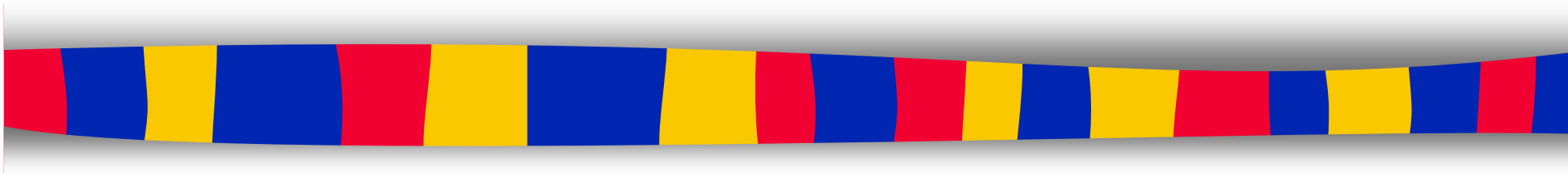
CISC 322
Software Architecture



Lecture 06:
Architecture Styles

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Adapted from Ahmed E. Hassan and Spiros Mancoridis

What are Architectural Styles

- An **Architectural Style** defines a family of systems in terms of a pattern of structural organization. It determines:
  - the **vocabulary** of components and connectors that can be used in instances of that style
  - a set of **constraints** on how they can be combined.

Why Architectural Styles

- Makes for an easy way to communicate among stakeholders
- Documentation of early design decisions
- Allow for the reuse and transfer of qualities to similar systems

Describing an Architectural Style

- The architecture of a specific system is a collection of:
  - computational components
  - description of the interactions between these components (connectors)

Describing an Architectural Style (Cont'd)

- Software architectures are represented as graphs where **nodes** represent components:
  - procedures
  - modules
  - processes
  - tools
  - databases
- and **edges** represent connectors:
  - procedure calls
  - event broadcasts
  - database queries
  - pipes

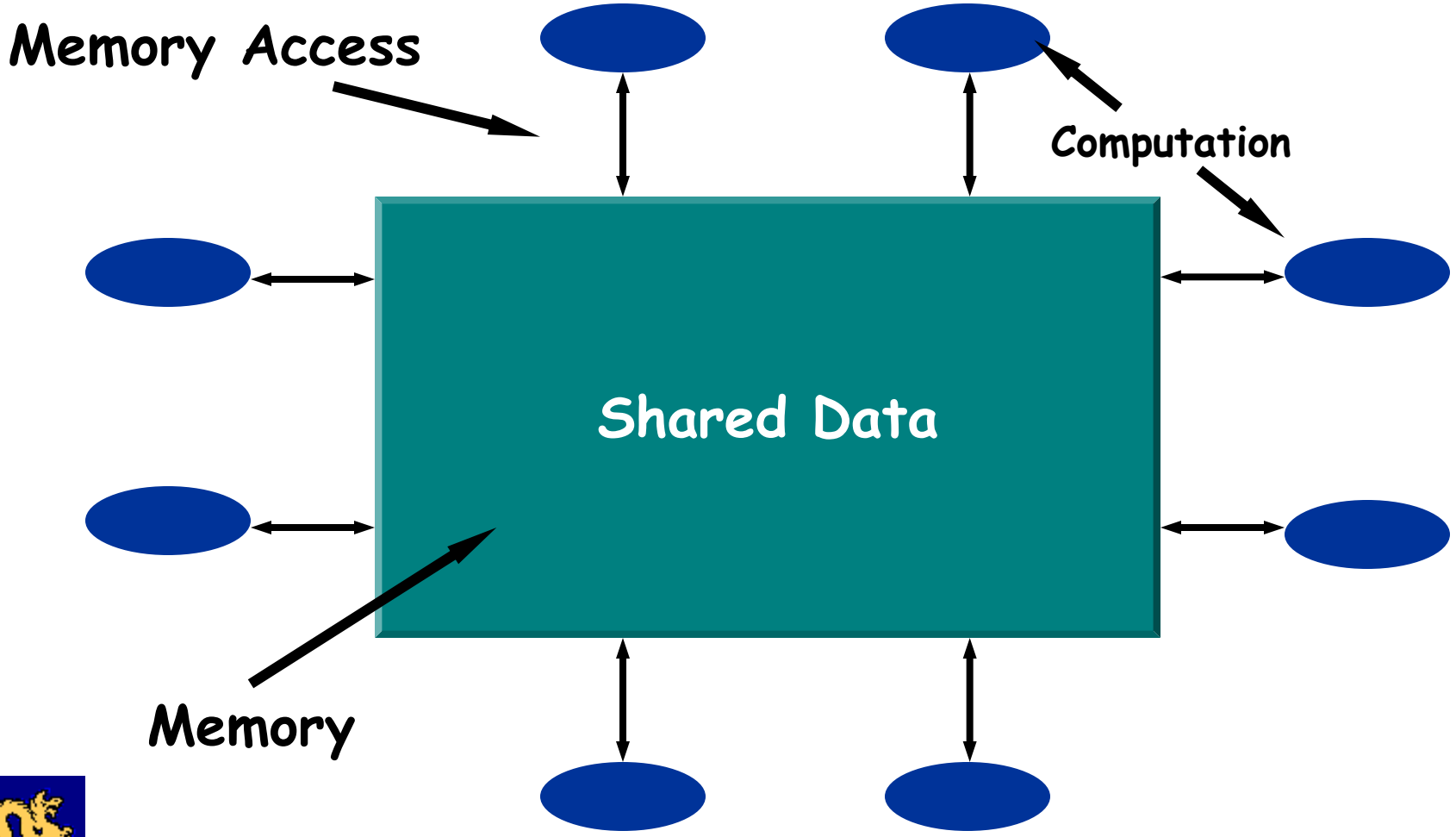
Repository Style

- Suitable for applications in which the central issue is establishing, augmenting, and maintaining a complex central body of information.
- Typically the information must be manipulated in a variety of ways. Often long-term persistence is required.

Repository Style (Cont'd)

- **Components:**
  - A central data structure representing the current state of the system.
  - A collection of independent components that operate on the central data structure.
- **Connectors:**
  - Typically procedure calls or direct memory accesses.

Repository Style (Cont'd)



Repository Style Specializations

- Changes to the data structure trigger computations.
- Data structure in memory (persistent option).
- Data structure on disk.
- Concurrent computations and data accesses.

Repository Style Examples

- Information Systems
- Programming Environments
- Graphical Editors
- AI Knowledge Bases
- Reverse Engineering Systems

Repository Style Advantages

- **Efficient** way to store large amounts of data.
- **Sharing** model is published as the repository schema.
- Centralized **management**:
  - backup
  - security
  - concurrency control

Repository Style Disadvantages

- Must **agree on a data model** a priori.
- Difficult to **distribute data**.
- Data **evolution is expensive**.

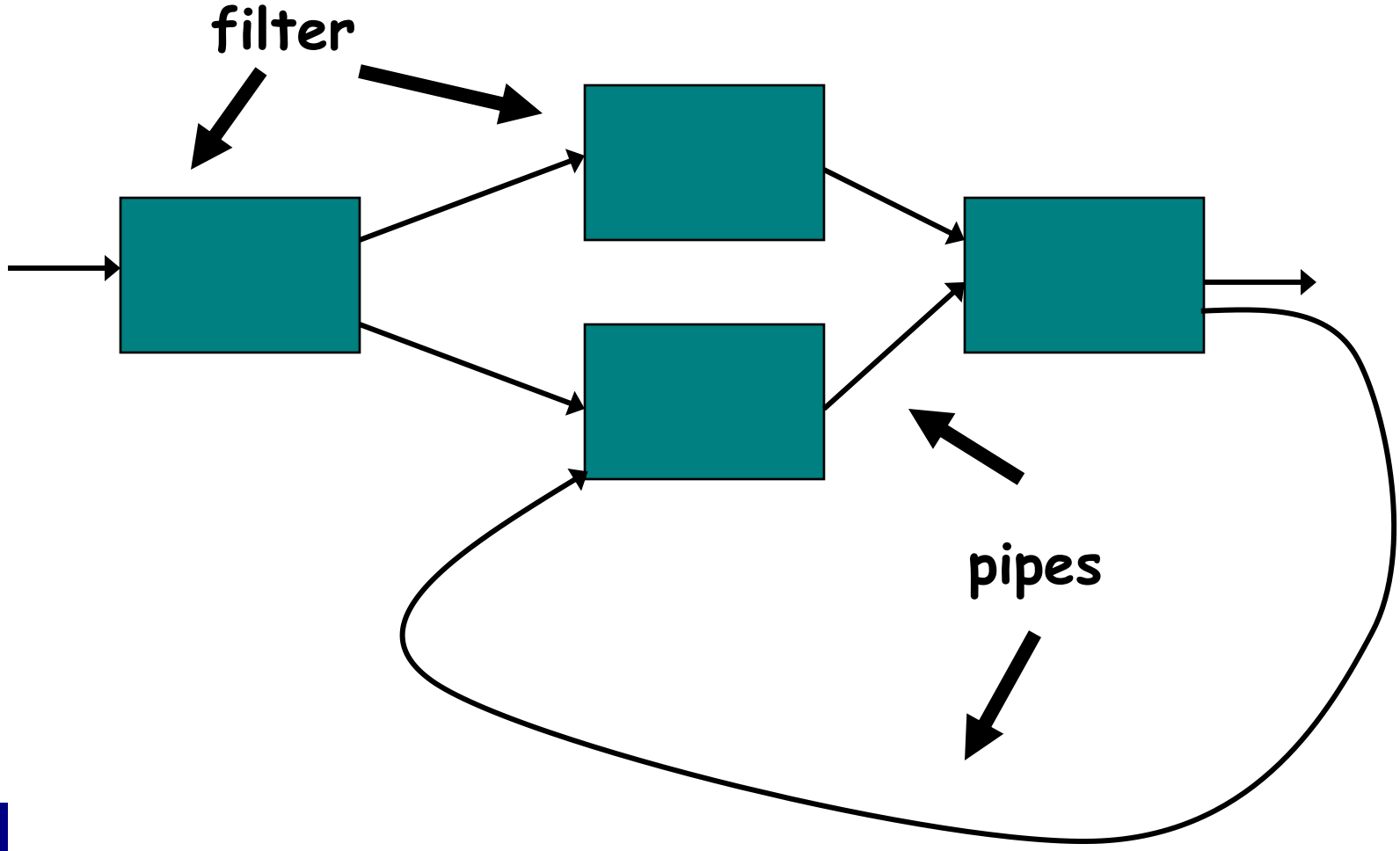
Pipe and Filter Architectural Style

- Suitable for applications that require a defined series of independent computations to be performed on data.
- A component reads streams of data as input and produces streams of data as output.

Pipe and Filter Architectural Style (Cont'd)

- **Components:** called **filters**, apply local transformations to their input streams and often do their computing incrementally so that output begins before all input is consumed.
- **Connectors:** called **pipes**, serve as conduits for the streams, transmitting outputs of one filter to inputs of another filter.

Pipe and Filter Architectural Style (Cont'd)



Pipe and Filter Invariants

- Filters **do not share state** with other filters.
- Filters **do not know the identity** of their upstream or downstream filters.

Pipe and Filter Specializations

- **Pipelines:** Restricts topologies to linear sequences of filters.
- **Batch Sequential:** A degenerate case of a pipeline architecture where each filter processes all of its input data before producing any output.

Pipe and Filter Examples

- **Unix Shell Scripts:** Provides a notation for connecting Unix processes via pipes.
  - *cat file | grep Erroll | wc -l*
- **Traditional Compilers:** Compilation phases are pipelined, though the phases are not always incremental. The phases in the pipeline include:
  - *lexical analysis + parsing + semantic analysis + code generation*

Pipe and Filter Advantages

- **Easy to understand** the overall input/output behavior of a system as a simple composition of the behaviors of the individual filters.
- They **support reuse**, since any two filters can be hooked together, provided they agree on the data that is being transmitted between them.

Pipe and Filter Advantages (Cont'd)

- Systems can be **easily maintained and enhanced**, since new filters can be added to existing systems and old filters can be replaced by improved ones.
- They permit certain kinds of **specialized analysis**, such as throughput and deadlock analysis.
- The naturally **support concurrent execution**.

Pipe and Filter Disadvantages

- Not good choice for **interactive systems**, because of their transformational character.
- Excessive parsing and unparsing leads to **loss of performance** and **increased complexity** in writing the filters themselves.

Case Study: Architecture of a Compiler

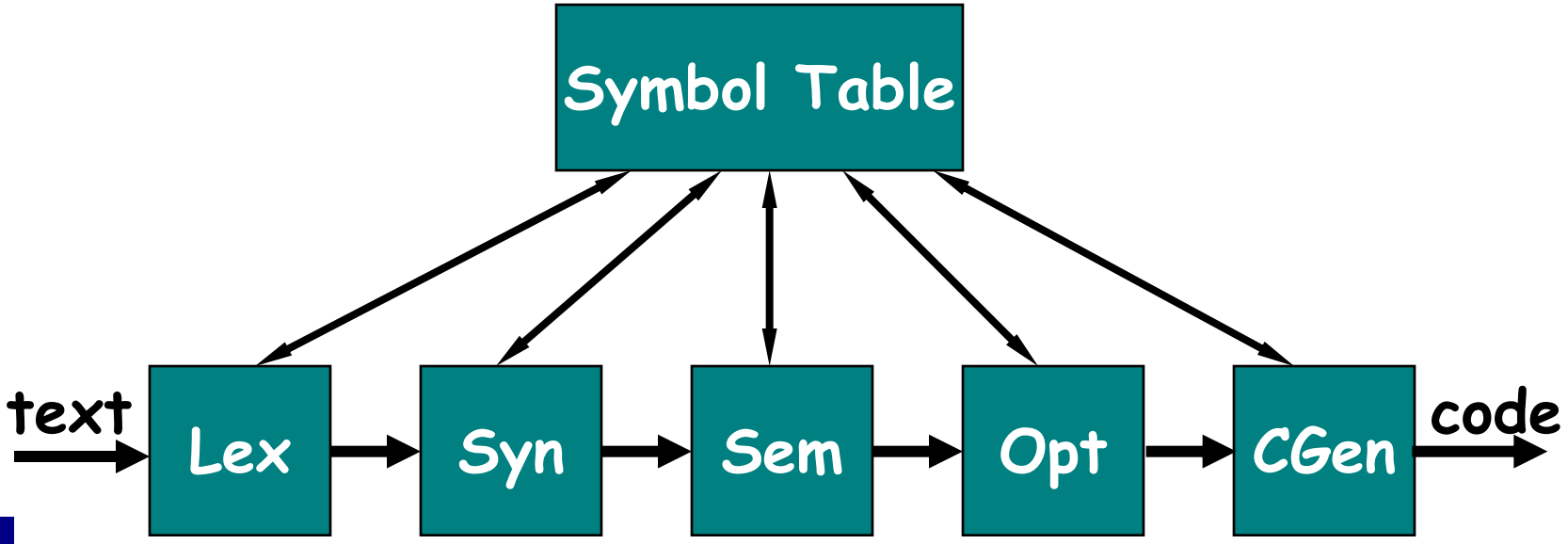
- The architecture of a system can change in response to improvements in technology.
- This can be seen in the way we think about compilers.

Early Compiler Architectures

- In the 1970s, compilation was regarded as a sequential (batch sequential or pipeline) process:

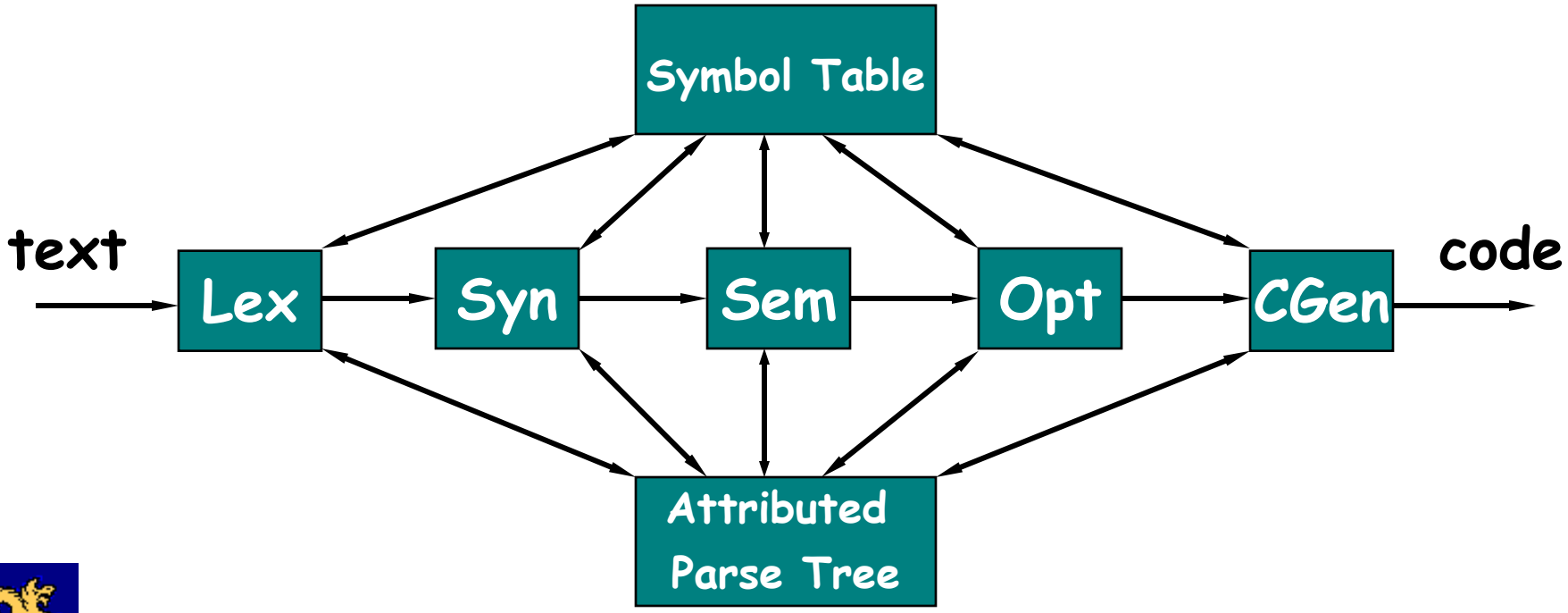
Early Compiler Architectures

- Most compilers create a separate symbol table during lexical analysis and used or updated it during subsequent passes.



Modern Compiler Architectures

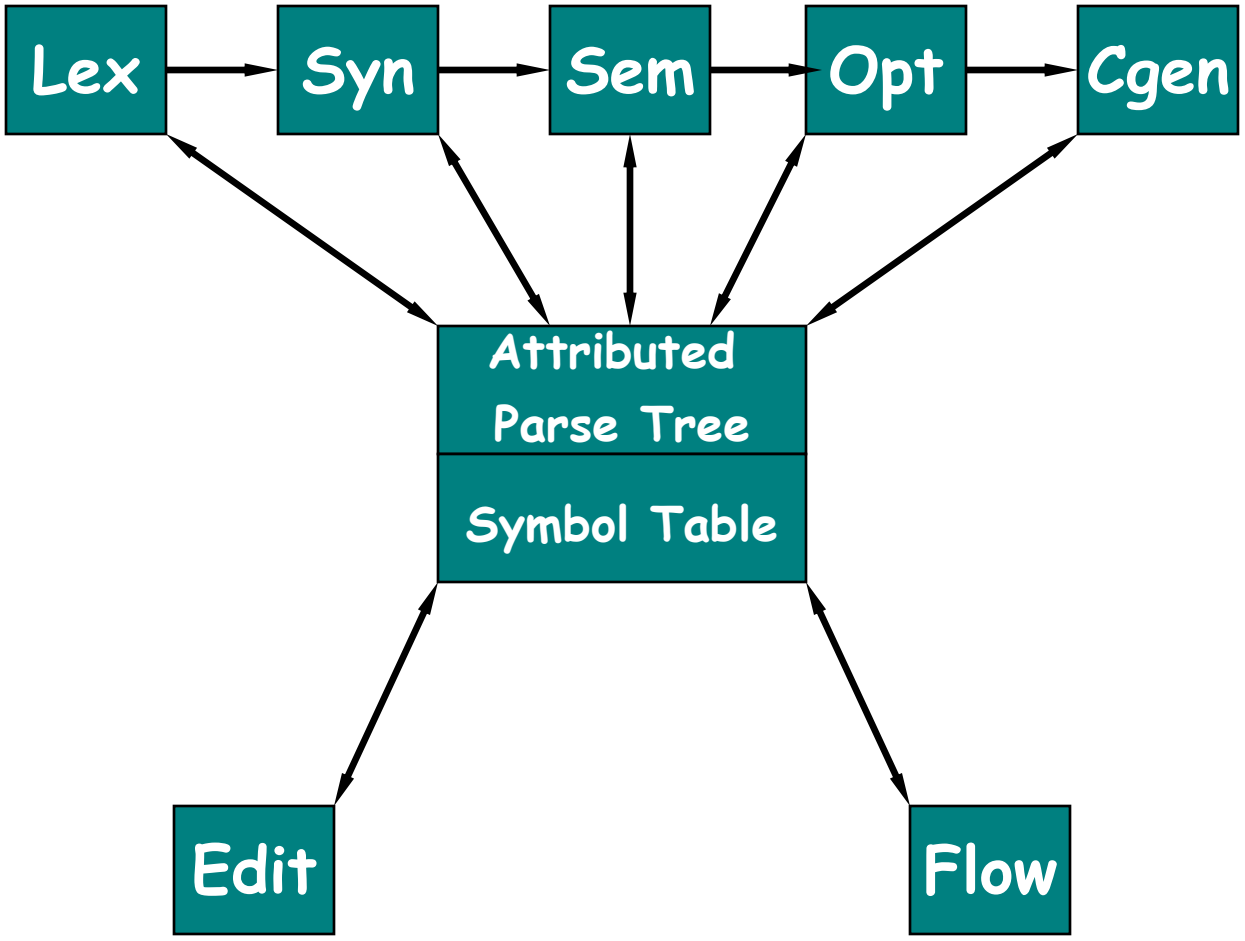
- Later, in the mid 1980s, increasing attention turned to the intermediate representation of the program during compilation.



Hybrid Compiler Architectures

- The new view accommodates various tools (*e.g.*, syntax-directed editors) that operate on the internal representation rather than the textual form of a program.
- Architectural shift to a **repository** style, with elements of the **pipeline** style, since the order of execution of the processes is still predetermined.

Hybrid Compiler Architectures



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