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Programming Paradigms, Software Architectural Patterns, and MVC

Programming Paradigms

Functional Programming (1930s to present): all about the evaluation of mathematical functions. Avoids state changes and mutable data.

- ”Programming” really done with expressions, not statements
- Output of a function depends solely on its arguments, so calling the same function twice with the same arguments will always give you the same result
- Lambda calculus, logic programming, Lisp, Scheme, Haskell

Programming Paradigms

Imperative Programming (1950s to 1970s): defines computation as statements that change a program state.

- Think “verbs”
- A variable contains a value, an assignment statement changes it
- A print statements sends a value to output
- A “go to” transfers control to another statement
- Functions and subprograms not really emphasized: used for code reuse only
- FORTRAN, COBOL, PL/1, Algol, Basic

Procedural Programming focused on *procedures*, also known as “routines”, “subroutines” and “functions”.

- Unlike the “functions” in functional programming, functions here are simply steps to be executed in order
- A procedure can be called at any time
- “Modularizing” programs encouraged
- With *scoping*, state changes can be global or localized within procedures
- Communication between multiple procedures is managed via passing parameters and return values, and values of arguments can be changed

Structured Programming focused on making programs easier to write, debug, and understand

- Proliferation of subprograms, block structures, and different kinds of statements
- if vs. if-then-else, C-style for vs. “in”-style for, while vs. repeat loops
- “go to” statements considered blasphemous
- Pascal, C

Programming Paradigms

Declarative Programming defines computational logic without defining its control flow

- Prolog, SQL

Object-Oriented Programming organizes programs as objects: data structures with attributes and methods together with their interactions.

- C++, Java, Python

In Automata-Based Programming, a program, or part of a program, is treated as a model of a finite state machine or similar formal automaton.

Programming Paradigms

In Event-Driven Programming, control flow is determined by events, such as input from sensors or user actions (mouse clicks, key presses, etc.) or messages from other programs or threads

- The notion is that the application sits, waiting for input from the user — which can come from many directions.
- *Event-driven programming is the dominant paradigm* for graphical user interfaces and other applications that are centered on performing certain actions in response to user input.

Software Architectural Patterns

Software Architectural Patterns are reusable approaches or solutions to problems in software design that show up frequently.

- They act like templates on which you base your software
- Software architectural patterns are conceptual, such as “peer-to-peer networking”.
- Software architectures are actual implementations of a pattern, such as TCP/IP.

SW Architectural Pattern: Model-View-Controller

Model-View-Controller (MVC) is a software architectural pattern for implementing user interfaces.

- It follows the event-driven paradigm for control flow.
- It divides an application into three interconnected parts in order to separate internal structures from the way they're presented to the user.

Model

- Consists of objects that encapsulate the data specific to the application
- Defines the logic and computations that manipulate and process that data.

SW Architectural Pattern: Model-View-Controller

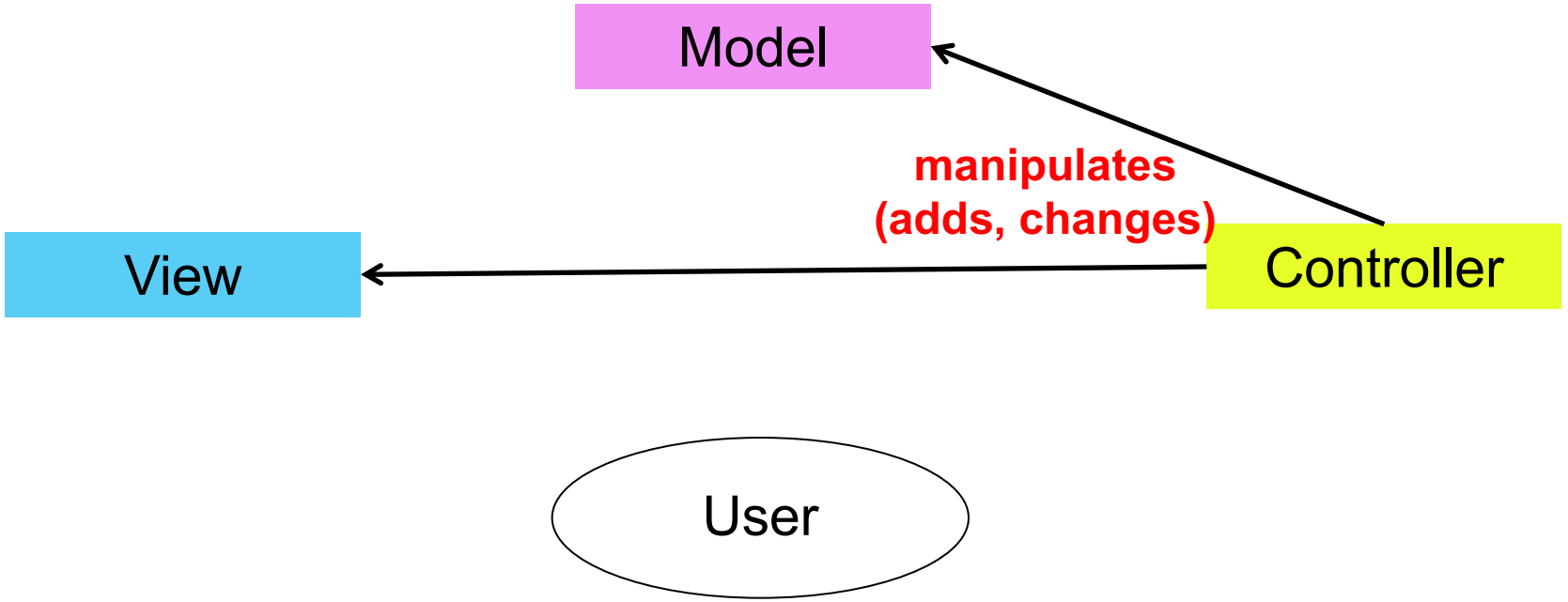
View

- Any object in an application that users can see. Main purpose: to display data from the model objects and enable editing of that data
- View objects know how to draw themselves, and can respond to user actions
- Provide consistency between applications
- Multiple views of the same information is possible; for example, a bar chart for management and a table view for finance.

Controller

- Acts as an intermediary between view objects and model objects
- Accepts input and converts it to commands for the model or view
- Can also perform setup and coordinating tasks for an application and manage the life cycles of objects

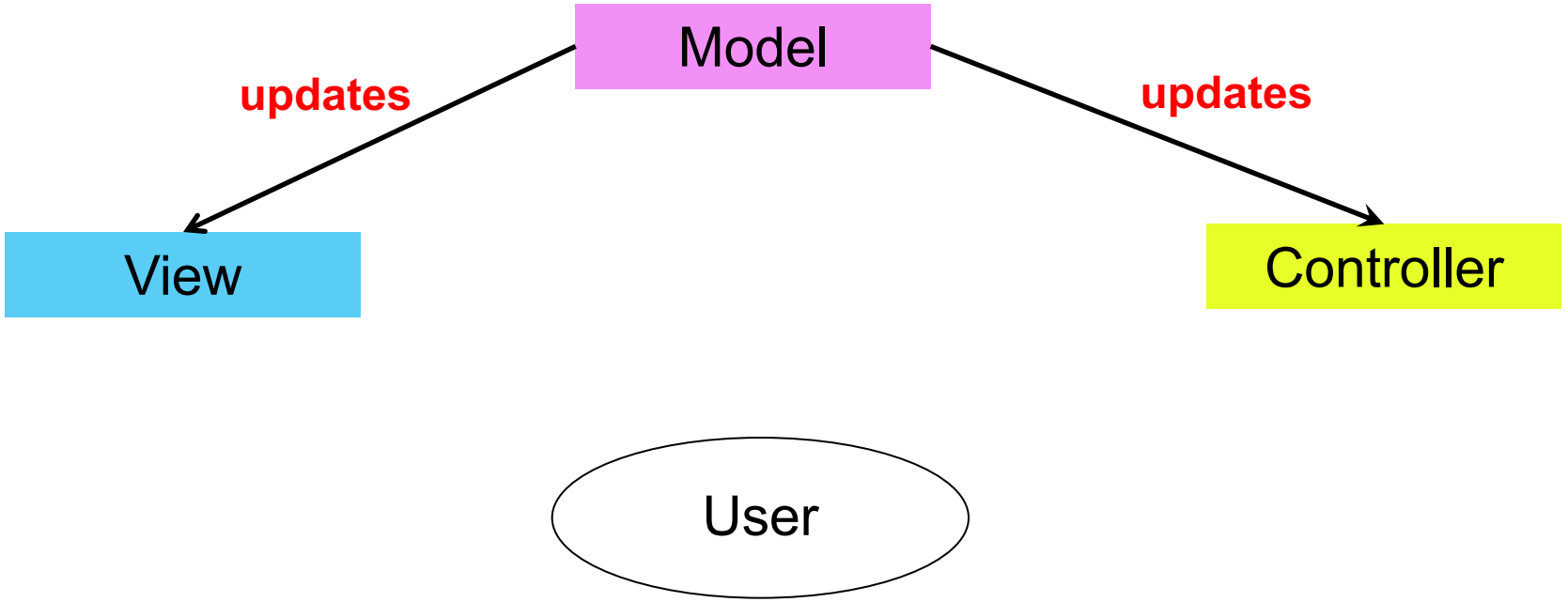
MVC: Controller



Controller:

- Interprets user actions made in view objects and communicates changes to the model to update the model's state
- When model objects change, controller communicates changes to the view to change the view's presentation

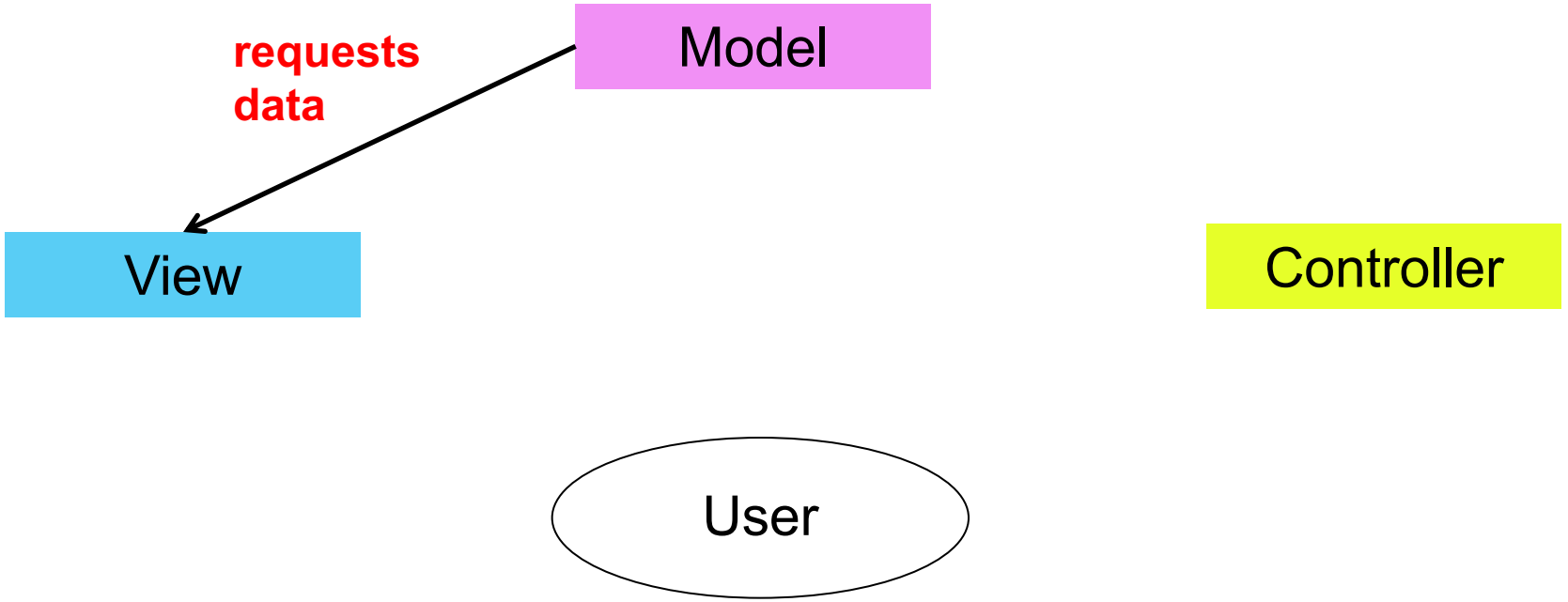
MVC: Model



Model:

- Tells the View when there has been a state change, causing the output from the View to be updated.
- Tells the Controller when there has been a state change, causing the Controller to change the set of commands available.

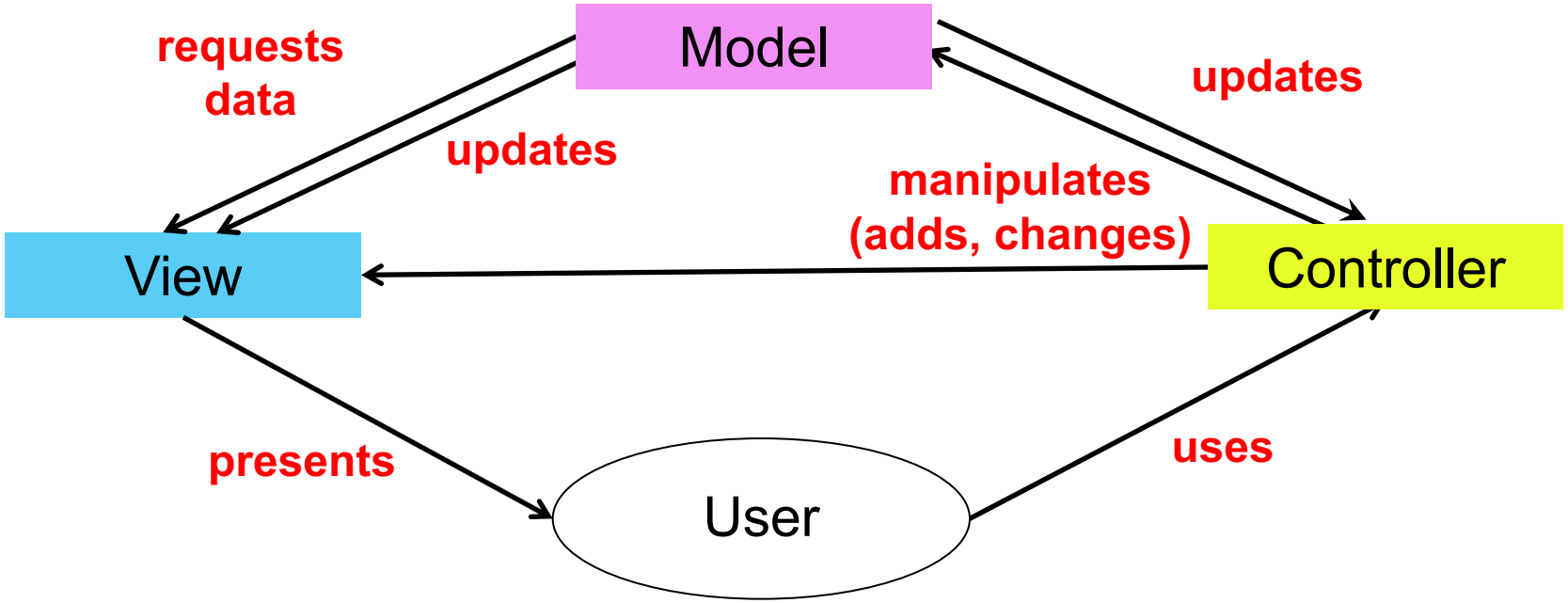
MVC: View



View:

- Requests information from the model that it uses to generate output to the user

MVC (cont.)



Note that the user never interacts directly with the model.

Model-View-Controller (cont.)

Model-View-Controller is often used in Web applications and Mobile applications.

- The View presents a window with controls to the user
- Any data that the user enters is sent to the Controller; for example, selecting an item such as “Notifications”.
- The Controller updates the Model (i.e., stores the data in a data structure, updates objects, etc.)
- The Model tells the View to display a different window
- The Model also tells the Controller that the controls from the previous window no longer work, and there are new ones to pay attention to.