Overview

Imperative Languages

- sequence of instructions, executed after each other

- **Procedural Languages**
  - variables, assignments, control structures

- **Object-Oriented Languages**
  - objects and classes
  - ADT and inheritance

Declarative Languages

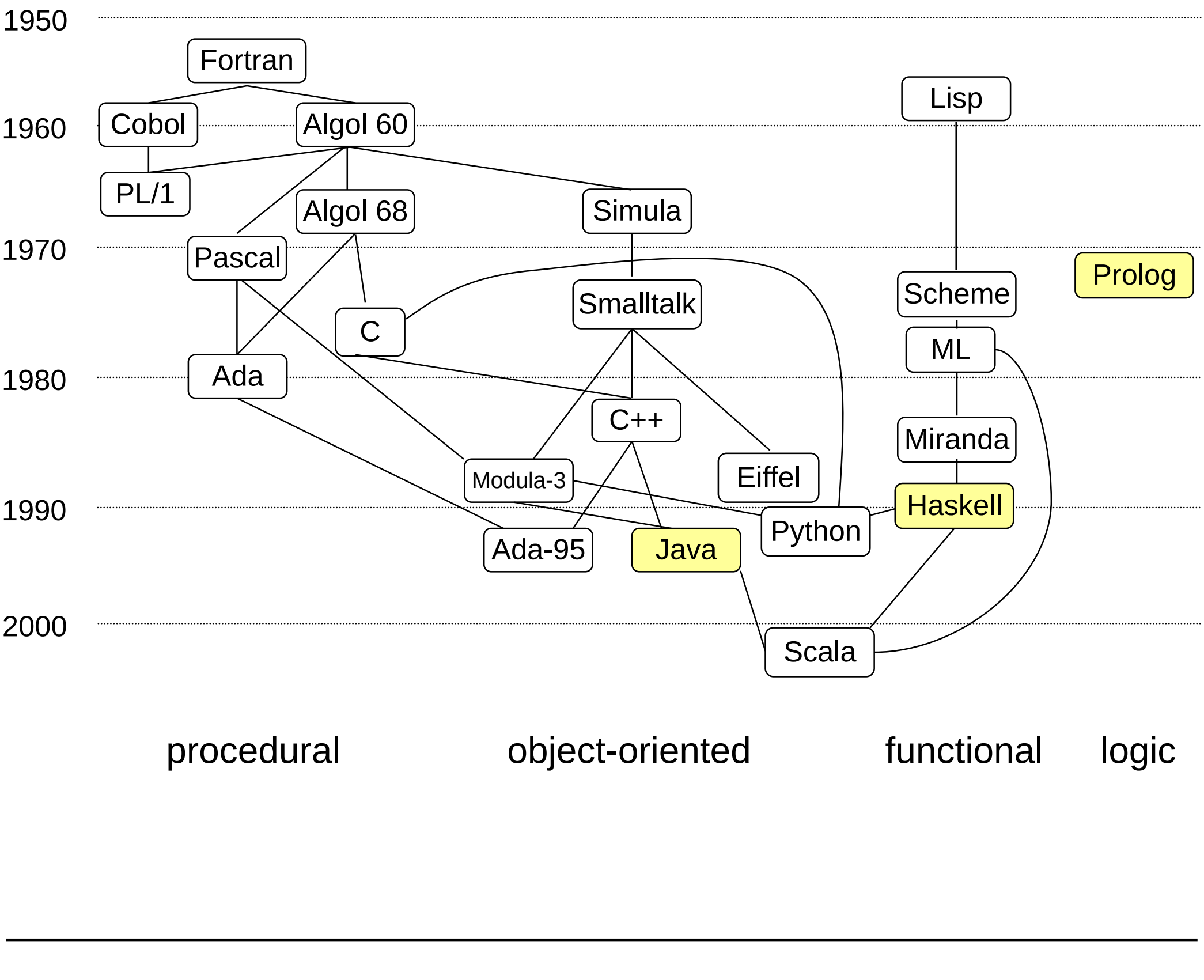
- specify *what* should be computed

- compiler determines *how* the computation works

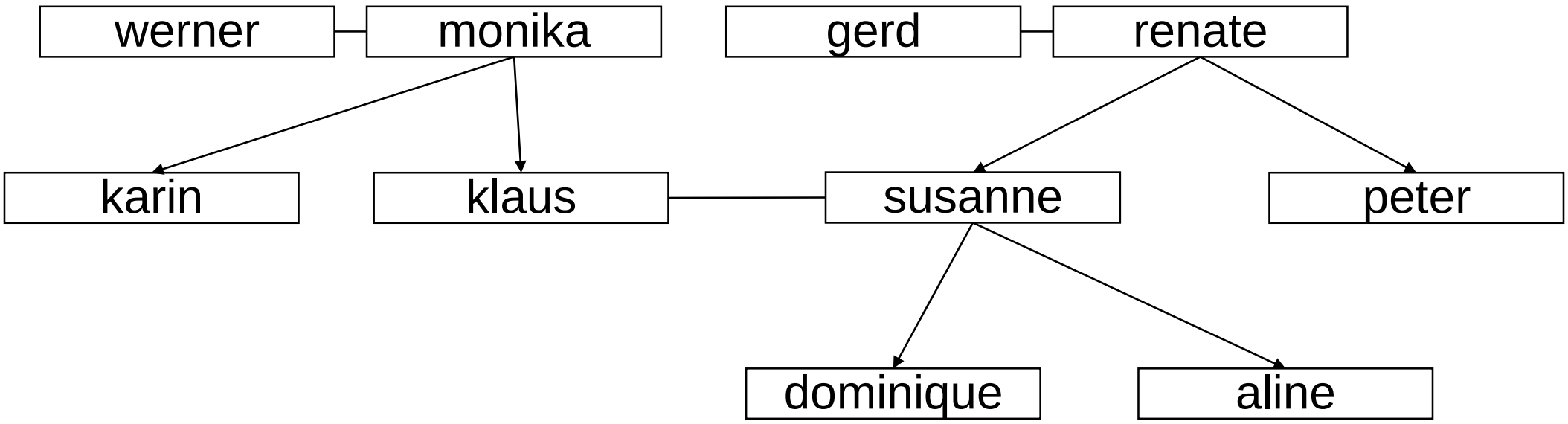
- **Functional Languages**
  - no side-effects
  - recursion

- **Logic Languages**
  - rules to define relations

Important Programming Languages



Facts and Queries



Program:

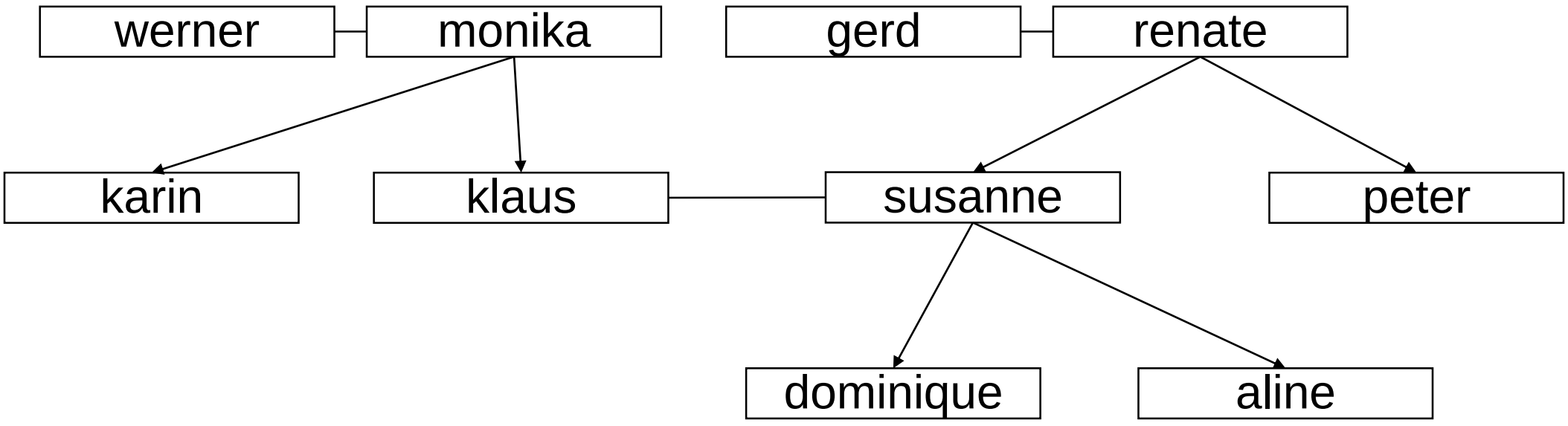
```
female(monika).                 male(werner).
female(karin).                  male(klaus).
female(renate).                 male(gerd).
female(susanne).                male(peter).
female(aline).                  male(dominique).

married(werner, monika).        motherOf(monika, karin).
married(gerd, renate).          motherOf(monika, klaus).
married(klaus, susanne).        motherOf(renate, susanne).
                                motherOf(renate, peter).
                                motherOf(susanne, aline).
human(X).                       motherOf(susanne, dominique).
```

```
?- male(gerd).
true.
```

```
?- married(gerd, monika).
false.
```

```
?- human(gerd).
true.
```

Variables in Queries



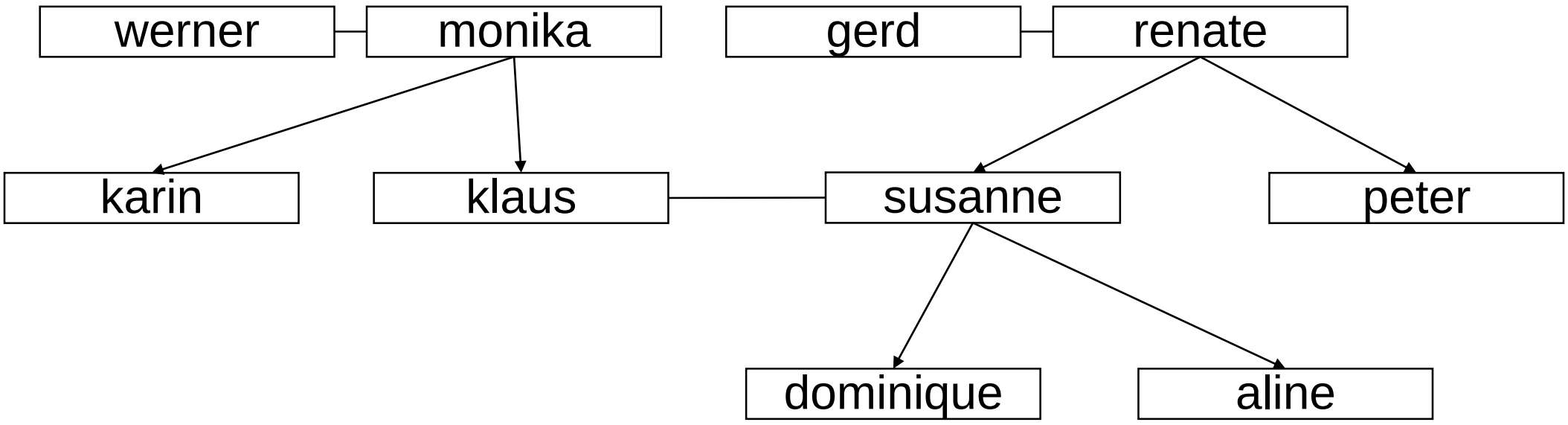
Program:

```
female(monika).                 male(werner).
    ...                             ...
female(aline).                  male(dominique).

married(werner, monika).        motherOf(monika, karin).
    ...                             ...
married(klaus, susanne).        motherOf(susanne, dominique).
```

```
?- motherOf(X, susanne).
X = renate.
```

```
?- motherOf(renate, Y).
Y = susanne ;
Y = peter.
```

Combined Queries

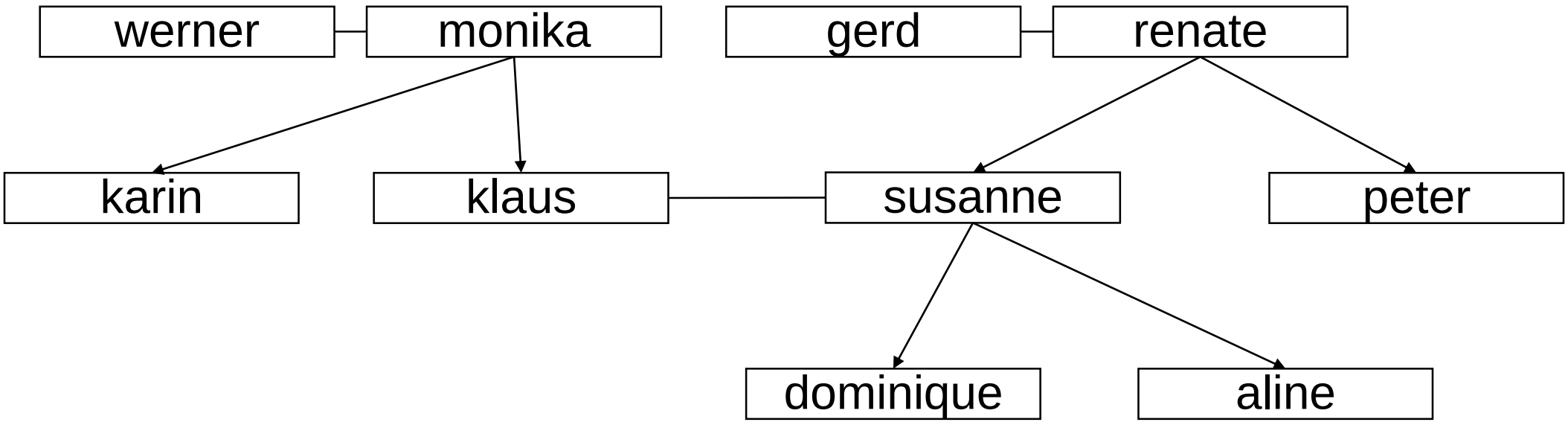


Program:

```
female(monika).                 male(werner).
      ...                             ...
female(aline).                  male(dominique).

married(werner, monika).        motherOf(monika, karin).
      ...                             ...
married(klaus, susanne).        motherOf(susanne, dominique).
```

```
?- married(gerd,W), motherOf(W,susanne).
W = renate.

?- motherOf(Grandma,Mom), motherOf(Mom,aline).
Grandma = renate,
Mom = susanne.
```

Rules



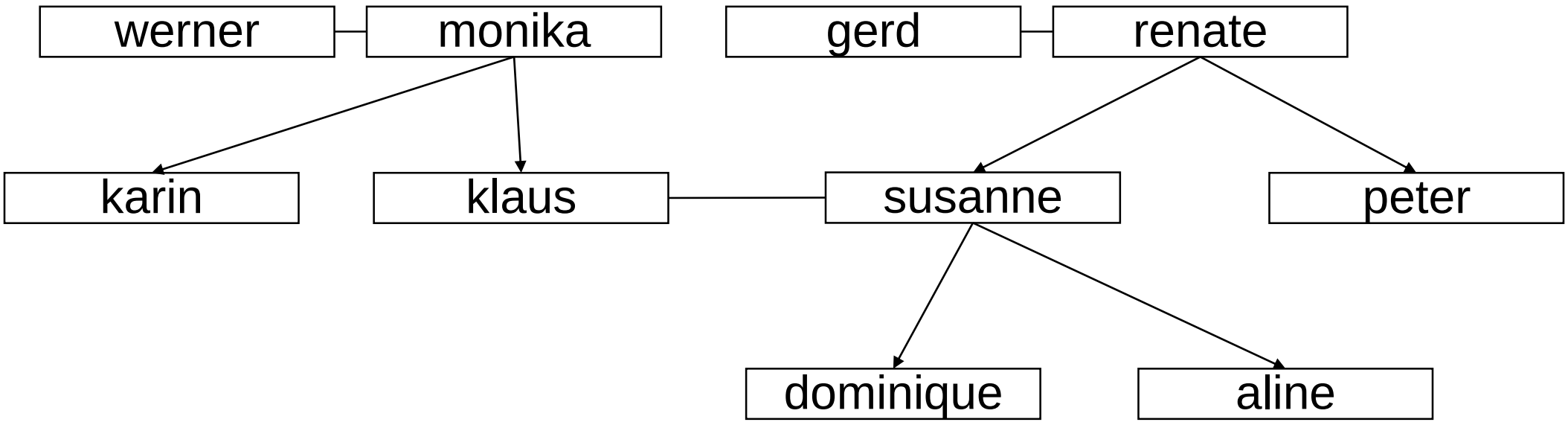
Program:

```
female(monika).                 male(werner).
    ...                             ...
female(aline).                  male(dominique).

married(werner, monika).        motherOf(monika, karin).
    ...                             ...
married(klaus, susanne).        motherOf(susanne, dominique).

fatherOf(F,C) :- married(F,W), motherOf(W,C).
```

```
?- fatherOf(gerd, susanne).
true.
```

```
?- fatherOf(gerd, Y).
Y = susanne ;
Y = peter.
```

Several Rules for one Predicate

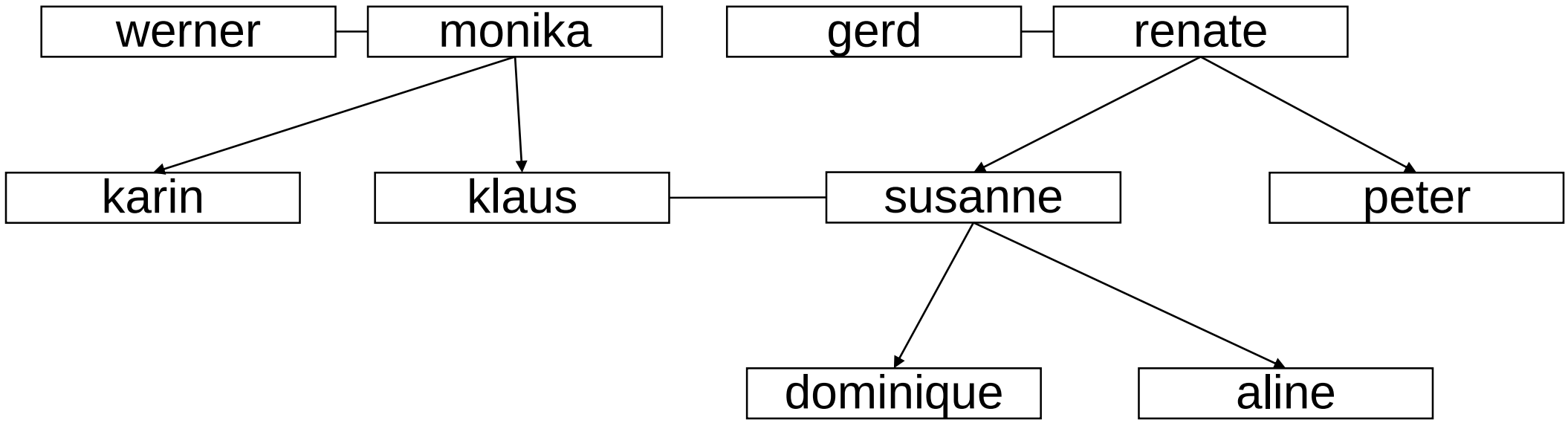


Program:

```
female(monika).                 male(werner).
    ...                             ...
female(aline).                  male(dominique).

married(werner, monika).        motherOf(monika, karin).
    ...                             ...
married(klaus, susanne).        motherOf(susanne, dominique).

fatherOf(F,C) :- married(F,W), motherOf(W,C).

parent(X, Y) :- motherOf(X,Y).
parent(X, Y) :- fatherOf(X,Y).
```

```
?- parent(X, susanne).
X = renate ;
X = gerd.
```

Recursive Rules



Program:

```
female(monika).                    male(werner).
      ...                                ...
married(klaus, susanne).           motherOf(susanne, dominique).

fatherOf(F,C) :- married(F,W), motherOf(W,C).

parent(X, Y) :- motherOf(X,Y).
parent(X, Y) :- fatherOf(X,Y).

ancestor(A,X) :- parent(A,X).
ancestor(A,X) :- parent(A,Y), ancestor(Y,X).
```

```
?- ancestor(X, aline).
X = susanne; X = klaus;
X = monika; X = renate; X = werner;  X = gerd.
```