# Laboratory 2

*For weeks starting September 27 and October 4.*

Working in teams of two, write two separately compiled programs:

**1.** The procedure `overlap`,
which takes 12 real arguments: ($x_{A0}$, $y_{A0}$, $x_{A1}$, $y_{A1}$, $x_{A2}$, $y_{A2}$, $x_{B0}$, $y_{B0}$, $x_{B1}$, $y_{B1}$, $x_{B2}$, $y_{B2}$)
(all arguments are real) with return value: integer as described by the table below**.**

| | disjoint | contained | ¬(disjoint ∨ contained ∨ tangent) | tangent |
|---|---|---|---|---|
| ¬ Acircle ∧ Bcircle | -1 | -1 | -1 | -1 |
| ¬ Bcircle ∧ Acircle | -2 | -2 | -2 | -2 |
| ¬ ( Bcircle ∨ Acircle) | -3 | -3 | -3 | -3 |
| Acircle ∧ Bcircle ∧ dist($x_{A1}$, $y_{A1}$, $x_{A0}$, $y_{A0}$) = dist($x_{B1}$, $y_{B1}$, $x_{B0}$, $y_{B0}$) | 1 | 2 | 3 | 4 |
| Acircle ∧ Bcircle ∧ dist($x_{A1}$, $y_{A1}$, $x_{A0}$, $y_{A0}$) < dist($x_{B1}$, $y_{B1}$, $x_{B0}$, $y_{B0}$) | 5 | 6 | 7 | 8 |
| Acircle ∧ Bcircle ∧ dist($x_{A1}$, $y_{A1}$, $x_{A0}$, $y_{A0}$) > dist($x_{B1}$, $y_{B1}$, $x_{B0}$, $y_{B0}$) | 9 | 10 | 11 | 12 |

## Definitions:

Since we are working with real numbers, we must define "=" to allow for numerical round-off.

**Def:** $a = b \equiv |a-b| \leq eps$, where eps should be a small positive value (a parameter). Note that this version of equality is reflexive, symmetric, but not transitive.

**Def:** $dist(x_1, y_1, x_2, y_2) \equiv sqrt((x_1 - x_2)^2 + (y_1 - y_2)^2)$

**Def:** $Acircle \equiv (dist(x_{A1}, y_{A1}, x_{A0}, y_{A0}) = dist(x_{A2}, y_{A2}, x_{A0}, y_{A0}) \wedge ((x_{A0}, y_{A0}) \neq (x_{A1}, y_{A1}) \wedge (x_{A0}, y_{A0}) \neq (x_{A2}, y_{A2}) \wedge (x_{A1}, y_{A1}) \neq (x_{A2}, y_{A2}))) \vee ((x_{A2}, y_{A2}) = (x_{A0}, y_{A0}) = (x_{A1}, y_{A1}))$

**Def:** $Bcircle \equiv (dist(x_{B1}, y_{B1}, x_{B0}, y_{B0}) = dist(x_{B2}, y_{B2}, x_{B0}, y_{B0}) \wedge ((x_{B0}, y_{B0}) \neq (x_{B1}, y_{B1}) \wedge (x_{B0}, y_{B0}) \neq (x_{B2}, y_{B2}) \wedge (x_{B1}, y_{B1}) \neq (x_{B2}, y_{B2}))) \vee ((x_{B2}, y_{B2}) = (x_{B0}, y_{B0}) = (x_{B1}, y_{B1}))$

**Def:** disjoint ≡
$(\forall x,(\forall y, dist(x, y, x_{A0}, y_{A0}) > dist(x_{A1}, y_{A1}, x_{A0}, y_{A0}) \vee dist(x, y, x_{B0}, y_{B0}) > dist(x_{B1}, y_{B1}, x_{B0}, y_{B0})))$

**Def:** contained ≡
$(\forall x,(\forall y, dist(x, y, x_{A0}, y_{A0}) \leq dist(x_{A1}, y_{A1}, x_{A0}, y_{A0}) \Rightarrow dist(x,y,x_{B0},y_{B0}) \leq dist(x_{B1},y_{B1},x_{B0},y_{B0}))) \vee$
$(\forall x,(\forall y, dist(x, y, x_{B0}, y_{B0}) \leq dist(x_{B1}, y_{B1}, x_{B0}, y_{B0}) \Rightarrow dist(x, y, x_{A0}, y_{A0}) \leq dist(x_{A1}, y_{A1}, x_{A0}, y_{A0})))$

**Def:** tangent ≡ ¬ (disjoint ∨ contained) ∧
$(\forall x,(\forall y, dist(x, y, x_{A0}, y_{A0}) \leq dist(x_{A1}, y_{A1}, x_{A0}, y_{A0}) \wedge dist(x, y, x_{B0}, y_{B0}) \leq dist(x_{B1}, y_{B1}, x_{B0}, y_{B0}) \Rightarrow$
$dist(x, y, x_{A0}, y_{A0)} = dist(x_{A1}, y_{A1}, x_{A0}, y_{A0}) \wedge dist(x, y, x_{B0}, y_{B0}) = dist(x_{B1},y_{B1},x_{B0},y_{B0}) ))$

**2.** A program that interacts with a user, prompts the user to describe two circles and then displays (on the screen) an english language statement about the circles that the user has described, e.g. "The two circles are disjoint". This program should use `overlap`.

Test both programs until you are satisfied that they are correct, then combine them to produce a system that can be demonstrated. This should be completed *by the end of the first week.*

Keep a log of all major decisions and all errors discovered. This log will become a part of your laboratory report. If you consult with anyone on the design of these programs, summarise that conversation in your log.

*In the second week*, you will be asked to exchange the `overlap` procedure with other groups, to test the other group's procedures and then combine your interface program with the circle comparison program that you got from the other group. When writing, testing, and demonstrating these programs, log all errors and write a final lab report - due one week after the lab is complete. Your report should analyse the difficulties that you encountered and explain how they could have been avoided.