Architectural Patterns

Idaho State University | Computer Science

Isaac Griffith

CS 3321
Department of Computer Science
Idaho State University

ROAR

Idaho State University
Computer Science

Topics Covered

- Architectural patterns
- Application architectures

ROAR

More Architectural patterns

Repository architecture

- Sub-systems must exchange data. This may be done in two ways:
  - Shared data is held in a central database or repository and may be accessed by all sub-systems;
  - Each sub-system maintains its own database and passes data explicitly to other sub-systems.
- When large amounts of data are to be shared, the repository model of sharing is most commonly used a this is an efficient data sharing mechanism.

Idaho State University
Computer Science

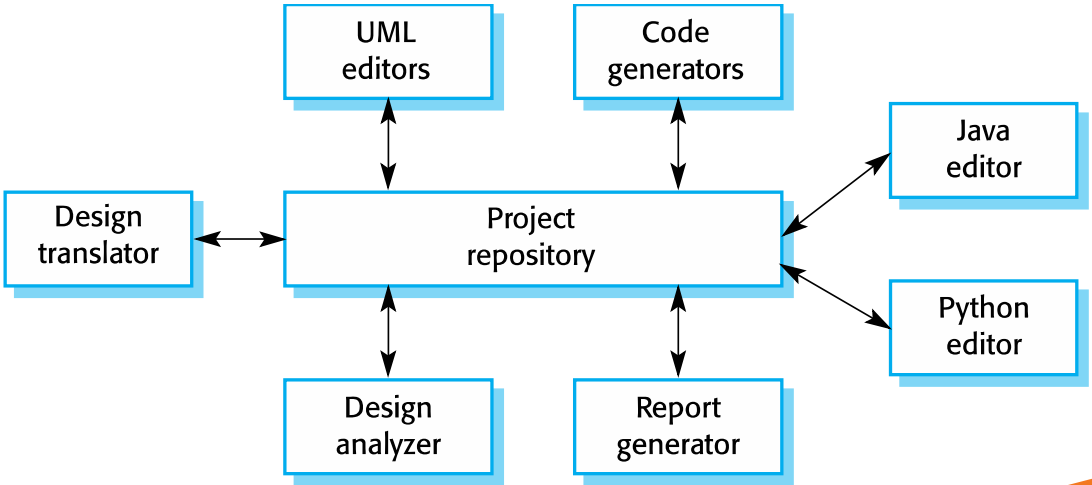
The Repository pattern

- **Description**
  - All data in a system is managed in a central repository that is accessible to all system components. Components do not interact directly, only through the repository.
- **Example**
  - Figure 6.9 is an example of an IDE where the components use a repository of system design information. Each software tool generates information which is then available for use by other tools.
- **When used**
  - You should use this pattern when you have a system in which large volumes of information are generated that has to be stored for a long time. You may also use it in data-driven systems where the inclusion of data in the repository triggers an action or tool.

The Repository pattern

- **Advantages**
  - Components can be independent—they do not need to know of the existence of other components. Changes made by one component can be propagated to all components. All data can be managed consistently (e.g., backups done at the same time) as it is all in one place.
- **Disadvantages**
  - The repository is a single point of failure so problems in the repository affect the whole system. May be inefficiencies in organizing all communication through the repository. Distributing the repository across several computers may be difficult.

Repository architecture for an IDE



Client-server architecture

- Distributed system model which shows how data and processing is distributed across a range of components.
  - Can be implemented on a single computer.
- Set of stand-alone servers which provide specific services such as printing, data management, etc.
- Set of clients which call on these services.
- Network which allows clients to access servers.

The Client-server pattern

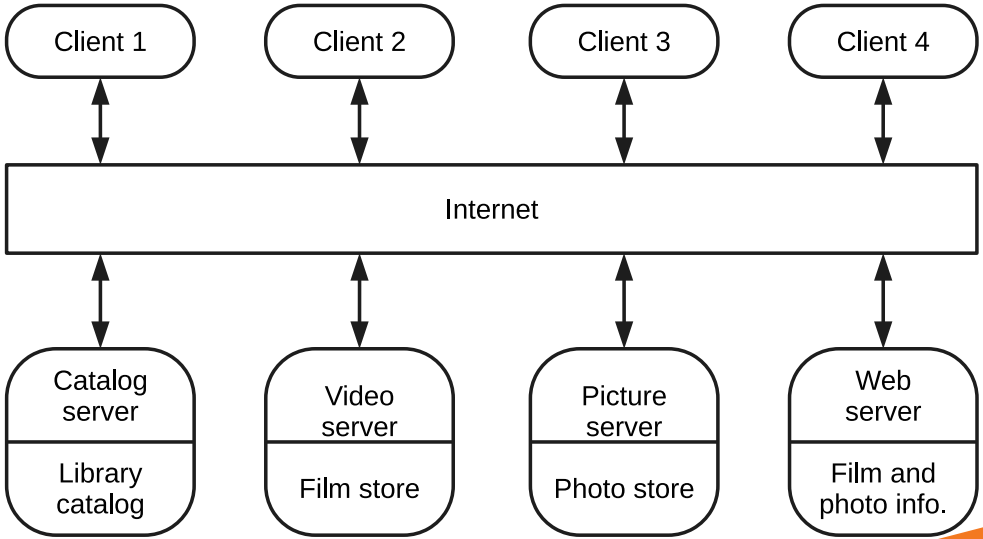
- **Description**
  - In a client–server architecture, the functionality of the system is organized into services, with each service delivered from a separate server. Clients are users of these services and access servers to make use of them.
- **Example**
  - Figure 6.11 is an example of a film and video/DVD library organized as a client–server system.
- **When used**
  - Used when data in a shared database has to be accessed from a range of locations. Because servers can be replicated, may also be used when the load on a system is variable.

The Client-server pattern

- **Advantages**
  - The principal advantage of this model is that servers can be distributed across a network. General functionality (e.g., a printing service) can be available to all clients and does not need to be implemented by all services.
- **Disadvantages**
  - Each service is a single point of failure so susceptible to denial of service attacks or server failure. Performance may be unpredictable because it depends on the network as well as the system. May be management problems if servers are owned by different organizations.

Idaho State University
Computer Science

Client-server arch for film library



ROAR

Pipe and filter architecture

- Functional transformations process their inputs to produce outputs.
- May be referred to as a pipe and filter model (as in UNIX shell).
- Variants of this approach are very common. When transformations are sequential, this is a batch sequential model which is extensively used in data processing systems.
- Not really suitable for interactive systems.

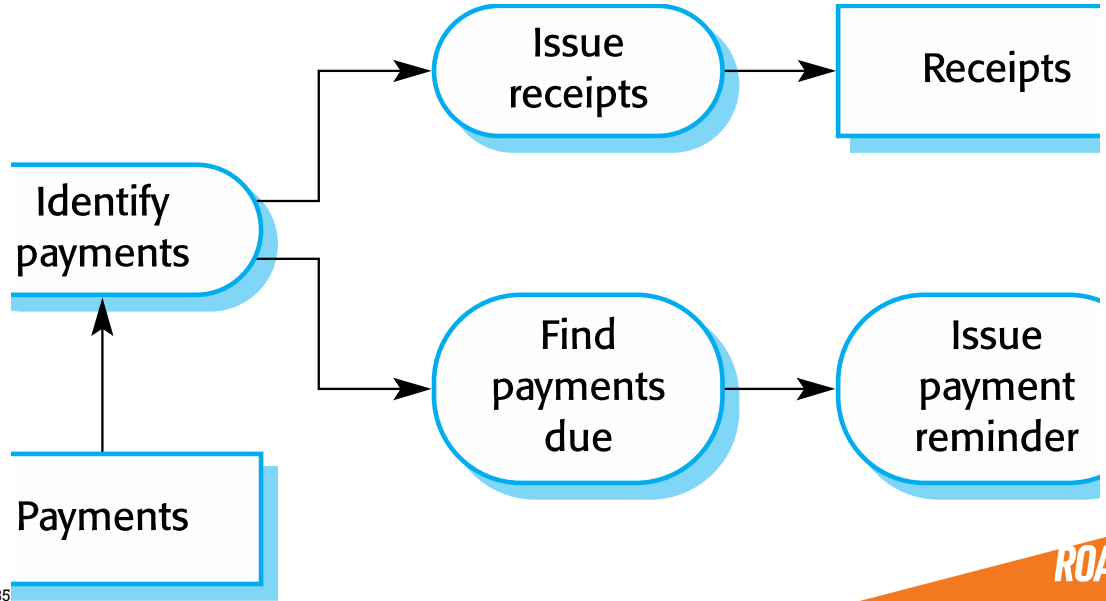
The pipe and filter pattern

- **Description**
  - The processing of the data in a system is organized so that each processing component (filter) is discrete and carries out one type of data transformation. The data flows (as in a pipe) from one component to another for processing.
- **Example**
  - Figure 6.13 is an example of a pipe and filter system used for processing invoices.
- **When used**
  - Commonly used in data processing applications (both batch- and transaction-based) where inputs are processed in separate stages to generate related outputs.

The pipe and filter pattern

- **Advantages**
  - Easy to understand and supports transformation reuse. Workflow style matches the structure of many business processes. Evolution by adding transformations is straightforward. Can be implemented as either a sequential or concurrent system.
- **Disadvantages**
  - The format for data transfer has to be agreed upon between communicating transformations. Each transformation must parse its input and unparse its output to the agreed form. This increases system overhead and may mean that it is impossible to reuse functional transformations that use incompatible data structures.

Pipe and filter example



Application architectures

Application architectures

- Application systems are designed to meet an organizational need.
- As businesses have much in common, their application systems also tend to have a common architecture that reflects the application requirements.
- A generic application architecture is an architecture for a type of software system that may be configured and adapted to create a system that meets specific requirements.

Use of application architectures

- As a starting point for architectural design.
- As a design checklist.
- As a way of organizing the work of the development team.
- As a means of assessing components for reuse.
- As a vocabulary for talking about application types.

Idaho State University
Computer Science

Examples of application types

- Data processing applications
  - Data driven applications that process data in batches without explicit user intervention during the processing.
- Transaction processing applications
  - Data-centered applications that process user requests and update information in a system database.
- Event processing systems
  - Applications where system actions depend on interpreting events from the system's environment.
- Language processing systems
  - Applications where the users' intentions are specified in a formal language that is processed and interpreted by the system.

ROAR

Application type examples

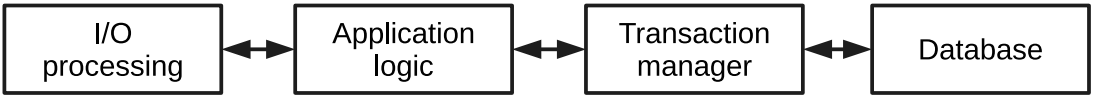
- Two very widely used generic application architectures are transaction processing systems and language processing systems.
- Transaction processing systems
  - E-commerce systems;
  - Reservation systems.
- Language processing systems
  - Compilers;
  - Command interpreters.

Idaho State University
Computer Science

Transaction processing systems

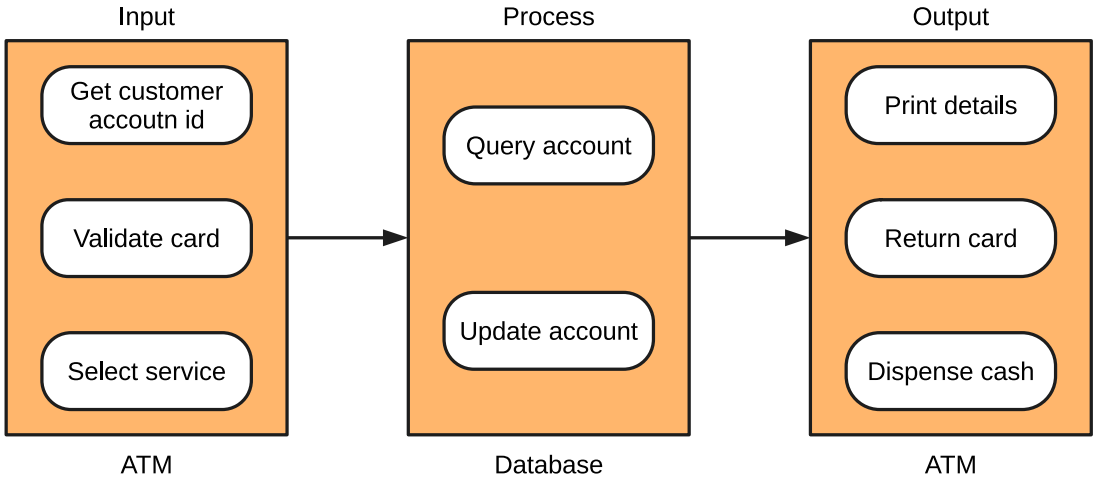
- Process user requests for information from a database or requests to update the database.
- From a user perspective a transaction is:
  - Any coherent sequence of operations that satisfies a goal;
  - For example - find the times of flights from London to Paris.
- Users make asynchronous requests for service which are then processed by a transaction manager.

Transaction processing app structure



Idaho State University
Computer Science

ATM system architecture



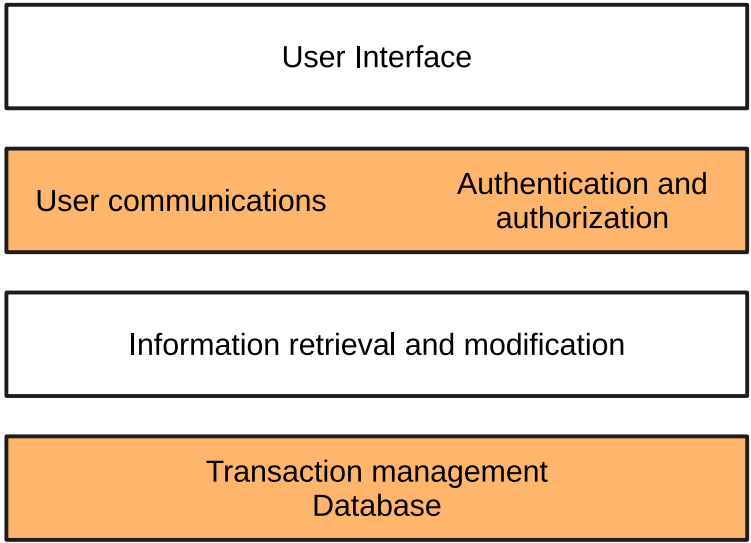
ROAR

Information systems architecture

- Information systems have a generic architecture that can be organized as a layered architecture.
- These are transaction-based systems as interaction with these systems generally involves database transactions.
- Layers include:
  - The user interface
  - User communications
  - Information retrieval
  - System database

Idaho State University
Computer Science

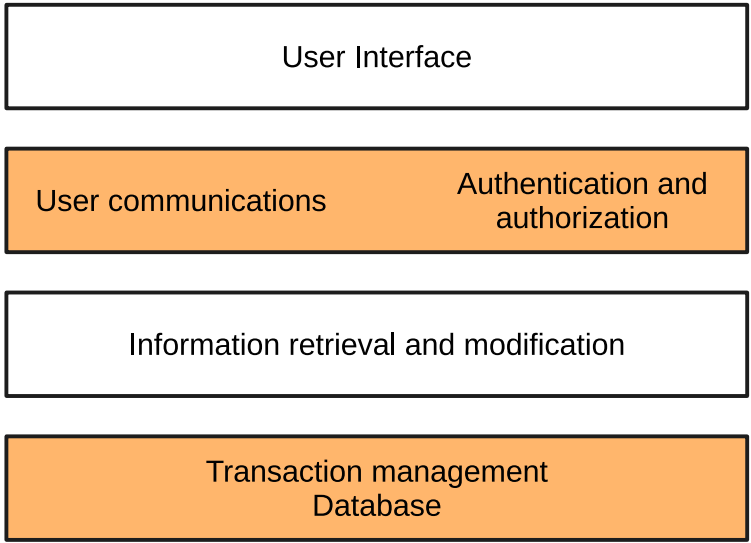
Layered IS architecture



ROAR

Idaho State University
Computer Science

Mentcare architecture



ROAR

Web-based information systems

- Information and resource management systems are now usually web-based systems where the user interfaces are implemented using a web browser.
- For example, e-commerce systems are Internet-based resource management systems that accept electronic orders for goods or services and then arrange delivery of these goods or services to the customer.
- In an e-commerce system, the application-specific layer includes additional functionality supporting a ‘shopping cart’ in which users can place a number of items in separate transactions, then pay for them all together in a single transaction.

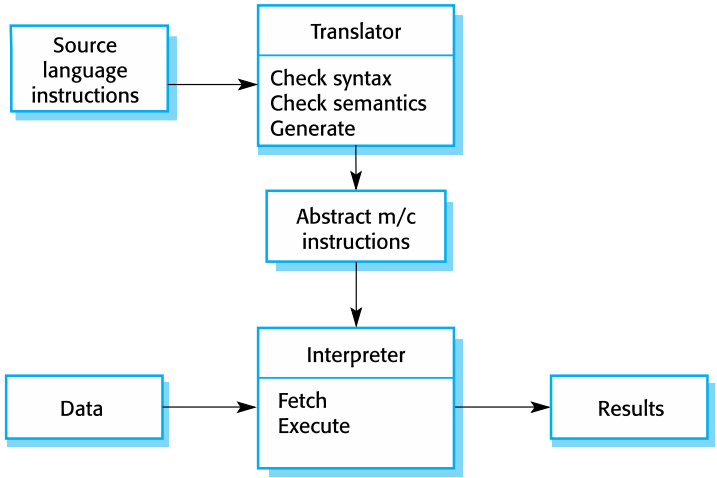
Server implementation

- These systems are often implemented as multi-tier client server/architectures (discussed in Chapter 17)
  - The web server is responsible for all user communications, with the user interface implemented using a web browser;
  - The application server is responsible for implementing application-specific logic as well as information storage and retrieval requests;
  - The database server moves information to and from the database and handles transaction management.

Language processing systems

- Accept a natural or artificial language as input and generate some other representation of that language.
- May include an interpreter to act on the instructions in the language that is being processed.
- Used in situations where the easiest way to solve a problem is to describe an algorithm or describe the system data
  - Meta-case tools process tool descriptions, method rules, etc and generate tools.

Language processing system arch

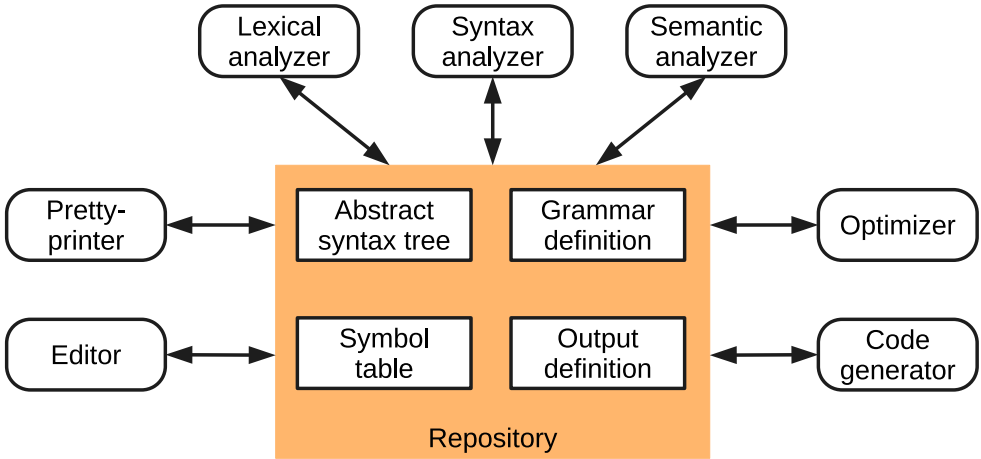


Compiler components

- **Lexical analyzer** - takes input language tokens and converts them to an internal form.
- **Symbol table** - holds information about the names of entities (variables, class names, object names, etc.) used in the text that is being translated.
- **Syntax analyzer** - checks the syntax of the language being translated.
- **Syntax tree** - an internal structure representing the program being compiled.
- **Semantic analyzer** - uses information from the syntax tree and the symbol table to check the semantic correctness of the input language text.
- **Code generator** - 'walks' the syntax tree and generates abstract machine code.

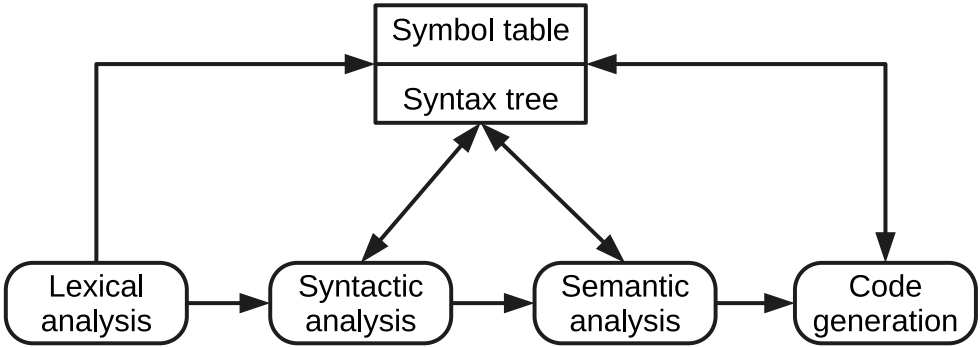
Idaho State University
Computer Science

Repository architecture for LPS



ROAR

A pipe and filter compiler



Key points

- Architectural patterns are a means of reusing knowledge about generic system architectures. They describe the architecture, explain when it may be used and describe its advantages and disadvantages.
- Models of application systems architectures help us understand and compare applications, validate application system designs and assess large-scale components for reuse.
- Transaction processing systems are interactive systems that allow information in a database to be remotely accessed and modified by a number of users.
- Language processing systems are used to translate texts from one language into another and to carry out the instructions specified in the input language. They include a translator and an abstract machine that executes the generated language.

Are there any questions?