

(12) **United States Patent**
Atman et al.

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- (54) **FRAME-BASED KNOWLEDGE REPRESENTATION SYSTEM AND METHODS**
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- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
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Related U.S. Application Data

- (60) Provisional application No. 60/112,423, filed on Dec. 15, 1998.
- (51) **Int. Cl.⁷** **G06F 17/30**
- (52) **U.S. Cl.** **707/103; 707/2**
- (58) **Field of Search** **707/2, 103; 706/53; 709/316**

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(57) **ABSTRACT**

A frame-based knowledge representation system is built on a relational database that is completely transparent to the user. A user at a client machine sends standard knowledge base queries across a distributed computer system and the system translates the queries into a language suitable for querying the database, such as Structured Query Language (SQL). The system stores a hierarchical data model that includes classes, particular instances of the classes, and relations among the classes and instances. Primitive objects, such as classes and instances, are organized with their associated attributes into frames. The system consists of three main tables and auxiliary tables. The frames table stores frames with associated slots and values, along with associated ownerships, access permissions, and other facets. The superclass-set table stores the frames and associated superclasses or ancestor classes. The third table, the classes table, stores class frames, slots, and values, and a slot type designating a slot as own or template. The database also includes tables for security definitions, logging, and other features. To query the knowledge base, the user submits a query, preferably according to the Open Knowledge Base Connectivity protocol, and the system translates the query into SQL. The result is formatted and processed to check user permissions before being returned to the user over the computer network. The system is accessed through a variety of interfaces, including a Web browser and various application programming interfaces.

25 Claims, 9 Drawing Sheets

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Prior Art

FIG. 1

- ❖ Thing
 - Data
 - Interpreted Data
 - Crosslink-Length-Data
 - Measured Data
 - Biochemical-Data
 - ◆ Antibiotic-Resistance-Data
 - ◆ Binding-Affinity-Data
 - ◆ Cleavage-Data
 - ◆ Compositional-Data
 - ◆ Cross-Linking-Data
 - ◆ Footprinting Data
 - Chemical-Footprinting-Data
 - Enzymatic-Footprinting-Data
 - Fe-Radical-Attack-Data
 - ◆ Ligand-Incorporation-Data
 - ◆ Rna-Partial-Digestion-Data
 - ◆ Sedimentation-Coefficient-Data
 - ◆ Transaction-Rate-Data
 - Phylogenetic-Data
 - Physical-Data
 - Structural-Model-Data
 - Methods
 - Organism
 - Physical-Thing
 - Reference-Information
 - RiboWeb-Output

Prior Art

FIG. 2

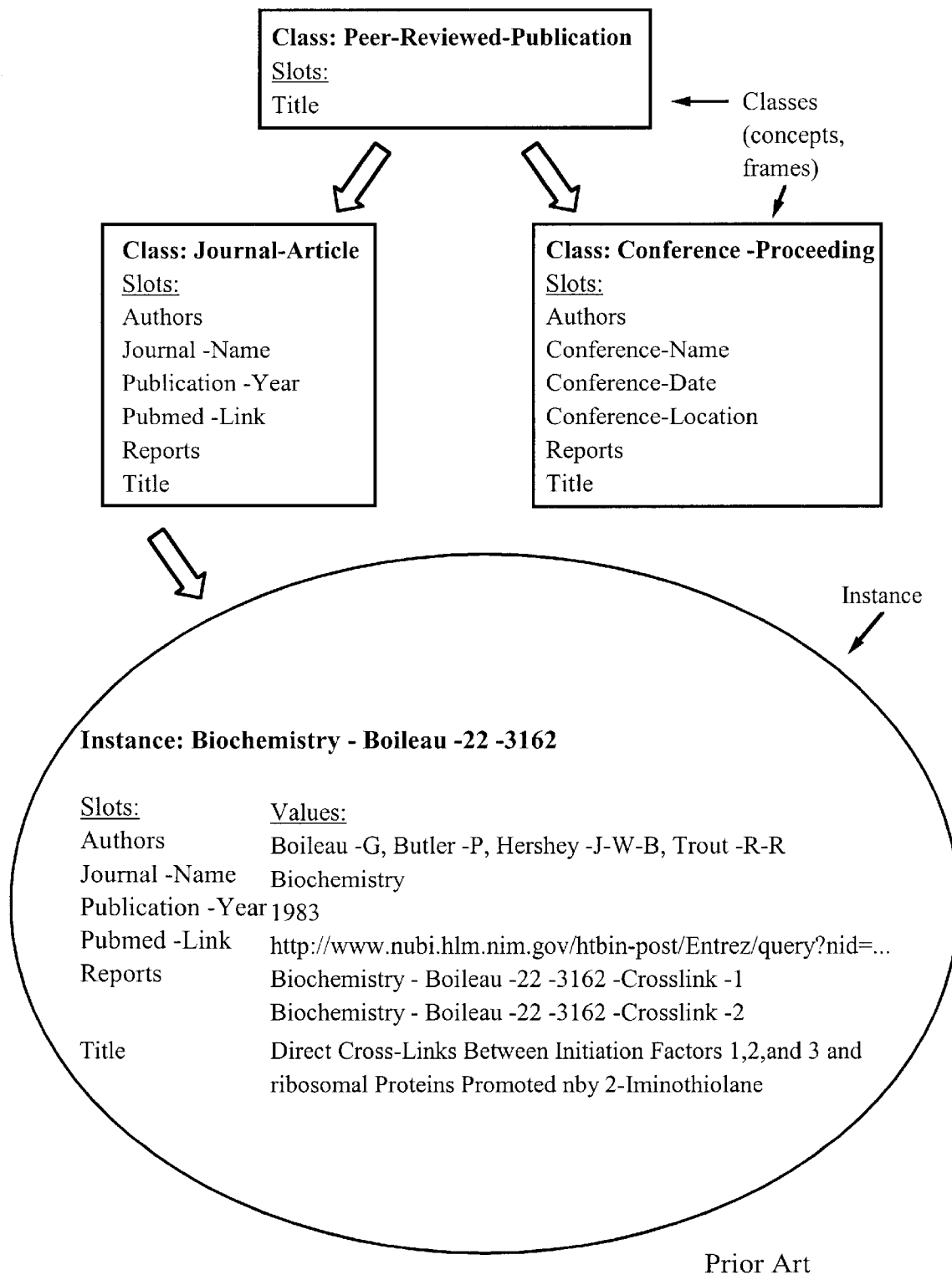


FIG. 3

32 → ID	34 → frame	36 → slot	38 → value	42 → owner	44 → permission	46 → creation date
181194	Rna-Mundus-4-1373-9	Cross-Linked-Thing	16e-U916	System	0	3/12/99
181195	Rna-Mundus-4-1373-9	Cross-Linking-Agent	Site-Specific-Psoralan-Apa	System	0	3/12/99
181196	Rna-Mundus-4-1373-9	Reported-By	Rna-Mundus-4-1373	System	0	3/12/99
1375	Rna-Partial-Digestion-Data	Arity	1	System	0	3/15/99
1376	Rna-Partial-Digestion-Data	Documentation	An experiment in which a	System	0	3/15/99
1377	Rna-Partial-Digestion-Data	Domain-Of	Associated-Parts	System	0	3/15/99
1378	Rna-Partial-Digestion-Data	Domain-Of	Digesting-Agent	System	0	3/15/99
1419	Rna-Partial-Digestion-Data	Instance-Of	Class	System	0	3/15/99
1420	Rna-Partial-Digestion-Data	Range-Of	Digesting-Agent-in	System	0	3/15/99
1421	Rna-Partial-Digestion-Data	Range-Of	Participates-in-Association	System	0	3/15/99
1422	Rna-Partial-Digestion-Data	Subclass-Of	Biochemical-Data	System	0	3/17/99
181197	Rna-Powers-1-194	Instance-Of	Journal-Article	System	0	3/17/99
181198	Rna-Powers-1-194	Journal-Name	Rna-Journal	System	0	3/17/99
181199	Rna-Powers-1-194	Title	Hydroxyl radical foot prin	System	0	3/17/99

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Frames: Table

FIG. 4

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