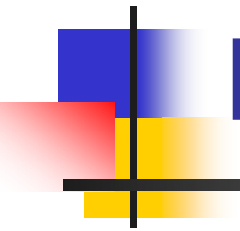
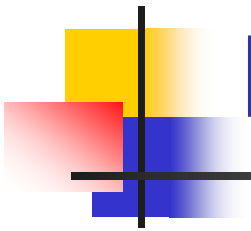


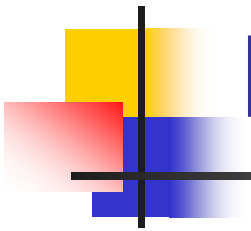
Prolog 3

Lists, Structures and More...



Lists

- Prolog represents a list using the ./2 relation but has a convenient bracket notation.
- `[ ]` is the empty list.
- `[x, 2+2, [a, b, c]]` is a list of three elements.
- The first element in the list is its “head”.
- The list with the head removed is the “tail”.



Lists

- Unification can be performed on lists:
  - - [a, b, c] = [X, Y, Z] results in

results in X = a, Y = b, Z = c

  - - [a, b, c] = [Head | Tail]

results in Head = a, Tail = [b, c]

- Nonempty lists can be matched against [Head|Tail].
- Empty lists will not match [Head|Tail].

Matching Heads and Tails

- If [a, b, c] = [Head | Tail] then,
  - a = Head and [b, c] = Tail
- If [a, b, c] = [X, Y | Tail], then
  - a = X, b = Y, and [c] = Tail
- If [a, b, c] = [X, Y, Z | Tail], then
  - a = X, b = Y, c = Z, and [ ] = Tail
- The tail of a list is always itself a list.

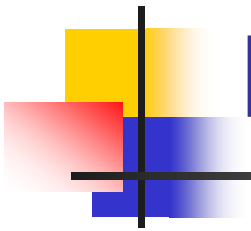
  [X | Y, Z] isn't legal.

Making Use of Unification

- • Prolog has no functions. But you can use a parameter as an “output variable.”
  - first([Head | Tail], X) :- X = Head.
- • You can use unification in parameter lists to do much of the needed work
  - first([X | _], X).
  - second([_, X | _], X).
  - third([_, _, X | _], X).

Structures and Lists

- The “univ” operator, =.. , can be used to convert between structures and lists:
  - loves(chuck, X) =.. [loves, chuck, X]
- • Double quotes indicate a list of ASCII values:
  - “abc” = [97, 98, 99]
    - This isn’t usually very useful.

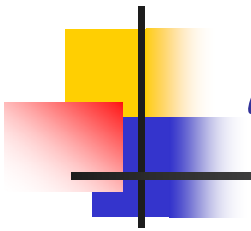


Recursion

- Recursion is fully supported

```
element(1, [X | _ ], X).
element(N, [ _ | X], Y) :- M is N - 1, element(M, X, Y).
```

- This is the typical way to process lists: do something with the head, recur with the tail.



member

```
member(X, [X | _ ]).
member(X, [ _ | Y]) :- member(X, Y).
```

- As usual, base cases go first, then recursive cases.
- There is in general no need for a “fail” case, because that’s automatic.

```
member( _, [ ]) :- fail.
```

Accumulated Information

- • If you reach a clause, you can assume that the earlier clauses of the same predicate have failed.

  ```
  member(X, [X | _ ]).
  ```

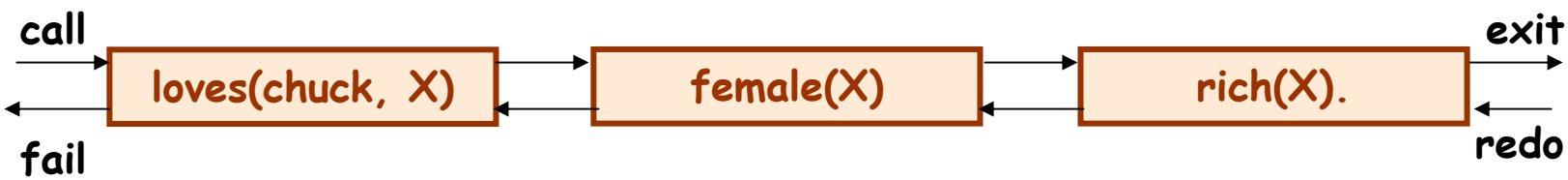
- • If you fail this clause, the first element is not the one you want, so

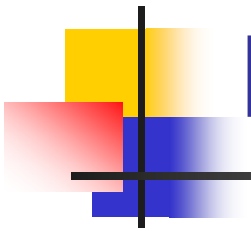
  ```
  member(X, [ _ | Y] :- member(X, Y).
  ```

Backtracking and Beads

- Each Prolog call is like a “bead” in a string of beads:


```
loves(chuck, X) :- female(X), rich(X).
```





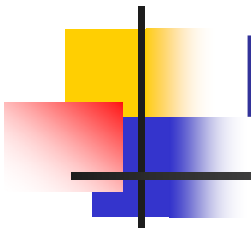
Fail Loops

- It is possible to build a “fail loop” in Prolog

```
print_elements(List) :-
member(X, List), write(X), nl, fail.
```

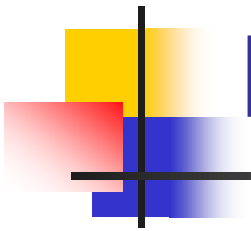
- But recursion is almost always better:

```
print_elements([Head|Tail]) :-
write(Head), nl, print_elements(Tail).
```



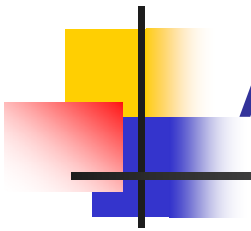
Forcing a predicate to succeed

```
notice_objects_at(Place) :- at(X, Place),
write('There is a '), write(X),
write(' here.'), nl, fail.
notice_objects_at(_).
```



Forcing a predicate to fail

```
loves(chuck, X) :- really_ugly(X), !, fail.
loves(chuck, X) :- female(X), rich(X).
```

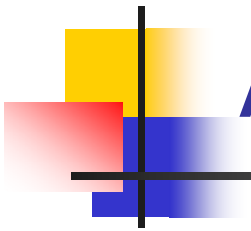


Asserting Clauses

```
assert( new_clause).
assert(path(garden, n, toolshed)).
assert(( loves(chuck,X) :- female(X) ,
   rich(X) )).
asserta( new_clause).
assertz( new_clause).
```

Removing clauses

- retract(clause).
- retract(path(garden, n, toolshed)).
- retract(path(X, Y, X)).
- retract((loves(chuck,X) :- female(X) , rich(X))).
- abolish(path, 3).



Arithmetic

- The equals sign, =, means “unify.”
- 2 + 2 does not unify with 4.
- To force arithmetic to be performed, use “is”: `X is 2 + 2, X = 4.`
- Comparisons =:= =/= > >= < <= also force their operands to be evaluated.
- + - * / mod, *when evaluated*, have their usual meanings.