

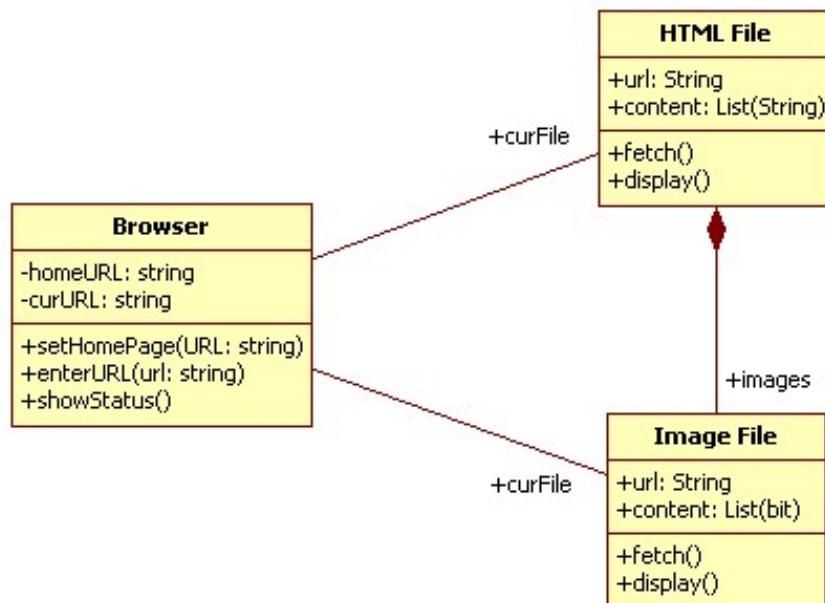
2IW05 Examination A – Software Specification

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Exercise 1 Consider the following specification of a simple internet browser. The user can enter a URL and as a result, the corresponding file is fetched and its contents is displayed in the main window. At each moment in time, only one file is open, whose URL is written in the status bar. There are two types of files, HTML files and image files; each type has its own display method. An HTML file may in turn have references to image files. The display method of both types of files takes a canvas to draw the contents on it, and when the browser wants to display a file, the canvas is the main window of the browser. There is a “home” button on the browser, which takes the browser to a pre-set URL. The “home” URL can be set at any time by the user.

Given the above specification, a designer has come up with the following class diagram.



Criticize this class diagram, explicitly write what is not consistent with the informal specification and give an improved class diagram. (10 points)

Exercise 2 Consider the following algebraic specification N of sorts \mathbb{N} and \mathbb{B} .

constructor function symbols:

$$\begin{array}{lcl} 0 & : & \rightarrow \mathbb{N} \\ S & : & \mathbb{N} \rightarrow \mathbb{N} \\ \text{true} & : & \rightarrow \mathbb{B} \\ \text{false} & : & \rightarrow \mathbb{B} \end{array}$$

additional function symbols:

$$\text{if } _ \text{ then } _ \text{ else } _ : \mathbb{B} \times \mathbb{N} \times \mathbb{N} \rightarrow \mathbb{N}$$

equations:

$$\begin{array}{lcl} \text{if true then } x \text{ else } y & = & x \\ \text{if false then } x \text{ else } y & = & y \\ S(\text{if } b \text{ then } x \text{ else } y) & = & \text{if } b \text{ then } S(x) \text{ else } S(y) \end{array}$$

1. Define an additional function symbol $min : \mathbb{N} \times \mathbb{N} \rightarrow \mathbb{N}$ that gives the minimum of two natural numbers. It is not allowed to use the additional function symbol \leq that is asked for in the next item. **(5 points)**
2. Define an additional function symbol $\leq : \mathbb{N} \times \mathbb{N} \rightarrow \mathbb{B}$ that gives true in case the left hand side argument is less than or equal to the right hand side argument, and false otherwise. **(5 points)**
3. Prove the property

$$N' \vdash min(x, y) = \text{if } x \leq y \text{ then } x \text{ else } y$$

where N' is the the algebraic specification that is obtained from N by the additions from the previous two items. **(10 points)**

Exercise 3 Consider the following Z specification.

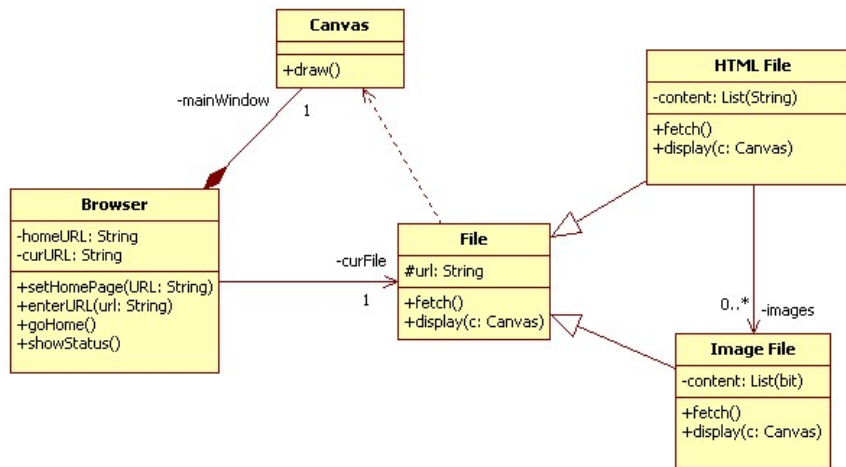
$$\begin{array}{l} [Char, Content] \\ FileName == \text{seq } Char \end{array}$$

$\begin{array}{l} \text{FileSystem} \\ fs : FileName \leftrightarrow Content \end{array}$

1. Define an operation schema which inputs an old and a new name and changes the name of the corresponding file, if a file with the old name exists and the new file name is not already taken. If the operation is successful, then a message is output indicating the success of the operation; otherwise, a message indicating failure is given. **(10 points)**
2. Define an operation schema $ListPref$ which outputs the set of files names starting with a given input string $prefix?$. For example, applying $ListPref$ with $prefix? = abc$ on a filesystem comprising files with the names abc , abd and $abcd$, results in $outset! = \{abc, abcd\}$. **(10 points)**

Answer 1 There are 6 main problems in the given class diagram:

1. The visibility of attributes `url`, `content`, association `curFile` and method `showStatus` is set to public while all of them should be private.
2. The navigability of association `url` is from `Browser` to `File` (HTML or Image) which is not given.
3. The multiplicity of association should be 1.
4. The composition from HTML File to Image file should be an association.
5. The class `Canvas` is not given; it is part of the `Browser` class under the name `mainWindow`. It is also related to the class for `File` with a dependency (for drawing its content, the `display` method uses a canvas).
6. The association between `Browser` and the two types of files, should be simplified by creating an abstract class called `File` and specializing `HTML File` and `Image File` from it.



Answer 2

1.

$$\begin{aligned}
 \min(0, x) &= 0 \\
 \min(x, 0) &= 0 \\
 \min(S(x), S(y)) &= S(\min(x, y))
 \end{aligned}$$

2.

$$\begin{aligned}
 0 \leq x &= \text{true} \\
 S(x) \leq 0 &= \text{false} \\
 S(x) \leq S(y) &= x \leq y
 \end{aligned}$$

3. By constructor induction on variable x :

- $\min(0, y) = 0$ = if true then 0 else y = if $0 \leq y$ then 0 else y
- Assume $\min(x', y) =$ if $x' \leq y$ then x' else y . Then, by constructor induction on y :
 - $\min(S(x'), 0) = 0$ = if false then $S(x')$ else 0 = if $S(x') \leq 0$ then $S(x')$ else 0

– Assume $\min(x', y') = \text{if } x' \leq y' \text{ then } x' \text{ else } y'$. Then

$$\begin{aligned}
\min(S(x'), S(y')) &= S(\min(x', y')) \\
&= S(\text{if } x' \leq y' \text{ then } x' \text{ else } y') \\
&= \text{if } x' \leq y' \text{ then } S(x') \text{ else } S(y') \\
&= \text{if } S(x') \leq S(y') \text{ then } S(x') \text{ else } S(y')
\end{aligned}$$

Answer 3

1.

$\text{Report} ::= \text{successful} \mid \text{failed}$

RenFileSuccess $\Delta \text{FileSystem}$ $\text{old?}, \text{new?} : \text{seq Char}$ $\text{report!} : \text{Report}$
$\text{old?} \in \text{dom } fs$ $\text{new?} \notin \text{dom } fs$ $fs' = (fs \setminus \{\text{old?} \mapsto fs(\text{old?})\}) \cup \{\text{new?} \mapsto fs(\text{old?})\}$ $\text{report!} = \text{successful}$

RenFileFail $\Xi \text{FileSystem}$ $\text{old?}, \text{new?} : \text{seq Char}$ $\text{report!} : \text{Report}$
$(\text{old?} \notin \text{dom } fs \vee \text{new?} \in \text{dom } fs)$ $\text{report!} = \text{failed}$

$\text{RenFile} == \text{RenFileSuccess} \vee \text{RenFileFail}$

2.

ListPref $\Xi \text{FileSystem}$ $\text{prefix?} : \text{FileName}$ $\text{outset!} : \mathbb{P} \text{FileName}$
$\forall n : \text{FileName} \bullet$ $n \in \text{outset!} \Leftrightarrow n \in \text{dom } fs \wedge \exists n' : \text{seq Char} \bullet \text{prefix?} \frown n' = n$