Introduction
The Purpose of This Lecture

Object Oriented Programming
2024 First Semester
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Object-Oriented / オブジェクト指向

- Schemes for constructing a computational model as a set of objects with their operations.
- OOP (Object Oriented Programming) schemes consist of the following features
  - Class inheritance / 継承
  - Polymorphism / 多形
  - Abstract classes / 抽象クラス
- Java supports OOP schemes

Procedures in programming

- Lectures on programming usually teach you grammatical structure
- Practical programming requires skills of
  - planning overall structure / 全体設計
  - arranging the targets / 問題整理
  - designing classes and modules / クラスとモジュールのデザイン
  - testing functions/ テスト
- Continuous skill improvement is necessary

This lecture covers the followings

- Skills in OOP through practical examples
  - Inheritance
  - Threads
  - Regular expressions
  - File IO
  - Events
  - GUI
- Coding styles of Java
- Effective skills for writing good codes

To be a proficient programmer

- Decomposing goals into smaller objectives
- Establishing a cohesive structure
  - Design and organize your codebase to ensure clarity, modularity, and maintainability.
- Segregating components
  - Divide your code into distinct sections, such as data and models, controls, and user interfaces.
- Employing suitable libraries
- Learning from good examples

Today's tasks

- Preparing your work platform
  - Java 21 is required
- Getting sample codes
- Reviewing fundamentals of Java through a `MergeSort` example
  - Recursive `MergeSort` algorithm
  - Investigating the actual processes
  - Understanding tips for implementation
- Reviewing fundamentals of classes and instances

Preparation

- Updating your JDK and NetBeans if necessary
  - `https://aws.amazon.com/jp/corretto/`
  - `https://netbeans.apache.org/download/index.html`
- JDK API manuals
  - `https://www.oracle.com/jp/java/technologies/documentation.html`
- Introducing Git clients if necessary
  - `https://git-scm.com/`
  - All examples of this lecture are provided through `GitHub`. `https://github.com/oop-mc-saga`

Getting sample codes

- NetBeans
  `team` → `Git`
  - Specify repository : no need to input user name and passwords
  - Specify the destination folder
- Command line
  - Move to the destination folder
  - `git clone` repository

Today's sample codes

- `https://github.com/oop-mc-saga/Sort`
- `example0` package

Merge Sort Algorithm

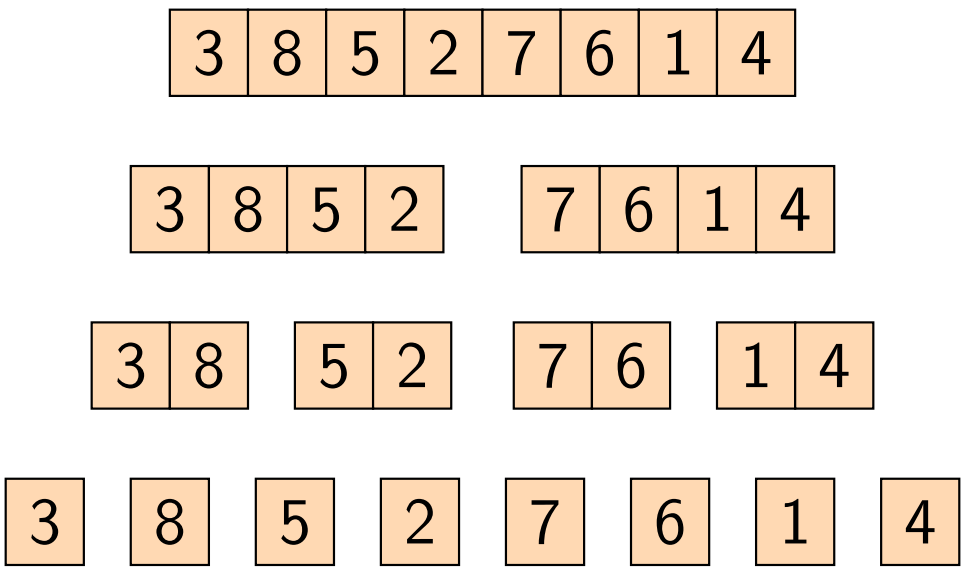
Algorithm 1 Merge Sort (recursive)

```
1: procedure SORT(l, r)
2:     if r > l + 1 then
3:         m = (l + r)/2                ▷ Divide a target into two.
4:         sort(l, m)
5:         sort(m, r)
6:         merge(l, m, r)               ▷ Merge two sorted lists.
7:     end if
8: end procedure
```

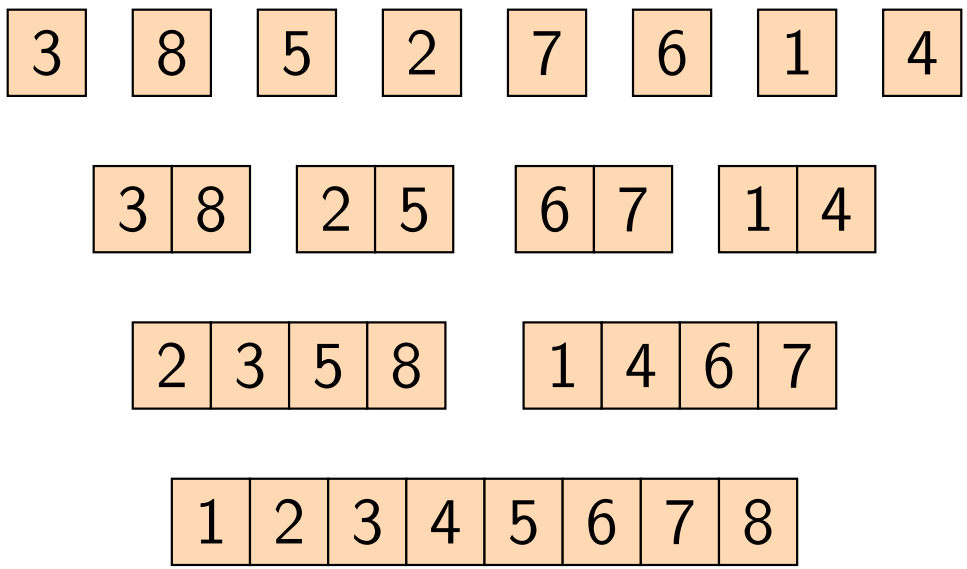
Idea of merge sort

- Merging two sorted list is an easy task: *linear order*
- Dividing the target into short lists of length 1.
- Merging short sorted lists repeatedly.: *logarithmic order*

Divide elements: 分割

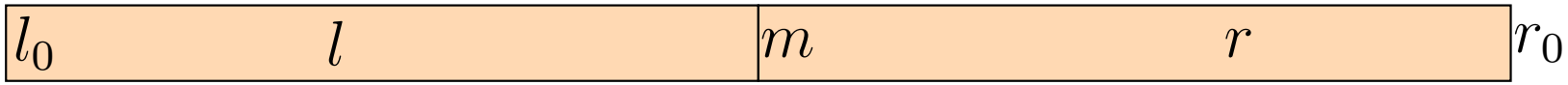


Merge: 結合



Merging two sorted lists

- Tips for implementation
  - Updating data of specifying range in the list
  - This requires work space (dummy list)



Algorithm 2 merge two sorted lists

procedure MERGELIST(l_0, m, r_0)
  $l = l_0, r = m$
  Prepare dummy list d_{dummy}
  while $l < m \wedge r < r_0$ **do**
    if $d_l < d_r$ **then**
      Append d_l to d_{dummy}
      $l++$
    else
      Append d_r to d_{dummy}
      $r++$
    end if
  end while
  if $l \geq m$ **then** ▷ Left part is completed
    Append right remainings to dummy
  end if
  if $r \geq r_0$ **then** ▷ Right part is completed
    Append left remainings to dummy
  end if
  Overwrite d_{dummy} on original list
end procedure

Actual processes : important!

3	8	5	2	7	6	1	4
3	8	5	2	7	6	1	4
3	8	5	2	7	6	1	4
3	8	5	2	7	6	1	4
3	8	5	2	7	6	1	4

3	8	5	2	7	6	1	4

3	8	2	5	7	6	1	4

2	3	5	8	7	6	1	4

Actual prodesses

- Sorting the right part $[7, 6, 1, 4]$ is waiting until finishing of sorting the left part $[3, 8, 5, 2]$.
- Sorting the right part $[5, 2]$ is waiting until finishing of sorting the left part $[3, 8]$.
- Sorting the right part $[8]$ is waiting until finishing of sorting the left part $[3]$.
- Then $[3]$ and $[8]$ are merged to $[3, 8]$
- And so on.

Exercise

Read source codes.

- `sortSub()` method
- `mergeList()` method

Classes and instances

- A *Class* is a template of objects
  - Fields: stores properties of the object
    - values, class instances
  - Constructor: initializes class instances
    - The name of the constructor method is the class name in Java.
  - Methods: manipulates the fields
    - Special methods: setters and getters
- An *Instance* is a class realization
  - Class instances are created through class constructors
  - Instances store own values in fields

Modifiers

- Modifiers for access controls
  - `public`: available from any places
  - `protected`: available only from inherited classes
  - `private`: available only in the class
  - Without modifier: The object is public in the package where the class is included.
- `final`: constant, not modifiable
  - The value must be assigned at its definition or in the constructor of the class.

`Static` modifier

- Methods are usually bound with instances
  - You can not use any methods or values without creating instances
- Some methods such as mathematical functions and values such as constants should not be bound with an instance.
- `static` methods and fields are bound with a class
  - Available without creating instances

Examples of static methods and fields

- `main()`: JVM invokes this method for starting application without creating an instance
- Mathematical functions and constants in `Math` class
  - Any instances of `Math` class can not be created
  - Constructor are not allowed to use.
  - Examples: `Math.sin()`, `Math.PI`

References

- M. Loy, P. Niemeyer, D. Leuck, Learning Java 6th ed. (O'Reilly, 2023).
- D. Poo, D. Kiong and S. Ashok, Object-Oriented Programming and java (Springer, 2008).
- Richard Warburton, Java 8 Lambdas, (O'Reilly, 2014).