Database Systems: Exam 2 Key

30 October, 2013

Name: _____key_____

1. Consider the relation $R = \{A, B, C, D, E, F, G, H, I, J\}$ and the set of functional dependencies $F = \{\{A, B\} \rightarrow \{C\}, \{B, D\} \rightarrow \{E, F\}, \{A, D\} \rightarrow \{G, H\}, \{A\} \rightarrow \{I\}, \{H\} \rightarrow \{J\}\}$.

   (a) **(5 points)** What are the keys of R?

   Attributes appearing on the left of FDs are $\{A, B, D, H\}$. From these all but $\{H\}$ seem plausibly part of keys. Calculating the closures of likely candidates gives:

   $$\begin{aligned} \{A, B\}^+ &= \{A, B, C, I\} \\ \{B, D\}^+ &= \{B, D, E, F\} \\ \{A, D\}^+ &= \{A, D, G, H, I, J\} \\ \{A, B, D\}^+ &= \{A, B, C, D, E, F, G, H, I, J\} \end{aligned}$$

   So $\{A, B, D\}$ is the only candidate key.

   (b) **(5 points)** Decompose R into 2NF.

   Decomposing attributes based on relations partially dependent on the key gives:

   $$\begin{aligned} R_1 &= \{\underline{A}, \underline{B}, C\} \\ R_2 &= \{\underline{B}, \underline{D}, E, F\} \\ R_3 &= \{\underline{A}, \underline{D}, G, H, J\} \\ R_4 &= \{\underline{A}, I\} \\ R_5 &= \{\underline{A}, \underline{B}, \underline{D}\} \end{aligned}$$

   Relation R_5 is kept to preserve the original primary key.

   (c) **(5 points)** Decompose that further into 3NF.

   Further decomposing attributes base on transitive dependencies keeps R_1, R_2, R_4, and R_5 from above but splits R_3 into:

   $$\begin{aligned} R_{3a} &= \{\underline{A}, \underline{D}, G, H\} \\ R_{3b} &= \{\underline{H}, J\} \end{aligned}$$

2. **(20 points)** See Figure 3 for an incomplete ER model based on the one actually used by Drupal to represent a website. Extend the diagram according to the following requirements:

   (a) All nodes must have a type. Each type has a unique name, as well as a description and a label. Node types may use another node type as a base type (a node type may be the base of many other types, but each type has only one base.)

   (b) Each user will have a unique id number, a name, password hash, email address, and signature text. A user will also have multiple roles, where each role has a name, weight, and permission string.

   (c) There will be a limit of 500 comments allowed for any node. Add the *(min, max)* cardinality notation to each side of the `Node_Comment` relationship reflecting this.

3. **(20 points)** Use the mapping algorithms to convert that ER schema (including the parts you added) to relational form.

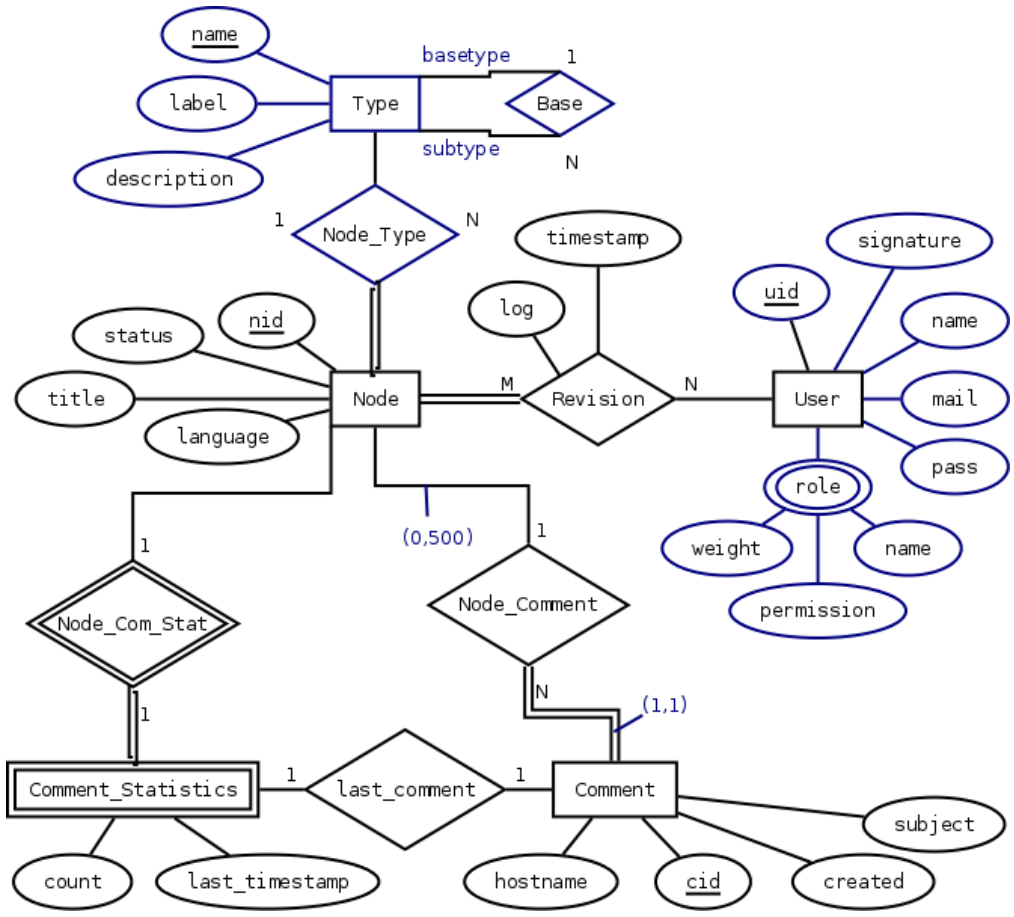

Figure 1: ER model of the Drupal 7 schema with additional requirements. `Role` could also be modeled as a separate entity.

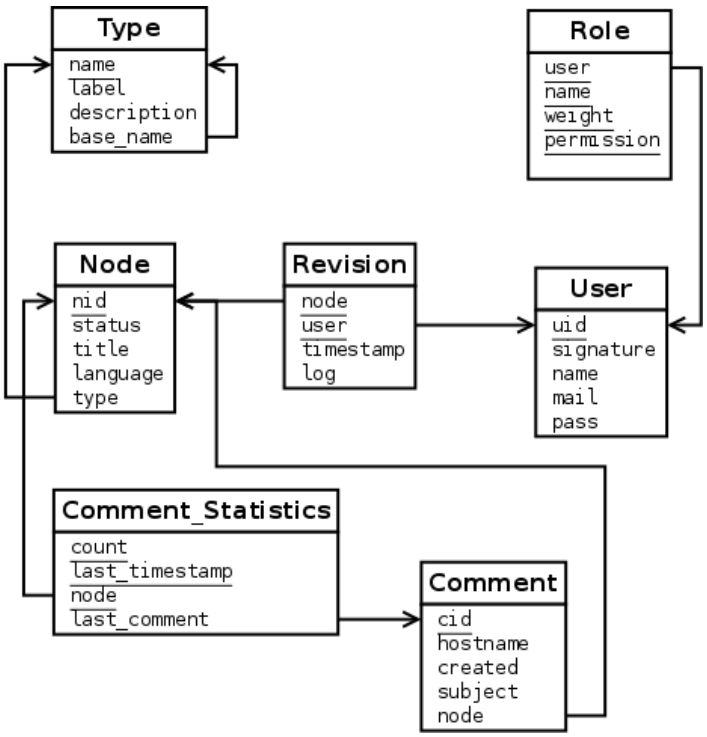

Figure 2: Relational model mapped from the Drupal 7 ER schema

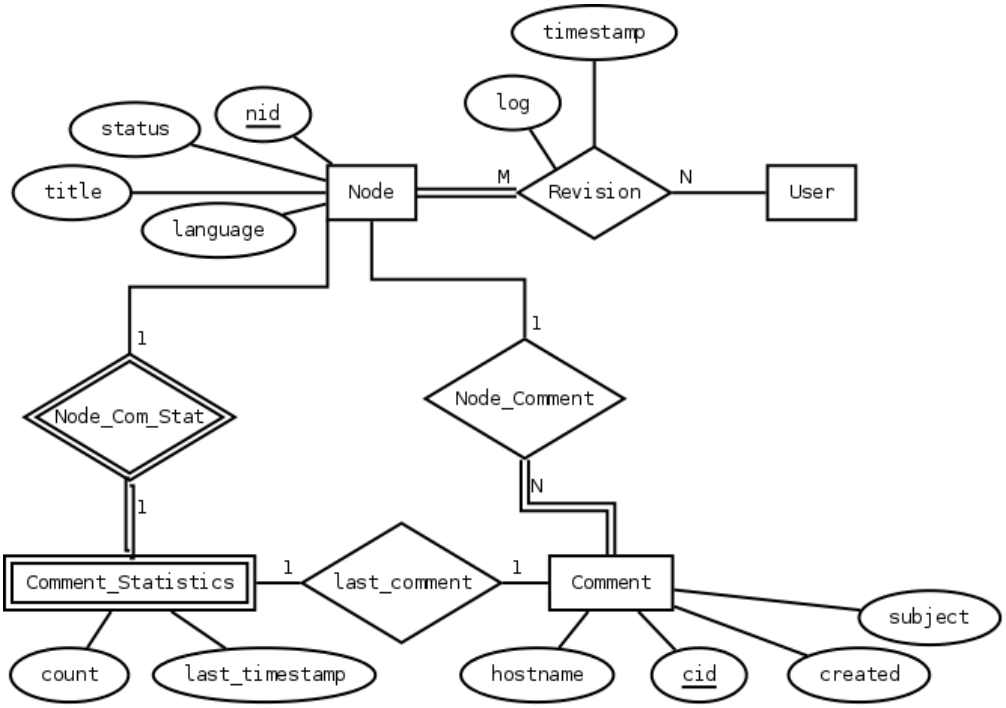

Figure 3: Partial ER model of the Drupal 7 schema