Software Eng. 2AO4 - Software Design I - 2001
Laboratory 3

For weeks starting October 12 and October 19

In the previous examples, rectangles were represented by giving the x,y coordinates of the upper left and lower right corners. There are many other ways to represent a rectangle; for example, we could give the coordinates of the lower left corner, the height, and the width, or we could give the upper right corner's coordinates, the width, and the area. In this laboratory you are expected to use a representation other than the coordinates of two corners.

In this assignment, we specify a package of programs that can be used to store data about two rectangles that satisfy the conditions of the previous exercise without the user of these programs knowing how the rectangles are actually represented.

The package interface is defined as follows:

1. A procedure, S2P, that takes 8 integer arguments: (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1}) representing two rectangles, A and B. The first pair of arguments gives the (x,y) coordinates of the upper left corner of rectangle A. The second pair gives the (x,y) coordinates of lower right corner of rectangle A. The third pair gives the (x,y) coordinates of the upper left corner of rectangle B. The fourth pair gives the (x,y) coordinates of lower right corner of rectangle B.

This procedure will return a value as specified by Table 1 using the following definitions.

Def: Arectangle $\equiv x_{A0} < x_{A1} \wedge y_{A0} > y_{A1}$

Def: Brectangle $\equiv x_{B0} < x_{B1} \wedge y_{B0} > y_{B1}$

	return value
$\neg$ Arectangle $\wedge$ Brectangle	-1
$\neg$ Brectangle $\wedge$ Arectangle	-2
$\neg$(Brectangle $\vee$Arectangle)	-3
Arectangle $\wedge$ Brectangle	0

Table 1: Return value for S2P, SPHW, **and** SPHA

This procedure may change the value returned by future invocations of certain programs defined below. A detailed description of the additional effects of this procedure is given in tables 2, 3, 4, 5, 6, 7, and 8 below.

2. A procedure, SPHW, that takes 8 integer arguments: (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B) representing two rectangles, A and B. The first pair of arguments gives the (x,y) coordinates of the upper left corner of rectangle A. The second pair gives the height and width of rectangle A. The third pair gives the (x,y) coordinates of the upper left corner of rectangle B. The fourth pair gives the height and width of rectangle B.

This procedure will return a value as specified by table 1 using the following definitions.

Def: Arectangle $\equiv h_A > 0 \wedge w_A > 0$

Def: Brectangle $\equiv h_B > 0 \wedge w_B > 0$

Additional effects of this procedure are defined in tables 2, 3, 4, 5, 6, 7, and 8 below.

3. A procedure, SPHA, that takes 8 integer arguments: (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B) representing two rectangles, A and B. The first pair of arguments gives the (x,y) coordinates of the upper left corner of rectangle A. The second pair gives the height and area of rectangle A. The third pair gives the (x,y) coordinates of the upper left corner of rectangle B. The fourth pair gives the height and area of rectangle B.

This procedure will return a value as specified by Table 1 using the following definitions.

Def: Natural(x) $\equiv x>0 \wedge$ integer(x)

Def: Arectangle $\equiv h_A > 0 \wedge$ natural(s_A/h_A)

Def: Brectangle $\equiv h_B > 0 \wedge$ natural(s_B/h_B)

Additional effects of this procedure are defined in Tables 2, 3, 4, 5, 6, 7, and 8 below.

4. Two procedures GξA, where ξ may be either A or B, that returns an integer value specified by the following table

Most recent call of an "S" procedure[a] =	S2P (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1})	SPHW (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B)	SPHA (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B)
¬ Arectangle ∧ Brectangle	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3
Arectangle ∧ Brectangle	$(x_{\xi 1}-x_{\xi 0}) \times (y_{\xi 0}- y_{\xi 1})$	$h_\xi \times w_\xi$	s_ξ

Table 2: Values returned by GAA and GBA

a. The S procedures are S2P, SPHA, and SPHW. Use the definitions of the predicates that are associated with the corresponding procedure. Consider ¬(Brectangle ∨Arectangle) to be true if no S procedure has been called. This note also applies to Tables 3 - 8.

5. Two procedures GξH, where ξ may be either A or B, that returns an integer value specified by the following table

Most recent call of an "S" procedure =	S2P (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1})	SPHW (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B)	SPHA (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B)
¬ Arectangle ∧ Brectangle	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3
Arectangle ∧ Brectangle	($y_{\xi 0}$- $y_{\xi 1}$)	h_ξ	h_ξ

Table 3: Values returned by GAH and GBH

6. Two procedures GξW, where ξ may be either A or B, that returns an integer value specified by the following table

Most recent call of an "S" procedure	S2P (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1})	SPHW (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B)	SPHA (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B)
¬ Arectangle ∧ Brectangle	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3
Arectangle ∧ Brectangle	($x_{\xi 1}$-$x_{\xi 0}$)	w_ξ	s_ξ/h_ξ

Table 4: Value returned by GAW and GBW

7. Four procedures GξULψ, where ξ may be either A or B and ψ may be either x or y, that returns an integer value specified by the following table

Most recent call of an "S" procedure	S2P (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1})	SPHW (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B)	SPHA (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B)
¬ Arectangle ∧ Brectangle	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3
Arectangle ∧ Brectangle	$\psi_{\xi 0}$	$\psi_{\xi 0}$	$\psi_{\xi 0}$

Table 5: Value returned by GAULx, GAULy, GBULx, and GBULy

8. Two procedure GξLRx, where ξ may be either A or B, that returns an integer value specified by the following table

Most recent call of an "S" procedure	S2P (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1})	SPHW (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B)	SPHA (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B)
¬ Arectangle ∧ Brectangle	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3
Arectangle ∧ Brectangle	$x_{\xi 1}$	$x_{\xi 0} + w_\xi$	$x_{\xi 0} + s_\xi/h_\xi$

Table 6: Values returned by G**A**LRx and G**B**LRx

9. Two procedures GξLRy, where ξ may be either A or B, that returns an integer value specified by the following table

Most recent call of an "S" procedure	S2P (x_{A0}, y_{A0}, x_{A1}, y_{A1}, x_{B0}, y_{B0}, x_{B1}, y_{B1})	SPHW (x_{A0}, y_{A0}, h_A, w_A, x_{B0}, y_{B0}, h_B, w_B)	SPHA (x_{A0}, y_{A0}, h_A, s_A, x_{B0}, y_{B0}, h_B, s_B)
¬ Arectangle ∧ Brectangle	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3
Arectangle ∧ Brectangle	$y_{\xi 1}$	$y_{\xi 0}$-h_ξ	$y_{\xi 0}$-h_ξ

Table 7: Values returned by G**A**LRy and G**B**LRy

10. A procedure, `overlap`, that must return an integer return value as described by the table below**.**

	AinB	BinA	disjoint	overlap	AisB	tangent
¬ Arectangle ∧ Brectangle	-1	-1	-1	-1	-1	-1
¬ Brectangle ∧ Arectangle	-2	-2	-2	-2	-2	-2
¬(Brectangle ∨Arectangle)	-3	-3	-3	-3	-3	-3
Arectangle ∧ Brectangle	1	2	3	4	5	6

Table 8: Return value for procedure `overlap`

The definitions of AinB, BinA, disjoint, overlap, AisB, and tangent are those used in Laboratory 2 with the substitution of

- GξULψ for $\psi_{\xi 0,}$ where ξ may be either A or B and ψ may be either x or y,
- GξLRx, for $x_{\xi 1}$, where ξ may be either A or B,
- GξLRy, for $y_{\xi 1}$ where ξ may be either A or B.

Please note that *everyone's* module must include *all* 18 of the procedures. You will not be able to mix procedures from different modules. A user should not be able to tell which procedure was used to enter the two rectangles' dimensions after the call to the S procedure is complete.