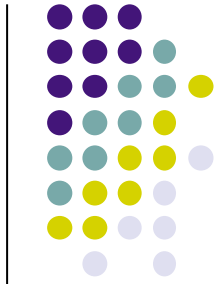
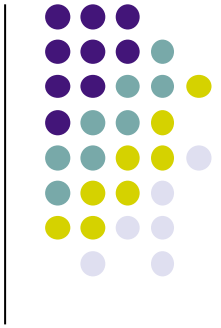
# The functional kernel language



- Now we have seen all the concepts in the functional paradigm that we will use
  - We can define its full kernel language
- We will use this kernel language to understand exactly what a functional program does
  - We have used it to see why list functions are tail-recursive
  - We will use it as part of the formal semantics (in lesson 6)
- Each time we introduce a new paradigm in the course we will define its kernel language
  - Each extends the functional kernel language with a new concept

# The functional kernel language (in part)

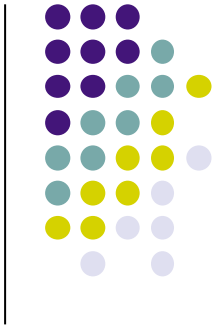


- <s> ::= **skip**
  | <s>$_1$ <s>$_2$
  | **local** <x> **in** <s> **end**
  | <x>$_1$=<x>$_2$
  | <x>=<v>
  | **if** <x> **then** <s>$_1$ **else** <s>$_2$ **end**
  | **proc** {<x> <x>$_1$ … <x>$_n$} <s> **end**
  | {<x> <y>$_1$ … <y>$_n$}
  | **case** <x> **of** <p> **then** <s>$_1$ **else** <s>$_2$ **end**

This is what we have seen so far

- <v> ::= <number> | <list> | ...
- <number> ::= <int> | <float>
- <list>, <p> ::= nil | <x> | <x> '|' <list>

# The functional kernel language (in part)



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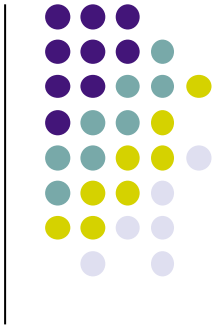
- <list>, <p> ::= nil | <x> | <x> '|' <list>

This is what we have seen so far; it needs *two changes* to become the full kernel language of the functional paradigm

1. Procedure declarations (should be values)

2. Compound types (should be more than lists only)

# The functional kernel language (in part)



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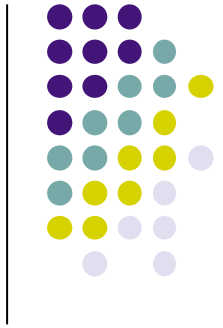
  | **if** <x> **then** <s>$_1$ **else** <s>$_2$ **end**
  | ~~**proc** {<x> <x>$_1$ … <x>$_n$} <s> **end**~~
  | {<x> <y>$_1$ … <y>$_n$}
  | **case** <x> **of** <p> **then** <s>$_1$ **else** <s>$_2$ **end**
- <v> ::= <number> | <procedure> | <list> | ...
- <number> ::= <int> | <float>
- <procedure> ::= **proc** {$ <x>$_1$ … <x>$_n$} <s> **end**
- <list>, <p> ::= nil | <x> | <x> '|' <list>

1. Procedures are values in memory (like numbers and lists)

# The functional kernel language (complete)



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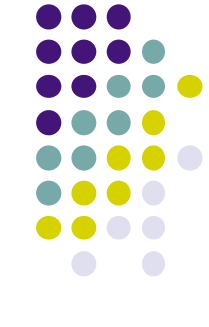
  | {<x> <y>$_1$ … <y>$_n$}
  | **case** <x> **of** <p> **then** <s>$_1$ **else** <s>$_2$ **end**
- <v> ::= <number> | <procedure> ~~| <list>~~ | <record>
- <number> ::= <int> | <float>
- <procedure> ::= **proc** {$ <x>$_1$ … <x>$_n$} <s> **end**
- <record>, <p> ::= <lit> | <lit>(<f>$_1$:<x>$_1$ … <f>$_n$:<x>$_n$)

2. Records subsume lists

# The functional kernel language (complete)



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  | **if** <x> **then** <s>$_1$ **else** <s>$_2$ **end**
  | {<x> <y>$_1$ … <y>$_n$}
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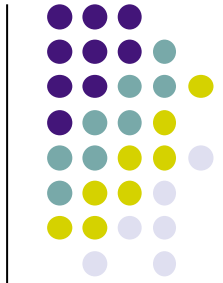
- <v> ::= <number> | <procedure> | <record>
- <number> ::= <int> | <float>
- <procedure> ::= **proc** {$ <x>$_1$ … <x>$_n$} <s> **end**
- <record>, <p> ::= <lit> | <lit>(<f>$_1$:<x>$_1$ … <f>$_n$:<x>$_n$)

Procedure values and records are important basic types. They allow, for example, to define all the concepts of object-oriented programming.

# Kernel language of the functional paradigm



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- <v> ::= <number> | <procedure> | <record>
- <number> ::= <int> | <float>
- <procedure> ::= **proc** {$ <x>$_1$ … <x>$_n$} <s> **end**
- <record>, <p> ::= <lit> | <lit>(<f>$_1$:<x>$_1$ … <f>$_n$:<x>$_n$)

# Three ways to understand languages