

**Review:**

Robots need to find their position on a map relative to landmarks. They must:

1. Identify at least 3 landmarks whose position is known on the map
2. Determine range to the landmark
3. Calculate the intersection point of the range circles

To find the intersection of 3 circles:

1. Use the equation for a circle:
  - a.  $(x - a)^2 + (y - b)^2 = r^2$
  - b. for landmarks located at (a,b) and at a range of r
2. Find the radical line by subtracting the two circle equations
3. Substitute back into one of the circle equations to get a quadratic formula in terms of one variable
4. Solve the quadratic equation to find the two value for that single variable
5. Substitute back into the radical line equation to get the two values for the other variable
6. Substitute these two points into the third circle equation to determine which point the robot is at

**Terms:**

Localization = finding its position on a map (the process of getting located)

**Formulas:**

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

(Quadratic)

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**Video Activity:**

Your robot is in a yard with a tree, a bush, and a bench. The tree is at (2, 13) and the range is 10 meters. The bush is at (13, 11) and the range is 5 meters. Finally, the bench is at (10,0) and the range is 7 meters.  
What is the robot's position?

Formula:  $(x - a)^2 + (y - b)^2 = r^2$

Tree

$$(x - \underline{\quad})^2 + (y - \underline{\quad})^2 = \underline{\quad}^2$$

Bush

$$(x - \underline{\quad})^2 + (y - \underline{\quad})^2 = \underline{\quad}^2$$

$$x^2 - \underline{\quad}x + y^2 - \underline{\quad} + \underline{\quad} \text{ (Tree)}$$

$$- (x^2 - \underline{\quad}x + y^2 - \underline{\quad} + \underline{\quad}) \text{ (Bush)}$$

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$$\underline{\quad}x - \underline{\quad}y - \underline{\quad} = 0$$

(Solve for y, will be used below)

$$y = - \underline{\quad} + \underline{\quad}x$$

$$(x - \underline{\quad})^2 + (\underline{\quad} - \underline{\quad})^2 = \underline{\quad}^2$$

\*Tree a\*      \*Tree - Bush\*      \*Tree b\*      \*Tree r\*

$$\underline{\quad}x^2 - \underline{\quad}x + \underline{\quad} = 0$$

$$ax^2 + bx + c = 0$$

$$- \underline{\quad} \pm \sqrt{\underline{\quad}^2 - 4 \underline{\quad} \underline{\quad}}$$

$$x = \frac{\underline{\quad}}{\underline{\quad}}$$

$$x_1 = \underline{\quad} \text{ or } x_2 = \underline{\quad}$$

$$y = - \underline{\quad} + \underline{\quad} \text{ (from above)}$$

\*substitute both x values\*

$$y_1 = \underline{\quad} \text{ or } y_2 = \underline{\quad}$$

Bench

$$(\underline{\quad} - \underline{\quad})^2 + (\underline{\quad} - \underline{\quad})^2 = \underline{\quad}^2$$

\*x value\* \*Bench a\*      \*y value\* \*Bench b\*      \*Bench r\*

\*substitute both x,y value sets\*

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