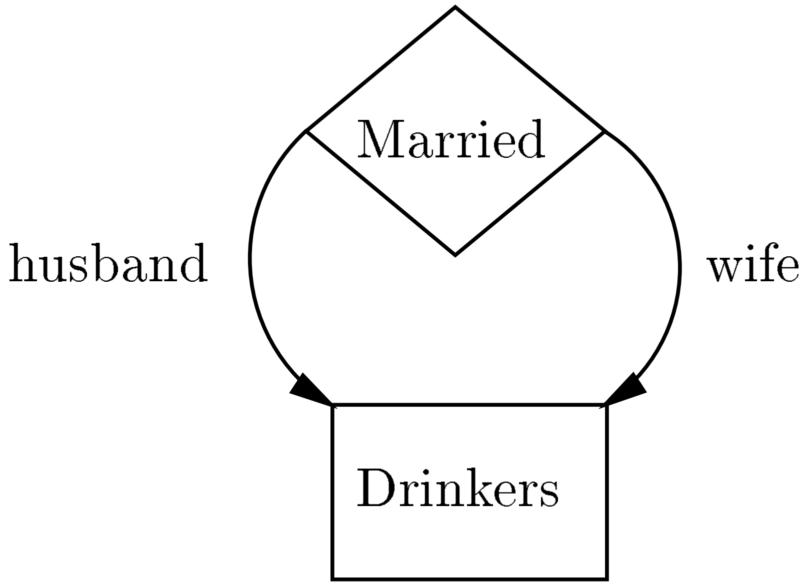
More Design Issues

1. Roles.
2. Subclasses.
3. Keys.
4. Weak entity sets.
5. Design principles and some hard examples.

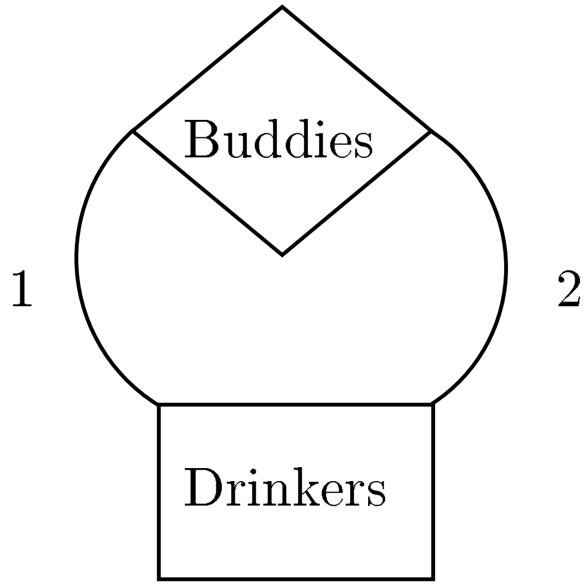
Roles

Sometimes an E.S. participates more than once in a relationship.

- Label edges with *roles* to distinguish.



Husband	Wife
d_1	d_2
d_3	d_4
$\ldots$	$\ldots$



Buddy1	Buddy2
d_1	d_2
d_1	d_3
d_2	d_1
d_2	d_4
$\ldots$	$\ldots$

- Notice *Buddies* is symmetric, *Married* not.
  - ✦ No way to say "symmetric" in E/R.
  - ✦ But in ODL, symmetric relations are their own inverse.

Roles in ODL

No problem; names of relationships handle "roles."

```
interface Drinkers {
    attribute string name;
    attribute Struct Bars::Addr
            address;
    relationship Set<Beers> likes
        inverse Beers::fans;
    relationship Set<Bars> frequents
        inverse Bars::customers;
    relationship Drinkers husband
        inverse wife;
    relationship Drinkers wife
        inverse husband;
    relationship Set<Drinkers> buddies
        inverse buddies;
}
```

- Notice that `Drinkers::` is optional when the inverse is a relationship of the same class.

Design Issue

Should we replace `husband` and `wife` by one relationship `spouse`?

Subclasses

Subclass = special case = fewer entities/objects = more properties.

- Example: Ales are a kind of beer. In addition to the properties (= attributes, relationships, methods) of beers, there is a "color" attribute for ales.

ODL Subclasses

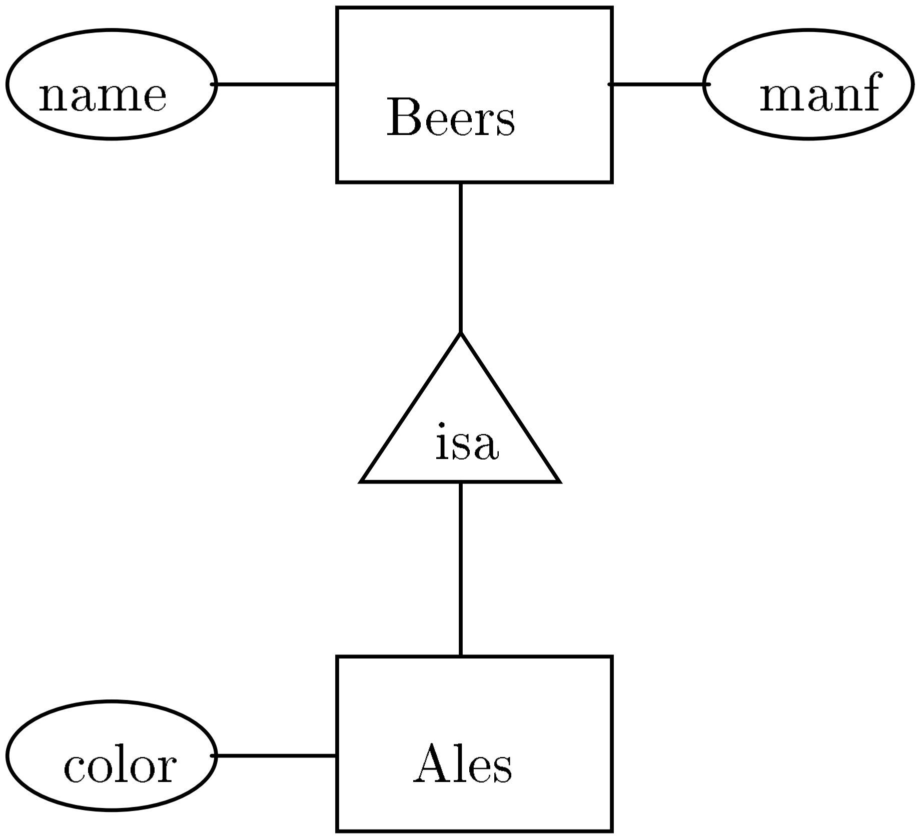
Follow name of subclass by colon and its superclass.

```
interface Ales:Beers {
    attribute String color;
}
```

- Objects of the `Ales` class acquire all the attributes and relationships of the `Beers` class.

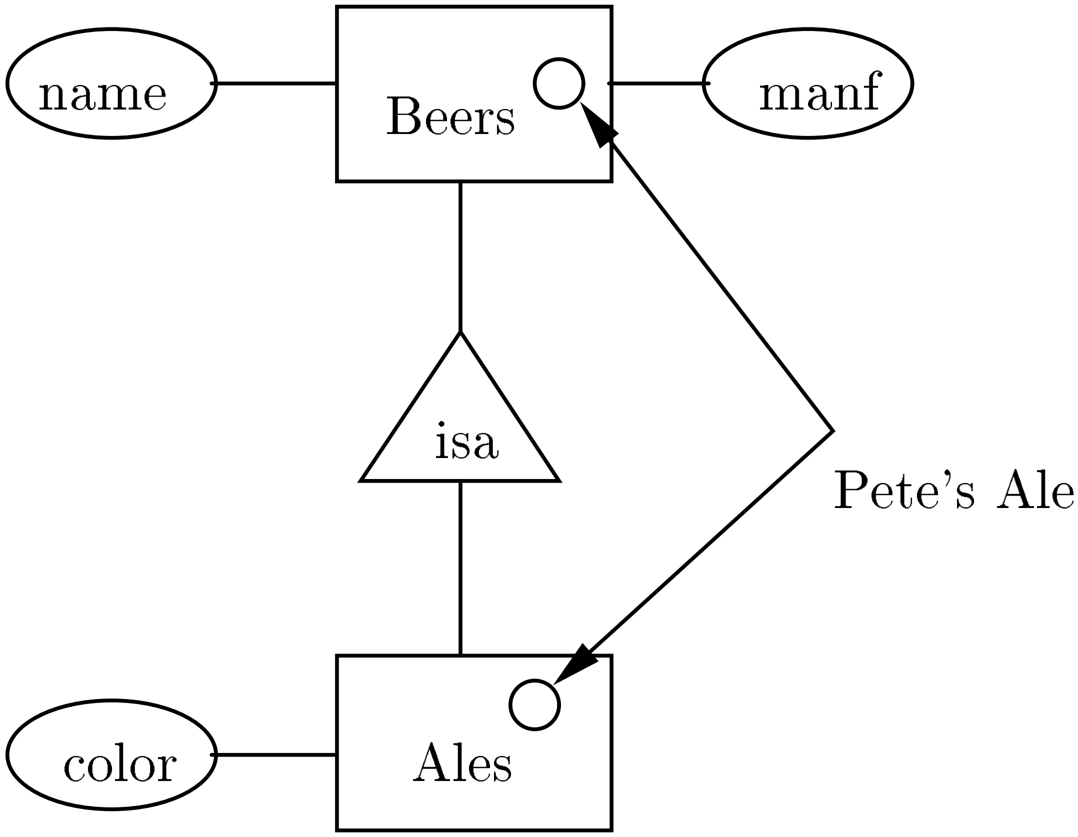
E/R Subclasses

- *isa* triangles indicate the subclass relation.



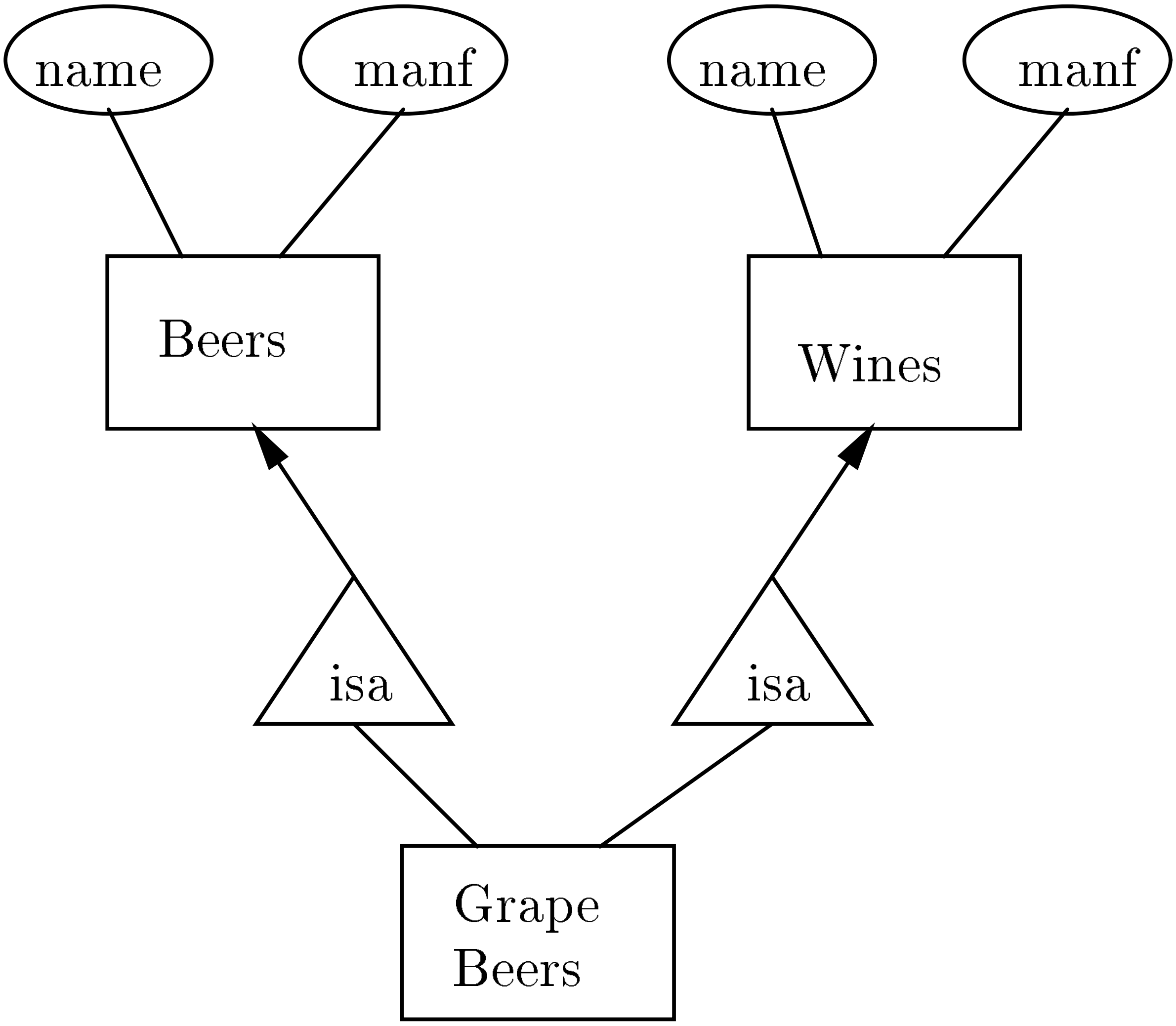
Difference in Subclass Viewpoints

- In ODL, an entity is in exactly one class.
  - ❖ It inherits properties of its superclass(es).
- In E/R, an entity has "representation" in all the subclasses to which it logically belongs.
  - ❖ Its properties are the union of the properties of these classes.
- The distinction matters later, when we convert ODL and E/R to relations.



Multiple Inheritance

Theoretically, a class/E.S. could be a subclass of several classes.



Problems

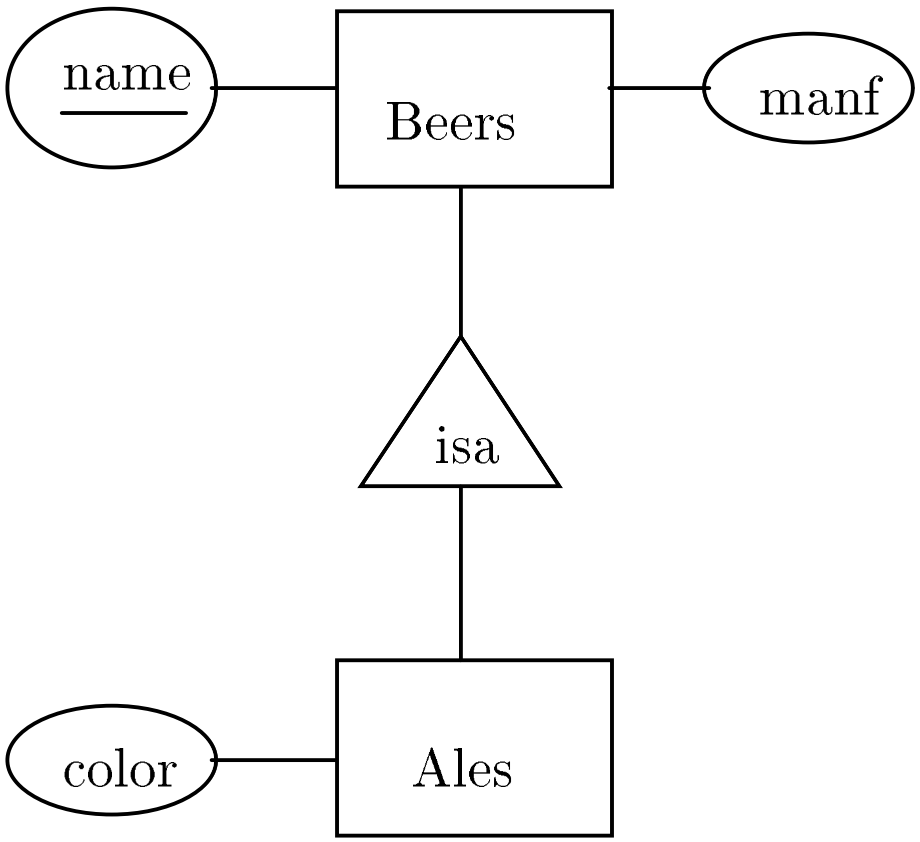
How should conflicts be resolved?

- Example: `manf` means grower for wines, bottler for beers. What does `manf` mean for "grape beers"?
- E/R mute on multiple inheritance; ODL leaves it to implementer.

Keys

= set of attributes whose values can belong to at most one entity or object.

- In E/R: underline all key attributes.
- In E/R, each E.S. must have a key.
- Example: Suppose `name` is key for *Beers*.



- Beer name is also key for ales.
    - ❖ In general, key at root (no multiple inheritance!) is key for all.

Keys in ODL

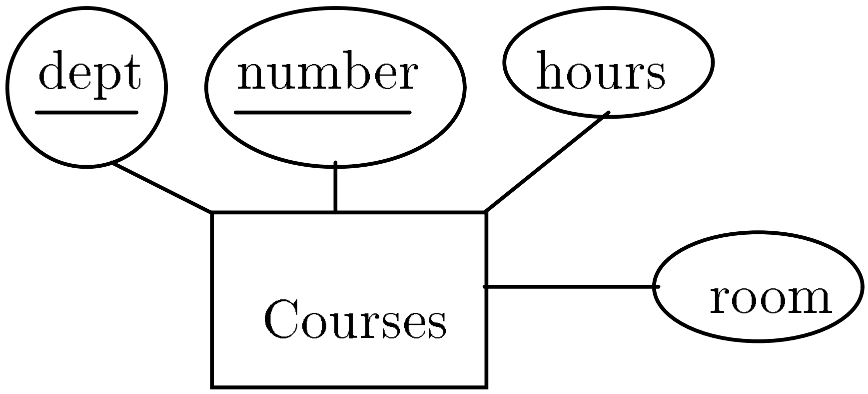
Indicate with `key(s)` following the class name, and a list of attributes forming the key.

- ❖ Several lists may be used to indicate several alternative keys.
- ❖ Parentheses group members of a key, and also group `key` to the declared keys.
- ❖ Thus, (`key`$(a_1, a_2, \ldots, a_n)$) = "one key consisting of all n attributes."
  (`key` $a_1, a_2, \ldots, a_n$) = "each a_i is a key by itself.

- Example:

```
interface Beers
    (key name)
{
    attribute string name ...
```

A Multiattribute Key




```
interface Courses
    (key (dept, number), (room, hours))
{
    ...
```

- E/R requires exactly one key, but ODL allows zero or more keys.
- **Very Important**: In ODL, "object identity" serves to distinguish objects, so *no key at all is necessary.*

Weak Entity Sets

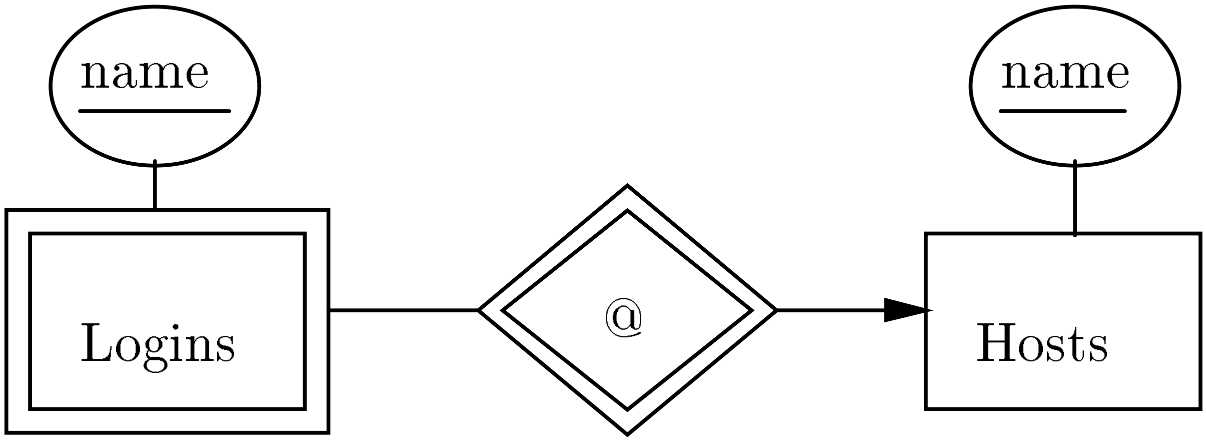
Sometimes an E.S.'s key comes not (completely) from its own attributes, but from the keys of one or more E.S's to which the first is linked by a many-one relationship.

- Called a *weak* E.S.
- Represented by putting double rectangle around the weak E.S. and a double diamond around each relationship to which the weak E.S. is linked to an E.S. that provides part of its key.
- Use of many-one relationship (includes 1-1) essential.
  - ✦ With a many-many, we wouldn't know which entity provided the key value.
- **Very Important**: There is no such thing as a "weak class" in ODL.
  - ✦ Because objects have object-identity, classes don't need keys, and therefore they don't need to "borrow" keys from related classes.

Example: Logins

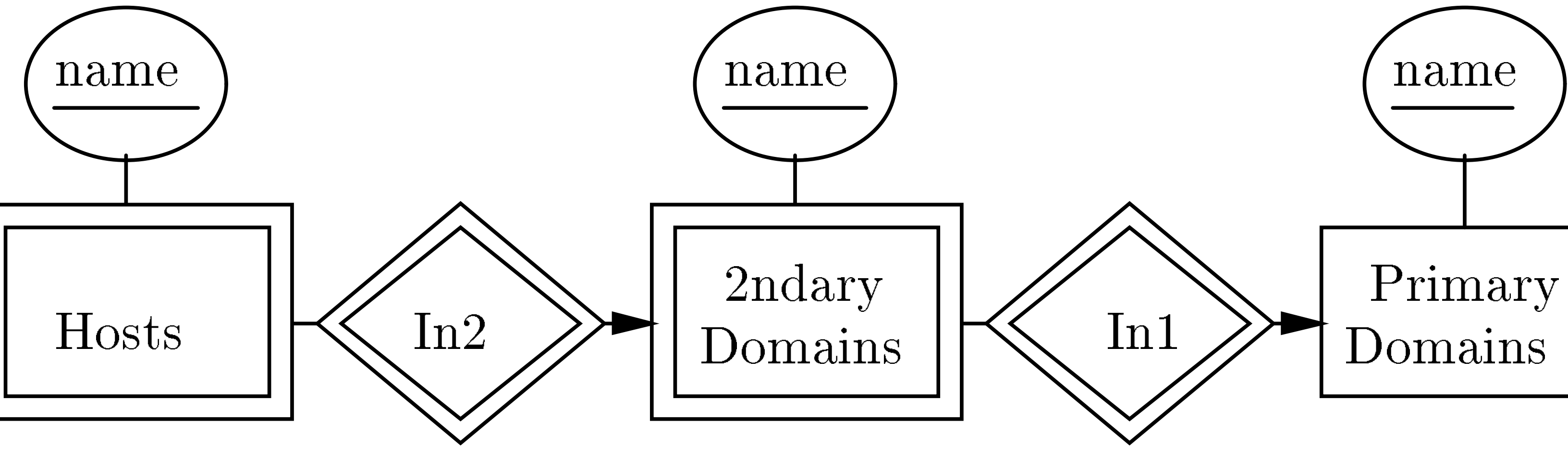
Login name = user name + host name, e.g., `ullman@shalmaneser.stanford.edu`.

- A "login" entity corresponds to a user name on a particular host, but the passwd table doesn't record the host, just the user name, e.g. `ullman`.
- Key for a login = the user name at the host (which is unique for that host only) + the name of the host (which is unique globally).



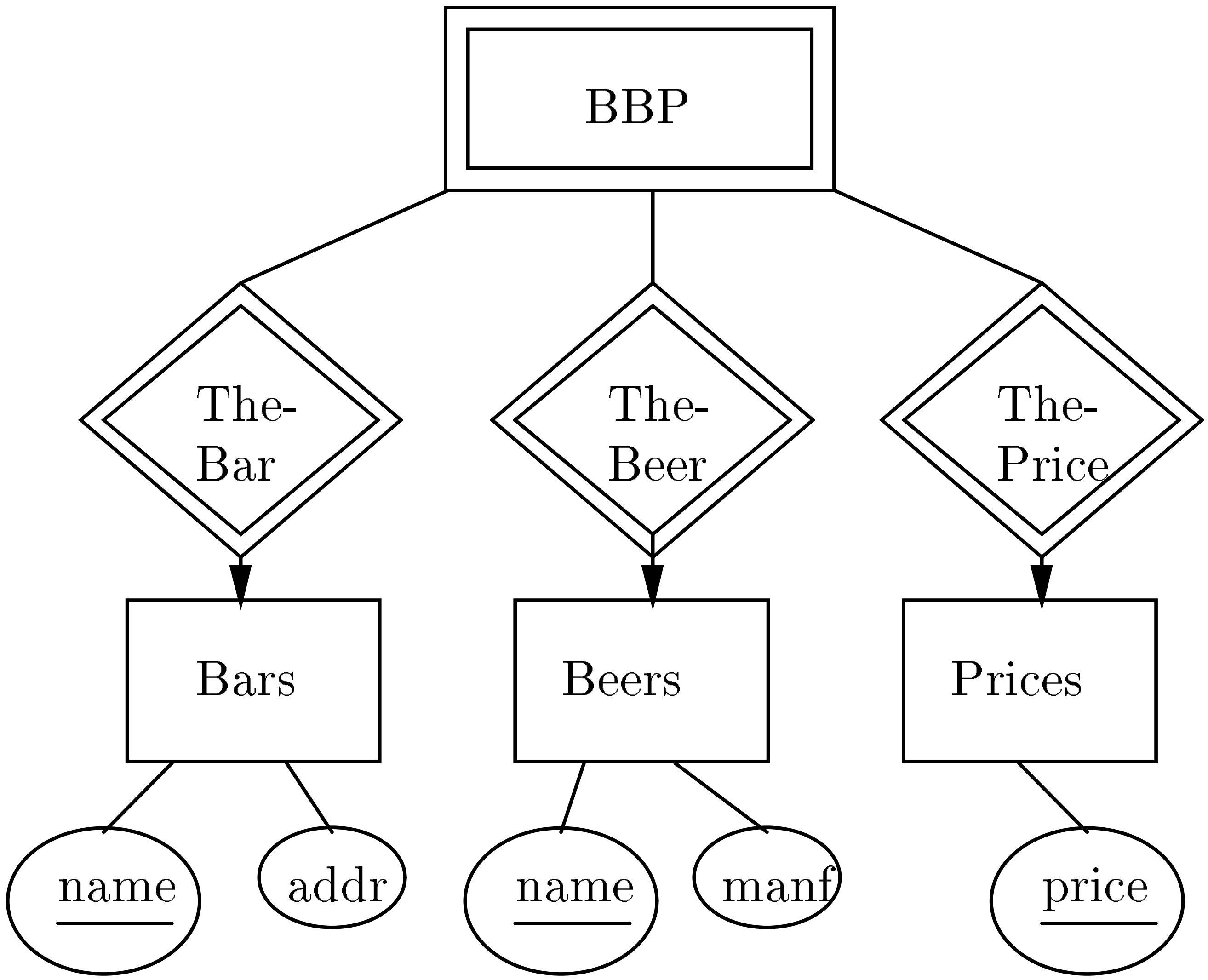
Example: Chain of "Weakness"

Consider IP addresses consisting of a primary domain (e.g., `edu`) subdomain (e.g., `stanford`), and host (e.g. `shalmaneser`).



- Key for primary domain = its name.
- Key for secondary domain = its name + name of primary domain.
- Key for host = its name + key of secondary domain = its name + name of secondary domain + name of primary domain.

All "Connecting" Entity Sets Are Weak



- In this special case, where bar and beer determine a price, we can omit `price` from the key, and remove the double diamond from `ThePrice`.