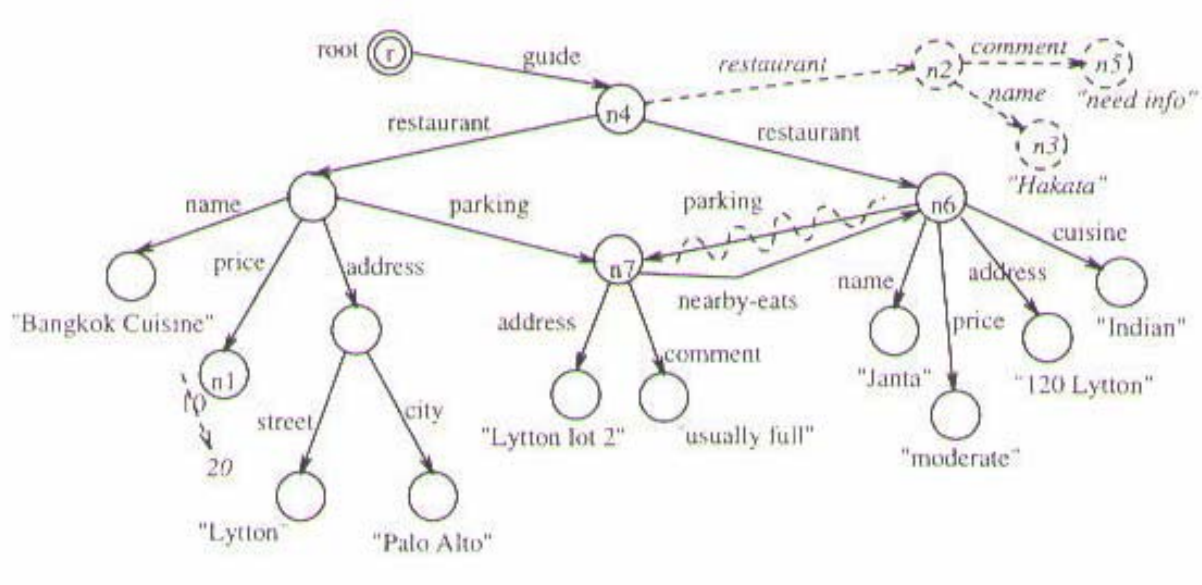
Semistructured Data

Semistructured Data

- *Semistructured data* is data that has some structure, but it may be irregular and incomplete and does not necessarily conform to a fixed schema
  - World-Wide Web
  - Integration of data from heterogeneous sources.

Object Exchange Model (OEM)



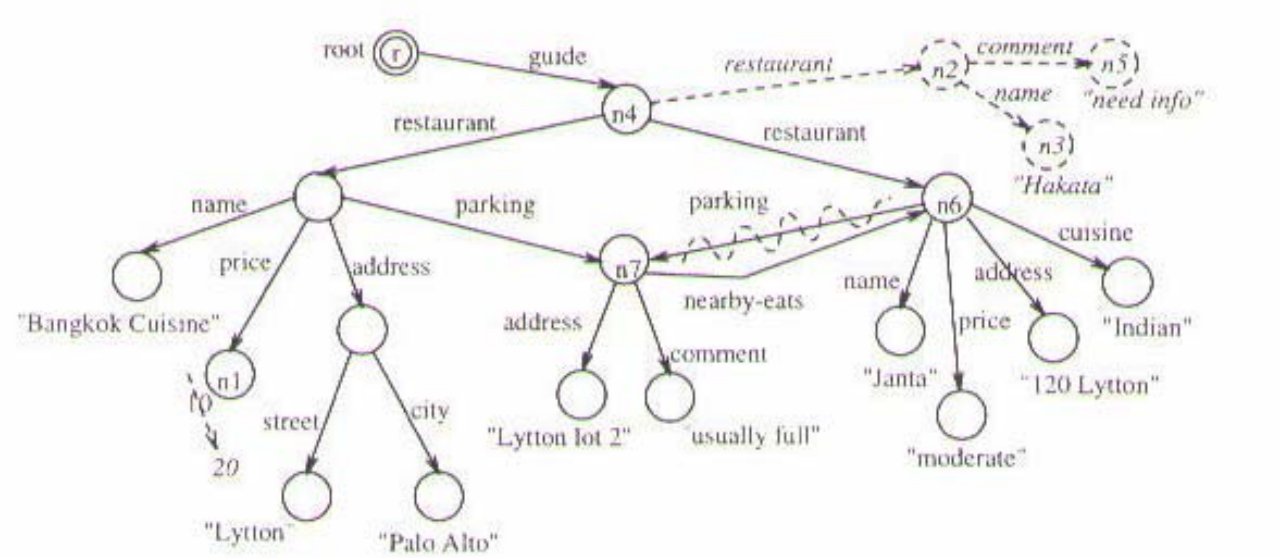
- Nodes without outgoing edges are called atomic objects; the rest of the nodes are called complex objects.
- Atomic objects have a value of type integer, real, string, etc. Complex objects have the reserved value C.

OEM - Definition

An OEM database is a 4-tuple $O=(N,A,v,r)$, where:

- N is a set of object identifiers;
- A is a set of labeled, directed arcs (p,l,c) where $p,c \in N$ and l is a string;
- v is a function that maps each node $n \in N$ to an atomic value or the reserved value C; and
- r is a distinguished node in N called the root of the database.

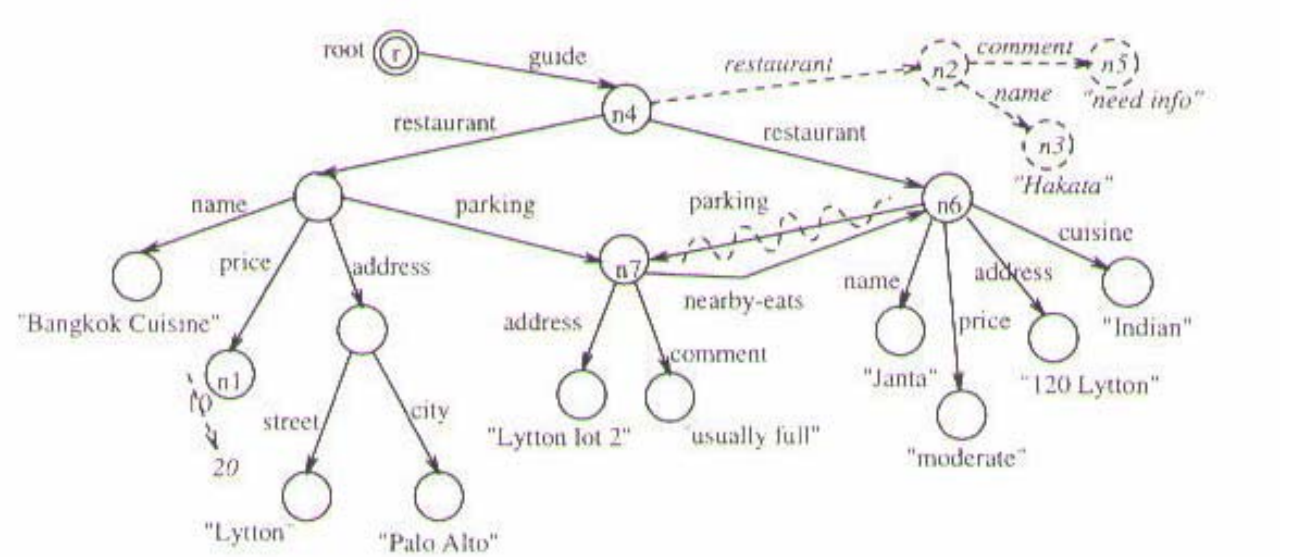
Lorel Example 1



Select Guide.restaurant
where guide.restaurant.price < 20.5

- The result of the query is a singleton set containing the restaurant object for "Bangkok Cuisine."
- Lorel coerces the values to a common same type before making the comparisons.

Lorel Example 2



Select Guide.restaurant
from Guide.restaurant.address.street Z
where Z = "Green"

select Guide.restaurant
from Guide.restaurant
where Guide.restaurant.address.street = "Green"

Basic Change Operations

- *creNode(n,v)*: creates a new object. The identifier n must be new.
- *updNode(n,v)*: changes the value of object *n*, where v is an atomic value or the special symbol *C*. Object n must be either an atomic object or a complex object without subobjects.
- *addArc(p,l,c)*: adds an arc labeled *l* from object *p* to object *c*. The new arc must not already exist.
- *remArc(p,l,c)*: removes an arc *(p,l,c)*.

Valid Change Sequence

- We say that a sequence $L = u_1, u_2, \ldots, u_n$ of basic change operations is *valid* for an OEM database O if u_i is valid for O_{i-1} for all $i = 1, \ldots, n$, where $O_o = O$, and $O_i = u_i(O_i\text{-}1)$, for $i = 1, \ldots, n$.

- We use $L(O)$ to denote the OEM database obtained by applying the entire L to O.

Valid Changes

We say that a set $U = \{u_1, u_2, \ldots, u_n\}$ of basic change operations is valid for an OEM database *O* if

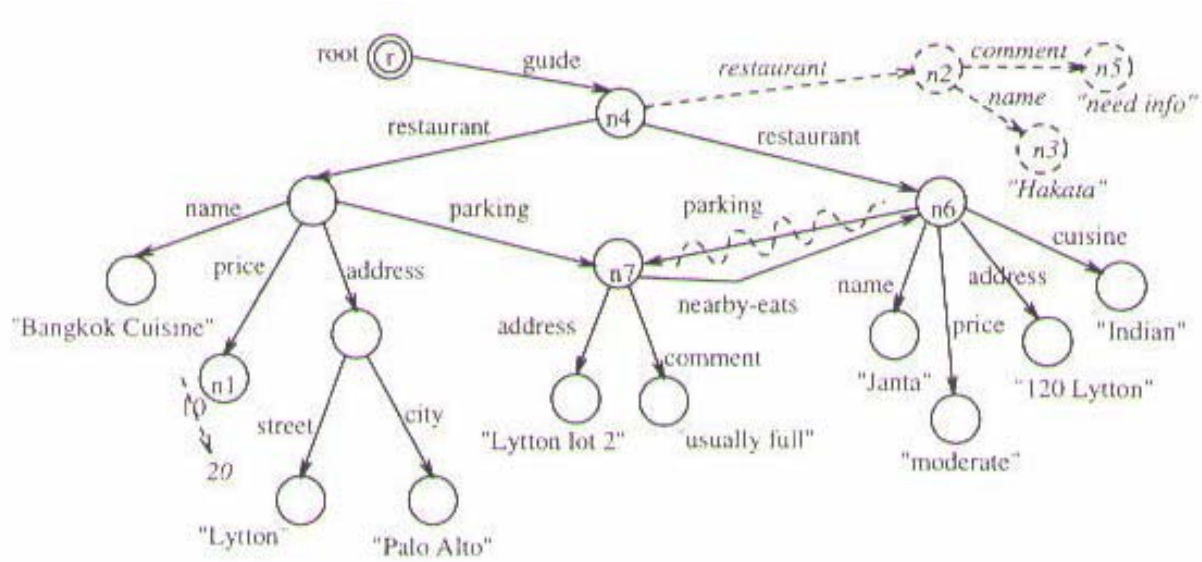
- for some ordering L of the changes in *U*, *L* is a valid sequence of changes,
- for any two such valid sequences *L* and *L'*, *L(O) = L'(O)*, and
- U does not contain both *addArc(p,l,c)* and *remArc(p,l,c)* for any *p*, *l*, and *c*.

OEM History

- ***OEM history*** is a sequence $H = (t_1, U_1), \ldots, (t_n, U_n)$, where U_i is a set of basic change operations and t_i is a timestamp, for $i = 1, \ldots, n$, and $t_i < t_{i+1}$ for $i = 1, \ldots, n-1$.

- We say H is ***valid*** for an OEM database O if, for all $i = 1, \ldots, n$, U_i is valid for O_{i-1}, where $O_o = O$, and $O_i = U_i(O_{i-1})$ for $i = 1, \ldots, n$.

OEM History Example

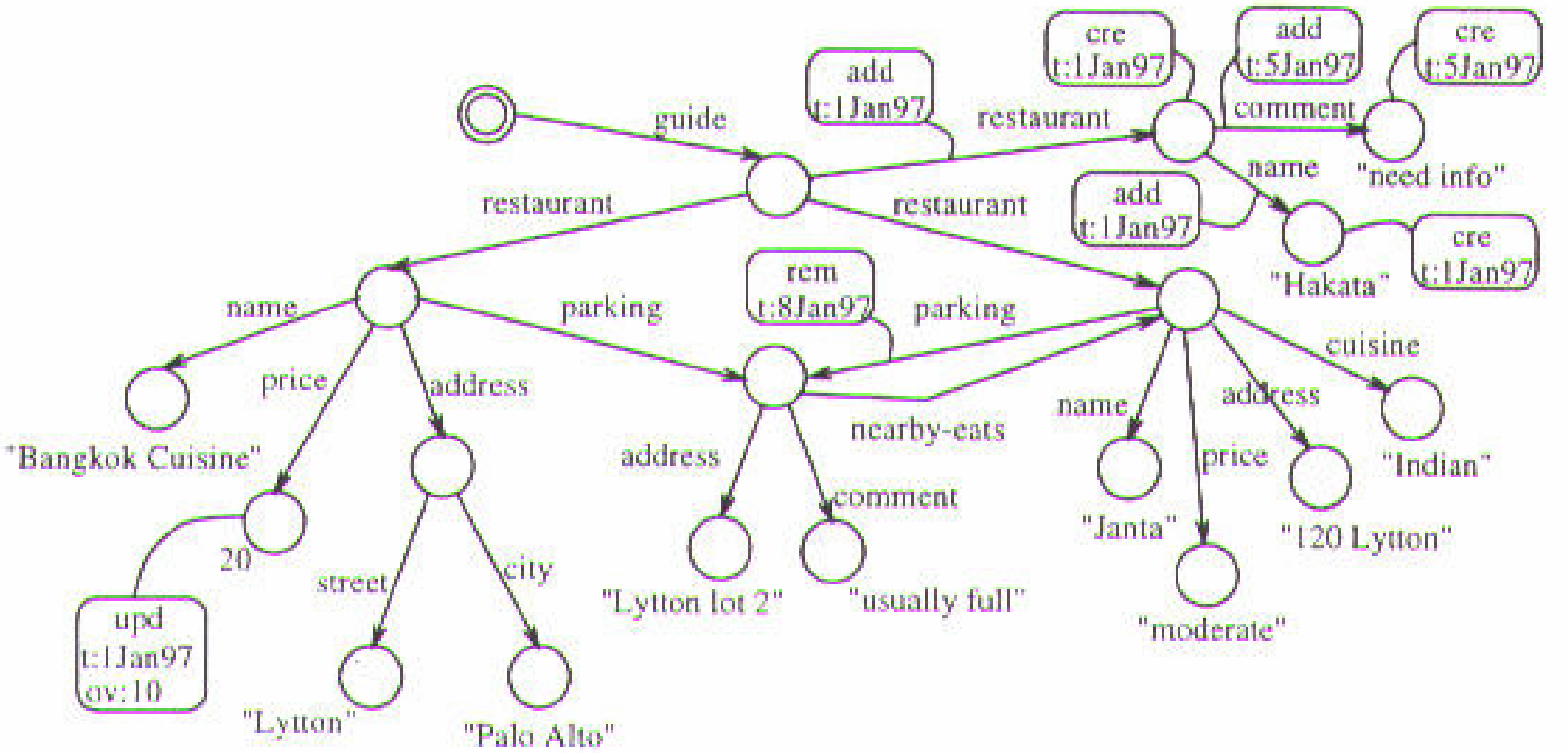


- We have the history H = ((t_1, U_1), (t_2, U_2),(t_3, U_3)), where t_1 = 1Jan97, t_2 = 5Jan97, t_3 = 8Jan97.
  - U_1 = { *updNode*(n_1,20), *creNode*(n_2,C), *creNode*(n_3,"Hakata"), *addArc*(n_4,"restaurant",n_2), *addArc*(n_2,"name", n_3)}
  - U_2 = { *creNode*(n_5, "need info") *addArc*(n_2, "comment", n_5)}
  - U_3 = { *remArc*(n_6, "parking", n_7)}

Annotations to the OEM graph

- Annotations are attached to the nodes and arcs to encode the history of basic change operations.
- Four types of annotations:
  - *cret*(*t*): the node was created at time *t*.
  - *upd*(*t*,*ov*): the node was updated at time *t*, *ov* is the old value.
  - *add*(*t*): the arc was added at time *t*.
  - *rem*(*t*): the arc was removed at time *t*.

OEM graph with Annotations



DOEM Database

- The set of all possible node annotations is denoted by ***node-annot***, and the set of all possible arc annotations is denoted by ***arc-annot.***

- *A **DOEM database** is a triple $D = (O, f_N, f_A)$, where $O = (N, A, v, r)$ is an OEM database, f_N maps each node in N to a finite subset of *node-annot*, and f_A maps each arc in A to a finite subset of *arc-annot*.*

DOEM Database - Properties

- Given a DOEM database D, it is easy to obtain
  - the original snapshot, $O_o(D)$,
  - the snapshot at time t, $O_t(D)$, and
  - the current snapshot, $O_c(D)$.

Chorel Example 1

QUERY: Find the names of all restaurants whose price ratings were updated on or after January 1st, 1997 to a value greater than 15, together with the time of the update and the new price.

Select *N, T, NV*
from *guide.restaurant.price* <*upd* at *T* to *NV*>,
guide.restaurant.name N
where *T* >= 1Jan97 and *NV* > 15

Answer: *name* "Bangkok Cuisine"
new-value 20
update-time 1Jan97

Chorel Example 2

QUERY: Find the names of restaurants to which a "moderate" price subobject was added since January 1st, 1997.

```
Select    N
from      guide.restaurant R, R.name N
where     R.<add at T> price = "moderate" and
          T>= 1Jan97
```

Syntax of Annotation Expression

- <*Annot* [at *timeV*]> if *Annot* is in { *add, rem, cre* }

  <*upd* [*at timeV*] [*from oldV*] [*to newV*]> for *upd*

- Arc annotation expressions must occur immediately before a label.

  Example: *guide.restaurant*. <*add* at *T*> price

- Node annotation expressions must occur immediately after a label.

  Example: *guide.restaurant.price* <*upd* at *T* to *NV*>