

# COMP3027J

## Software Architecture

### Software Architectural Styles (Data-centered Style )

DENG, YONGJIAN

Faculty of Computer Science, BJUT

Data Mining & Security Lab (DMS Lab)



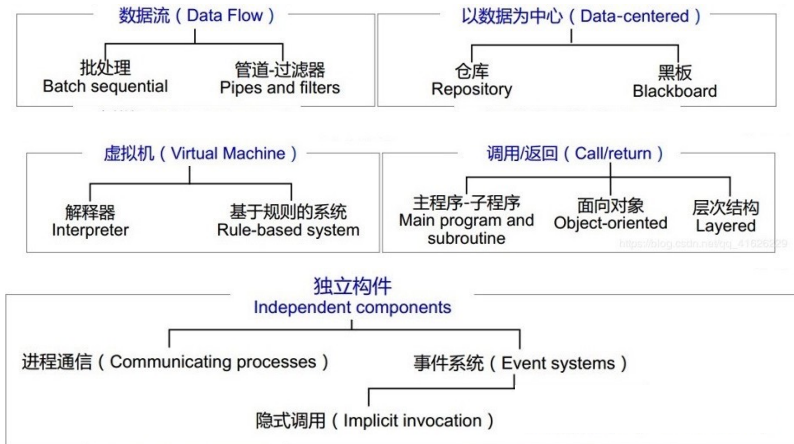
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# Outline

1. Data-centered Style
2. Repository Style
3. Blackboard Style



# Taxonomy of styles



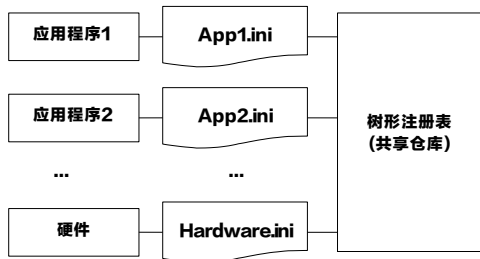
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# Structure of Windows Registry

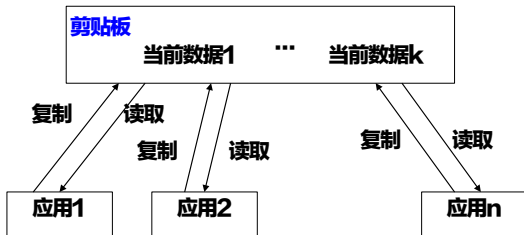
- Initially, the configuration information of the hardware/software system is saved in a configuration file (.ini);
- These files are scattered in all corners of the system, making it difficult to maintain them;
- Introduce the idea of the registry, gather all .ini files to form a shared warehouse, and play the role of centralized resource configuration management and control scheduling for system operation.



# Clipboard

**A software program used for short-term data storage and data transfer and exchange between documents/applications.**

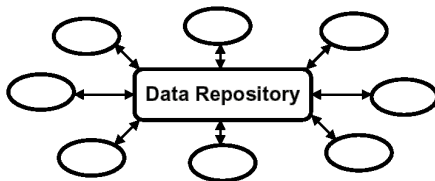
- A common area for storing and exchanging information (forming a shared warehouse);
- Different applications exchange formatted messages through this area;
- Ways to access the clipboard: copy & paste.





## What is Data-centered Style?

Data-centered architecture involves a **shared data source** approach for **information delivery**.



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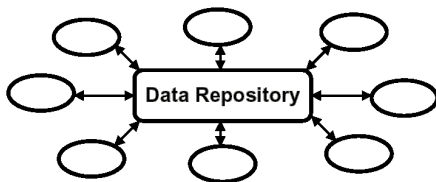


# Repository Style

A repository is a central place where data is stored and maintained. (仓库是存储和维护数据的中心场所)

In a repository style there are two quite distinct kinds of components:

- A central data structure representing the current state; (中心数据结构, 表示当前数据的状态)
- A collection of independent components operates on the central data store. (一组对中心数据进行操作的独立构件).





**Connector: Interactions between the repository and its external components.**

**Two major mechanisms:**

- Database: the types of transactions in an input stream trigger selection of process to execute; (数据库方式: 输入流中的事务类型触发需要执行的过程)
- Blackboard: the current state of the central data structure is the main trigger for selecting processes to execute. (黑板结构: 中心数据结构的当前状态触发并选择需要执行的过程)





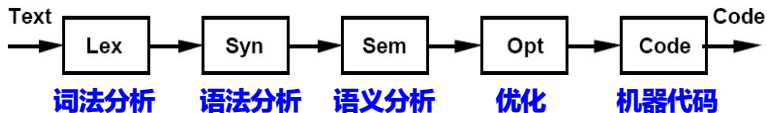
**Problem:** This pattern is suitable for applications in which *the central issue is establishing, augmenting, and maintaining a complex central body of information.*

## Typical application

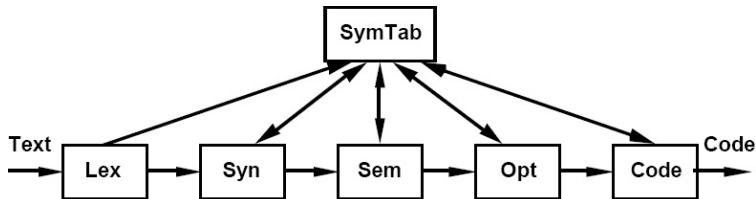
- Data processing (数据处理), driven primarily by the need to build business decision systems from conventional databases.
- Software development environments (软件开发环境), driven primarily by the need to represent and manipulate programs and designs.



# Example: Traditional Compiler Architecture: Batch/Pipeline-Filter



# Example: Traditional Compiler Architecture with Symbol Table



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## For problems as:

- There is no direct algorithm, and multiple methods may solve the problem;
- Unable to find a definite solution strategy (what to do first? What to do next?);
- There is no single solution to the problem: multiple possible solutions may arise at each solution step, and the optimal or acceptable solution needs to be sought.
- Requires expertise in multiple fields to be solved collaboratively.
- For example, natural language processing, speech processing, pattern recognition, image processing, etc.



# Blackboard Style, the answer to the above problems



- A large problem is decomposed into several sub-problems;
- The solution of each sub-problem requires different problem expressions and solution models, and the solution programs are designed separately;
  1. Each solver has a specific field of knowledge and can solve a certain aspect of the problem;
  2. These programs are independent of each other, there is no mutual call between them, and there is no operation sequence that can be determined in advance;





# Blackboard Style, the answer to the above problems



- A large problem is decomposed into several sub-problems;
  - The solution of each sub-problem requires different problem expressions and solution models, and the solution programs are designed separately;
3. According to the state in the process of solving the problem, the operation sequence between the various specialized programs is dynamically determined, and they work together to complete the solution of the entire problem through cooperative work;
  4. A dedicated control program is responsible for invoking the most appropriate solver according to the state of the problem solution, thus forming a random order of execution.

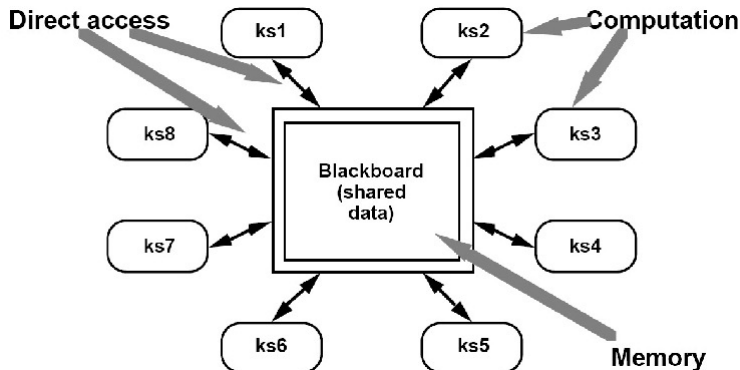


# Structure of Blackboard



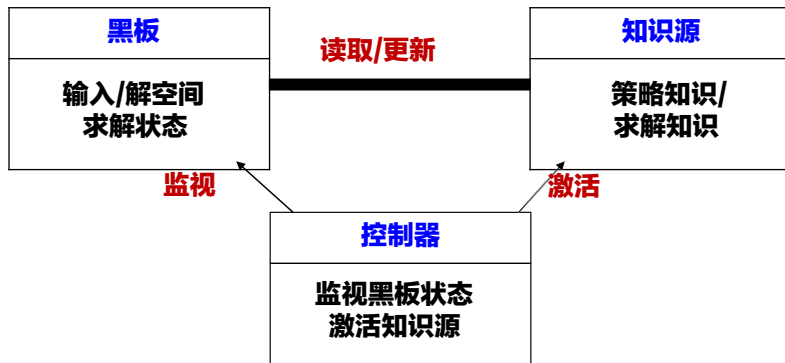
与repository的区分，给出一个例子，判断是用哪种来设计的

The current state of the central data structure triggers and selects the process that needs to be executed



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# Structure of Blackboard Systems



# Blackboard data Structure

1.Global database containing entire state of problem solution (全局数据库，用来存储数据、传递信息，包含解域的全部状态)。

2.problem-solving state data, organized into an application-dependent hierarchy. (解决问题过程中的状态数据，以层次形式组织起来)。

3.knowledge sources make changes to the blackboard that lead incrementally to a solution to the problem. (知识源对黑板进行修改，逐渐找到问题的解)。

4.Only means by which knowledge sources interact (各知识源之间的通讯和交互只通过黑板进行)。



# Puzzle Game based on Blackboard Structure

|                |                            |
|----------------|----------------------------|
| <b>Level 4</b> | <b>将大块装配起来</b>             |
| <b>Level 3</b> | <b>构造边上的大块<br/>构造内部的大块</b> |
| <b>Level 2</b> | <b>按边拼图<br/>按内部拼图</b>      |
| <b>Level 1</b> | <b>将所有的小块按照方向排列出来</b>      |



# Blackboard data Structure

- 1.Global database containing entire state of problem solution (全局数据库，用来存储数据、传递信息，包含解域的全部状态) .**
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# Components of Blackboard Structure:

## Knowledge Sources 知识源



The knowledge source is the knowledge base describing the knowledge of a problem in an independent field and its processing methods. It is stored separately and independently of each other. They communicate through the blackboard and cooperate to find the solution to the problem.

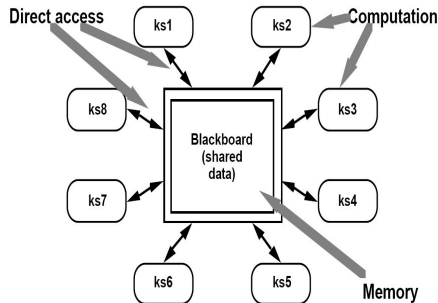
Typically, the knowledge source has a "condition-action" structure form. When the conditions are met, the knowledge source is triggered, and its action part increases or modifies the content on the blackboard.



# Components of Blackboard Structure:

## Knowledge Sources 知识源

1. The problem to be solved is divided into several sub-problems, and each sub-problem is calculated by an independent knowledge source.
2. Knowledge sources contain independent domain knowledge.

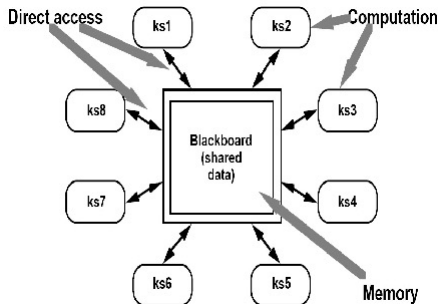




# Components of Blackboard Structure:

## Knowledge Sources 知识源

3. After the knowledge source executes the calculation, it will update the data status in the blackboard.
4. Multiple knowledge sources can only exchange knowledge through the blackboard—the exchange is completed by reading and writing operations on the blackboard.

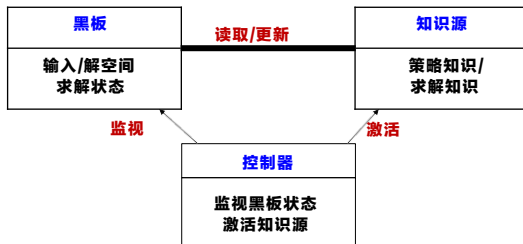


# Components of Blackboard Structure:

## Controller 控制器

### Definition

- Monitor the status changes of the blackboard at all times
- When the state of the blackboard satisfies the execution conditions of the knowledge source, the knowledge source is triggered by the controller to perform calculations, and then update the result to the blackboard

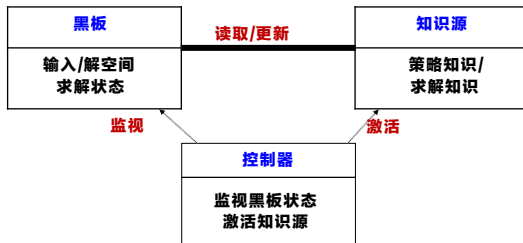


# Components of Blackboard Structure:

## Controller 控制器

### Definition

- Judging and evaluating the current state of information on the blackboard
- This update in turn causes other knowledge sources to participate in the computation and update the blackboard until a solution to the problem is found



# Components of Blackboard Structure:

## Controller 控制器

1. The reasoning mechanism of the blackboard model consists of a supervisor and a scheduler;
2. The supervisor program activates relevant knowledge sources according to the state changes of the blackboard;
3. The scheduler selects the most suitable knowledge source for execution and uses the execution result to modify the blackboard state;
4. Used to control and coordinate all knowledge sources to solve problems collaboratively.
5. Understand the capabilities of each knowledge source, and make real-time decision-making steps to solve problems.

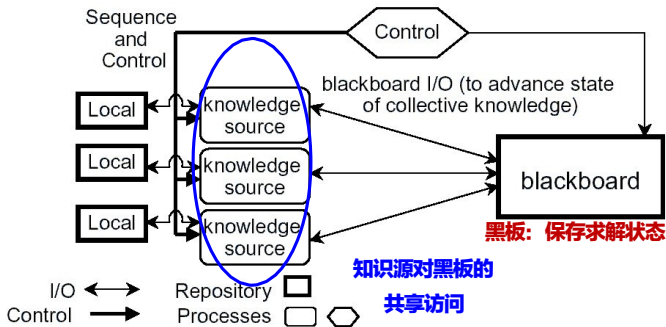


# Blackboard Style



知识源: 独立的求解程序

控制器: 根据当前状态  
决定知识源的执行次序



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# Applications of Blackboard Style

## Artificial Intelligence, e.g., Natural Language Processing, Image Processing, Pattern Recognition, etc.

- HEARSAY-II (自然语言处理系统，系统输入是自然语言的语音信号，经过语音音节、词汇、句法和语义分析后，获得用户对数据库的查询请求)
- HASP/SIAP(在特定海域根据声纳阵列信号探测敌方潜艇出没的系统)
- CRYALIS(根据 X 射线探测数据推测蛋白质分子三维结构的系统)
- TRICERO(在分布环境下监视飞机活动的系统)



# Thank you!