

# Patterns for Software Development

(2008-01-22)

## General questions:

### Question 1-general questions (2 points):

- It is said that patterns help standardization of the used terminology in a team. Explain why?
- A pattern presents a solution to a recurring problem in a pattern format. Some people claim that every pattern should be based on experience. Why?
- What is the difference between a “best practice” and a pattern?
- Why can't I write a practical algorithm to invent patterns based on the fundamental building blocks, such as UML artifacts?

### Question 2-Specific patterns (2 points):

- The Composite pattern is ultimately suitable for designing scalable systems. Why?
- Give 2 motivations why in the Composite pattern consistency is not enforced statically, but dynamically during program execution.
- Why the Visitor pattern can be considered as an object-oriented case statement?
- Should the visitor implement the traversing algorithm? Advantages/disadvantages?

### Question 3-Design problem I (3 points):

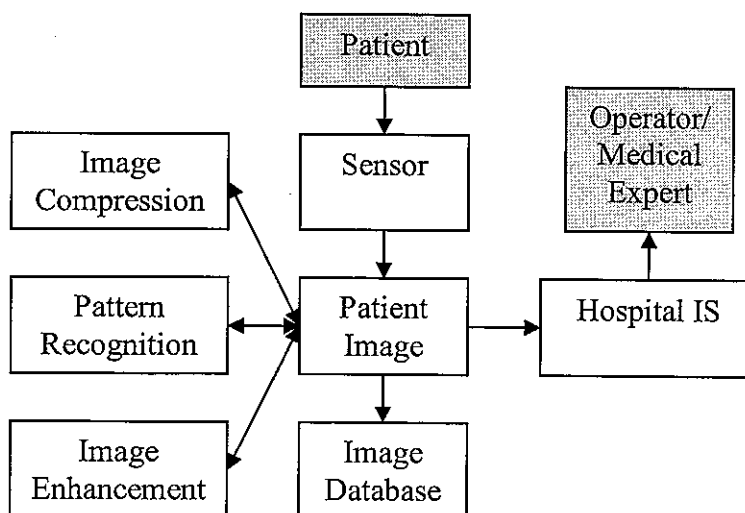


Figure 1. A block diagram of a patient scanner.

In this figure, the blocks Patient and Medical Expert are external to the system. The patient image is first converted to electronic data by the block Sensor and then stored in the database. The (stored) image can be accessed through the hospital information system (Hospital IS) and displayed through the dedicated terminal to the operator or medical experts. If necessary, the image can be compressed, enhanced, and/or recognized. The enhancement can be used for emphasizing certain aspects of images, for example, to make certain anomalies visible. The block Pattern Recognition can be used to recognize certain organs and/or diseases. Here the arrows mainly indicate the dataflow among the blocks.

Assume that a number of hospital information system applications are to be developed. These applications, possibly for different purposes, need to monitor one or more of the following actions:

- OBSERVER / MVC*
- I, III ; II, 4, 5*
- I. The patient is scanned;
  - ~~II~~ II. The image is compressed;
  - ~~III~~ III. The image is stored in the image database;
  - IV. The image is enhanced;
  - V. The image is recognized.
  - VI. The image is accessed through the information system;
  - VII. The image is displayed at a certain terminal;
  - VIII. The image is accessed by a certain expert,

- A. Which pattern is suitable for interfacing the applications? Draw the class diagram representing this example, show the operations and the attributes for each class used;
- B. Draw an object diagram for this example, show the important interactions (sequence of calls) among the objects used, and number them according to their precedence orders;
- C. Discuss the possible performance bottlenecks and the ways that you could possibly overcome them. Discuss the advantages and the disadvantages of your proposal;

#### Question 4-Design problem II (3 points):

Assume that we would like to implement a set of interpreters (using the interpreter pattern) which are adopted by different applications. Each interpreter checks if a certain order of processes have been occurred according to its own grammar. Consider for example an interpreter which checks the sequential occurrence of the actions listed in Question 3 from "the patient is scanned" to "the image is accessed by a certain client".

- A. Define the grammar of the pattern and draw its object diagram;
- B. Explain how you could possibly handle error conditions. Show an example using an object interaction (sequence of calls) diagram.
- C. Assume that the actions "the image is enhanced" and "the image is recognized" will be made optional. What will be the implication to this change to the object diagram? Show the modified diagram. Advantages/disadvantages?

Kenmerk : TW2009/DWMP/82/ha

Vak : **Calculus I voor INF/TEL**

Vakcode : 152101

Datum : 17 april 2009

Tijdstip : 9.00–12.00 uur

**Alle antwoorden dienen gemotiveerd te worden.**

**Alle berekeningen dienen exact uitgevoerd te worden (dus niet met decimale getallen); het gebruik van een rekenmachine is niet toegestaan.**

1. Bereken de volgende limieten indien ze bestaan:

(a) [2 pt]  $\lim_{x \rightarrow 2^-} \left( \frac{1}{x-2} - \frac{1}{|x-2|} \right)$

(b) [2 pt]  $\lim_{x \rightarrow 0} \frac{\tan x}{\arctan x}$ .

2. De functie  $f : \mathbb{R} \rightarrow \mathbb{R}$  is gegeven door:

$$f(x) = \begin{cases} x^2 + 2x - 1 & \text{als } x \leq 1 \\ 2x^2 - 12x + 12 & \text{als } x > 1. \end{cases}$$

(a) [2 pt] Toon aan dat  $f$  continu is op  $\mathbb{R}$ .

(b) [3 pt] Onderzoek met de (limiet)-definitie of  $f$  differentieerbaar is in 1.

(c) [2 pt] Op grond van welke stelling kan worden geconcludeerd dat  $f$  een absoluut maximum en absoluut minimum heeft op het interval  $[-2, 2]$ ? Formuleer deze stelling.

(d) [2 pt] Bepaal de maximale en minimale waarde van  $f$  op het interval  $[-2, 2]$ .

3. De functie  $f : (-\frac{1}{2}, \infty) \rightarrow \mathbb{R}$  is gegeven door:  $f(x) = \ln(1 + 2x)$ .

(a) [3 pt] Bepaal het derdegraads Taylorpolynoom  $T_3$  van  $f$  rond  $a = 0$ .

(b) [3 pt] Bepaal met de ongelijkheid van Taylor een afschatting voor

$$|R_3(0.25)| = |f(0.25) - T_3(0.25)|.$$

**Z.O.Z**

4. (a) [2 pt] De functie  $f$  is gegeven door:  $f(x) = \int_0^{2x} \frac{\cos t}{t^2 + 1} dt$ .  
Bepaal  $f'(\frac{\pi}{2})$ .
- (b) [3 pt] Bereken  $\int_1^e \frac{1}{x\sqrt{\ln x}} dx$ .
- (c) [4 pt] Bepaal  $\int \frac{x^2 + 6x - 1}{x^3 + x} dx$ .
5. Gegeven is het complexe getal  $w = -8i$ .
- (a) [1 pt] Bepaal de polaire vorm van  $w$ .
- (b) [3 pt] Bepaal alle complexe getallen  $z$  waarvoor geldt:  $z^3 = w$ .  
Geef de antwoorden in de vorm  $a + bi$ .
6. [4 pt]  
Bepaal de algemene reële oplossing van het beginwaardeprobleem

$$y'' + y' - 6y = 36x; \quad y(0) = 0; \quad y'(0) = 1.$$

**Totaal:**  $36 + 4 = 40$  punten