresponds to the “exists” SQL construct as in  
`EXISTS (SELECT * ...)`
  - Can be used as a subquery in a filter
- Full first-order logic is now supported
  - Both existential and universal quantifiers can be expressed

# Institutions



- Introduced by Goguen and Burstall
- The basis for DOL
- Useful for mapping between logical formalisms

# Institutions



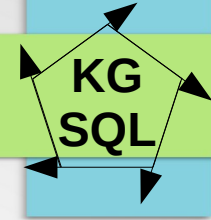
An *institution*  $\mathcal{I}$  consists of the following:

1. A category **Sign** whose objects are called *signatures*.
2. A functor  $Sen: \mathbf{Sign} \rightarrow \mathbf{Set}$ . For a signature  $\Sigma$ , the elements of  $Sen(\Sigma)$  are called the  $\Sigma$ -sentences.
3. A functor  $\mathbf{Mod}: \mathbf{Sign} \rightarrow \mathbf{Cat}^{op}$ . For a signature  $\Sigma$ , the elements of  $\mathbf{Mod}(\Sigma).ob$  are called the  $\Sigma$ -models, and the elements of  $\mathbf{Mod}(\Sigma).hom$  are called the  $\Sigma$ -morphisms.
4. A relation  $\models_{\Sigma} \subseteq \mathbf{Mod}(\Sigma).ob \times Sen(\Sigma)$ , for each  $\Sigma \in \mathbf{Sign}.ob$ , called  $\Sigma$ -satisfaction.

such that for every morphism  $\varphi: \Sigma \rightarrow \Sigma'$  in **Sign**, for every  $\Sigma$ -sentence  $e$ , and for every  $\Sigma'$ -model  $m'$ , the following holds:

$$m' \models_{\Sigma'} Sen(\varphi)(e) \text{ iff } \mathbf{Mod}(\varphi)(m') \models_{\Sigma} e.$$

# Denotational Semantics



- Defines functions by composing the component functions
- For KGSQL the primitive components are pattern instances
- Here is an example:

$$\llbracket ?a \llbracket ?e \text{ :name} \rrbracket \text{"Fred"} \rrbracket =$$
$$\{ (?a, ?e) \mid \text{The sentence } ?a \llbracket ?e \text{ :name} \rrbracket \text{"Fred"} \text{ is in the KG} \}$$

- Useful for implementing KGSQL.