

# Can Programming be Liberated from the von Neumann Style?

Manoj Kurapati and Leela Pakanati

## Criteria for Programs

- Elegant and concise mathematical description
- Notion of storage
- Reducible to simpler programs
- Clear expressions of computation

## Classifications of Models

- Simple Operational Model: Turing Machines
  - Not clear
  - Not conceptually helpful
- Applicative Model: Lambda Calculus
  - No storage
  - Not historically sensitive
- Von Neumann Model: conventional programming languages
  - Not elegant or concise

## Problems with von Neumann languages

- Word-at-a-Time bottleneck
- Complex Frameworks
- Few changeable parts with little expressive power
- No useful mathematical properties

## Alternatives to von Neumann languages

- Functional Programming Systems (FP Systems)
  - Built on the idea of combining new functions from existing functions
  - The goal is to program to build functions without variables
  - All functions map objects to objects and only take one argument
- Applicative State Transition Systems (AST Systems)
  - Keeps history sensitivity
  - Loosely coupled to states
  - Underlying Applicative System
- Formal Functional Programming (FFP) Systems
  - FP Systems have a major limiting factor where new functional forms cannot be made
  - FFP Systems allow for one to create new functional forms

## Functional Programming (FP) Systems

- Examples of Objects:
  - $\langle A, \langle \langle B \rangle, C \rangle, D \rangle$
- $f:x$  denotes an application. For example:
  - $+: \langle 1, 2 \rangle = 3$
- Functions are either provided primitive functions or functional forms
  - Primitive functions are basic functions supplied by the system
  - Functional forms are composed of multiple functions
- Definitions assign a function symbol to a functional form
  - $\text{Def } l \equiv r$ 
    - $l$  is functional symbol and  $r$  is the functional form

# Applicative State Transition (AST) Systems

- 3 Elements:
  - Applicative subsystem
  - State 'D'
  - State Transition Rules
- States persist during computation
  - Outputs and New State

