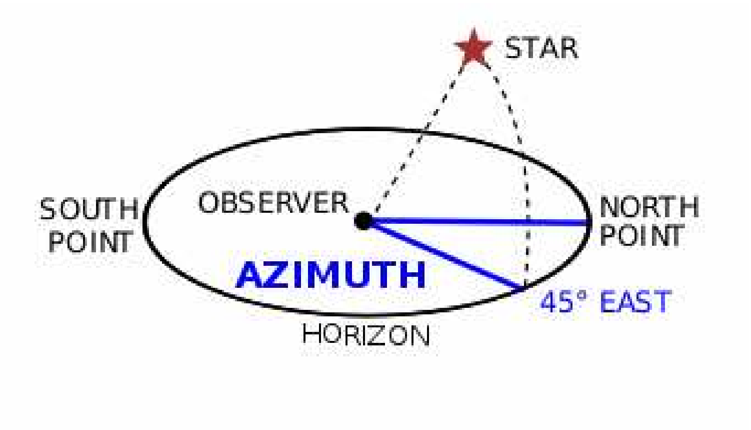


LEJOS
Java for LEGO Mindstorms

Doubts about how to use azimuth values from a Coordinate Object

Juan Antonio Breña Moral

#1 Definition

An Azimuth is the angle from a reference vector in a reference plane to a second vector in the same plane, pointing toward, (but not necessarily meeting), something of interest. For example, with the sea as your reference plane, the azimuth of the Sun might be the angle between due North and the point on the horizon the Sun is currently over. An imaginary line drawn along the surface of the sea might point in the direction of the Sun, but would obviously never meet it.

Source: Wikipedia

#2 Problem

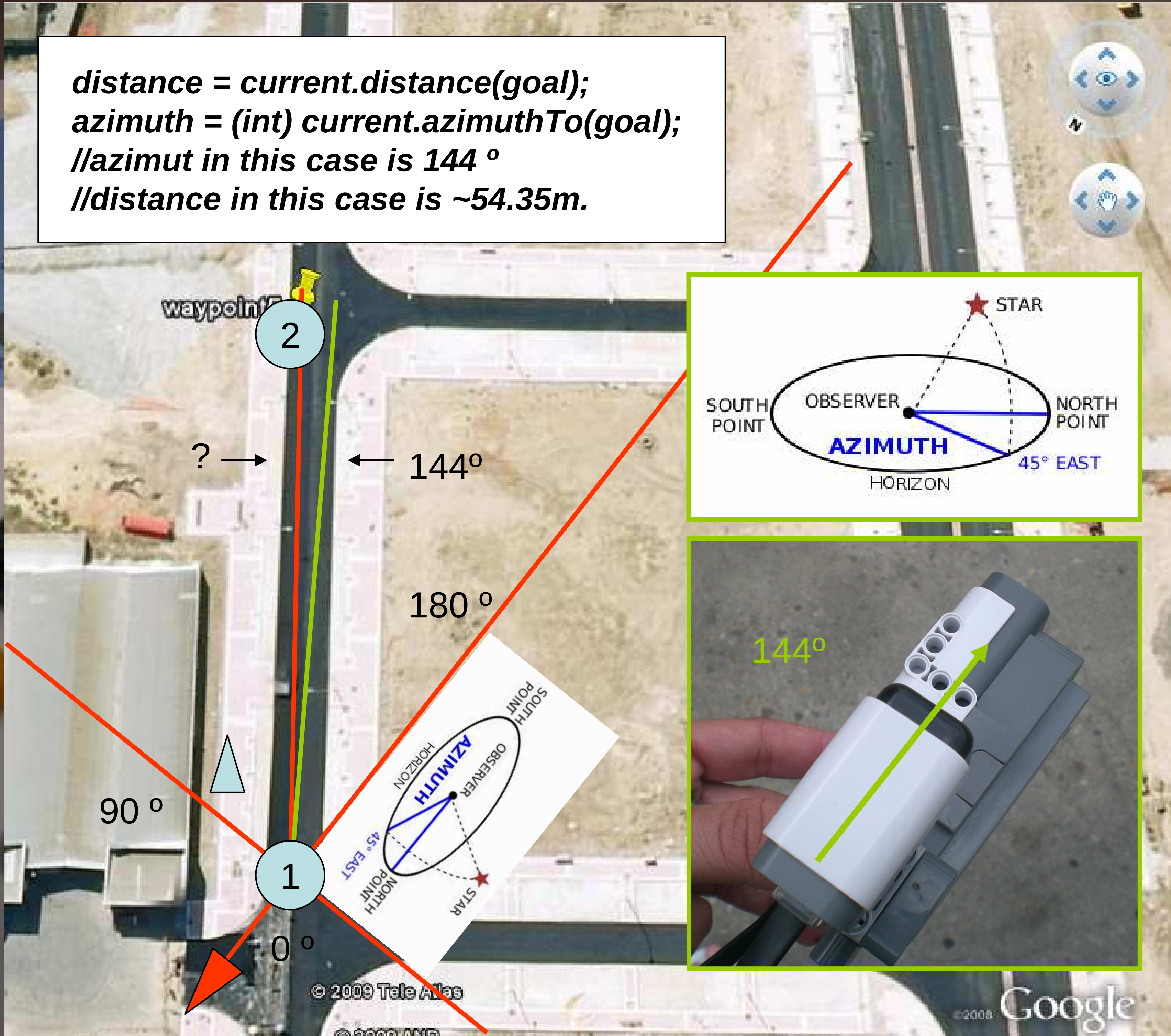
I have stored a GPS Point in a street. I save the same GPS point several times to avoid generating errors in the measure process. The point is:

```
goal = new Coordinates(40.445049309324573,-
3.4673066139221191,583.5999762622721);
```

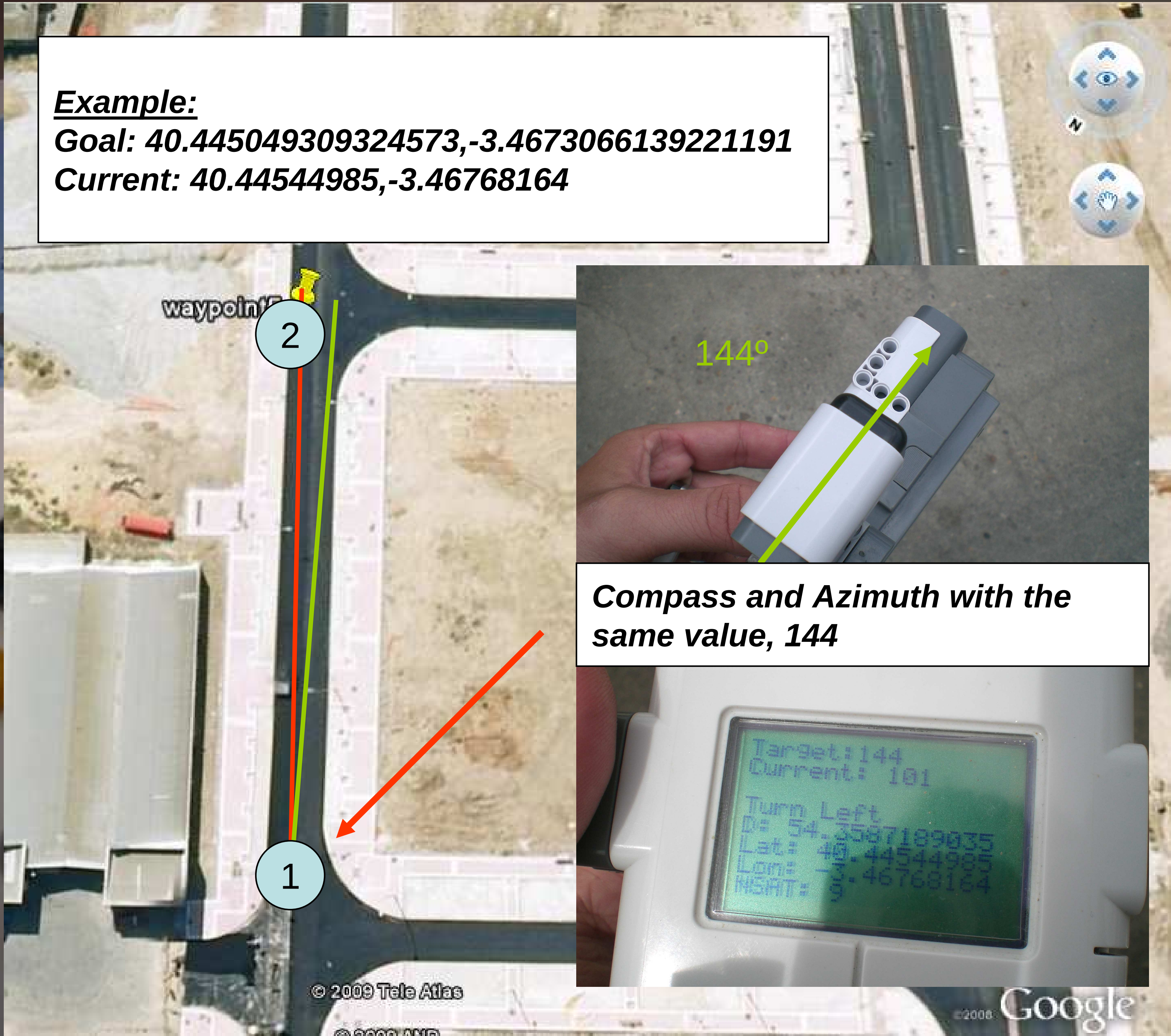
I read values from a GPS receiver and calculate the distance and azimuth from current GPS value to goal.

```
distance = current.distance(goal);
azimuth = (int) current.azimuthTo(goal);
```

```
distance = current.distance(goal);
azimuth = (int) current.azimuthTo(goal);
//azimut in this case is 144 º
//distance in this case is ~54.35m.
```



Example:
Goal: 40.445049309324573,-3.4673066139221191
Current: 40.44544985,-3.46768164

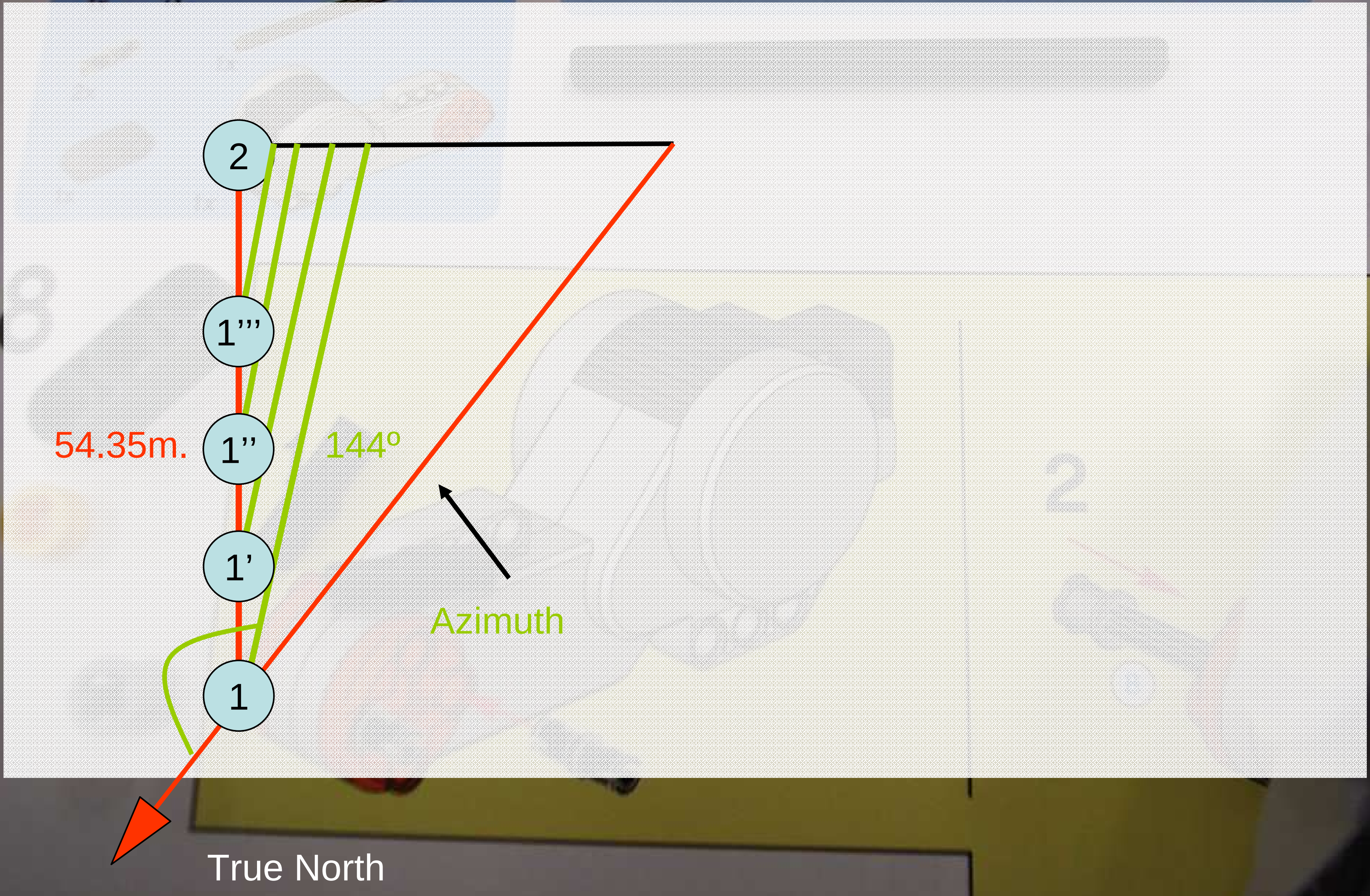


Compass and Azimuth with the same value, 144

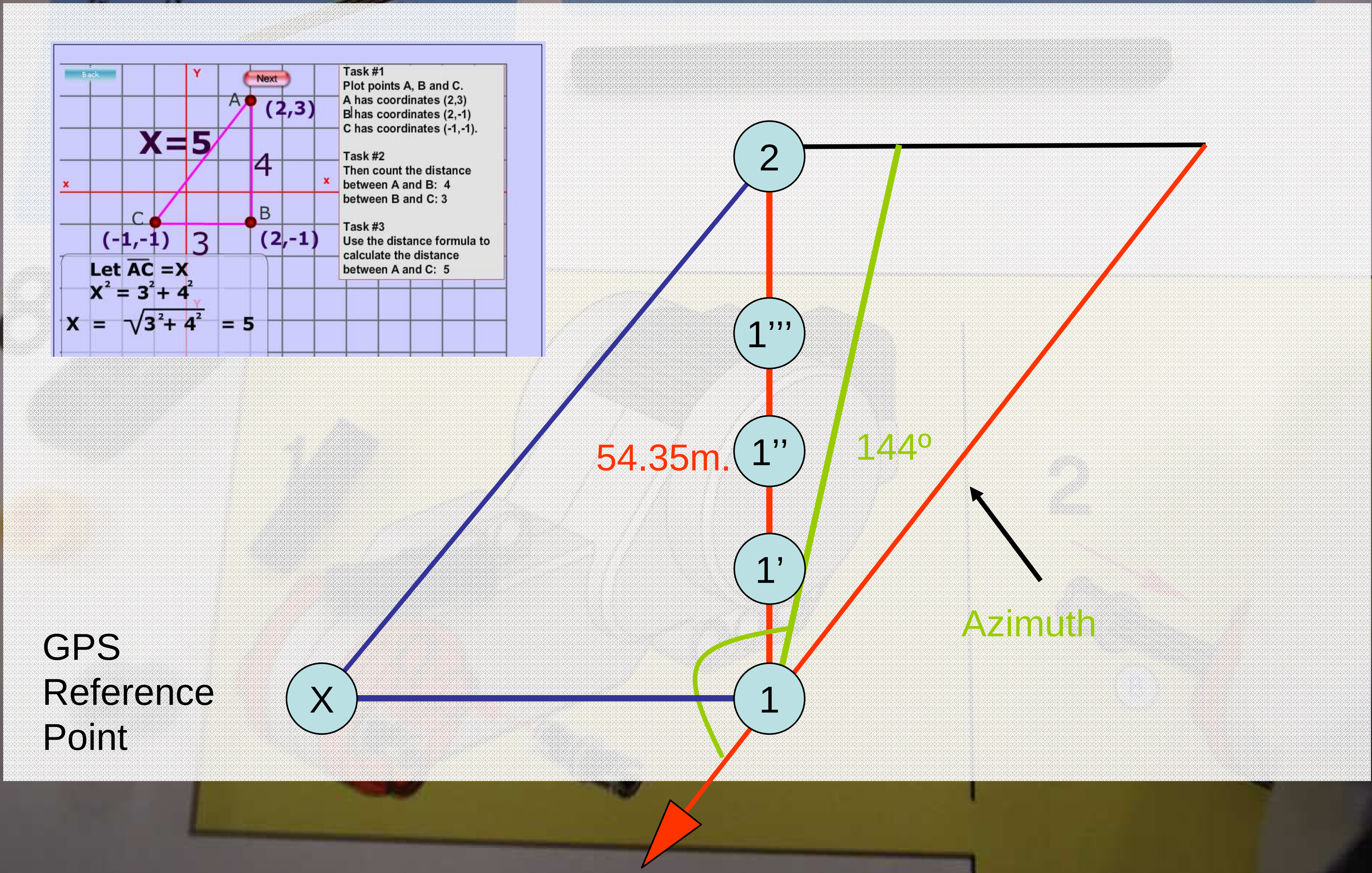
Example:
Goal: 40.445049309324573,-3.4673066139221191
Current: 40.44544985,-3.46768164

http://www.youtube.com/watch?v=3nA0v8rrpXU

#2 Problem

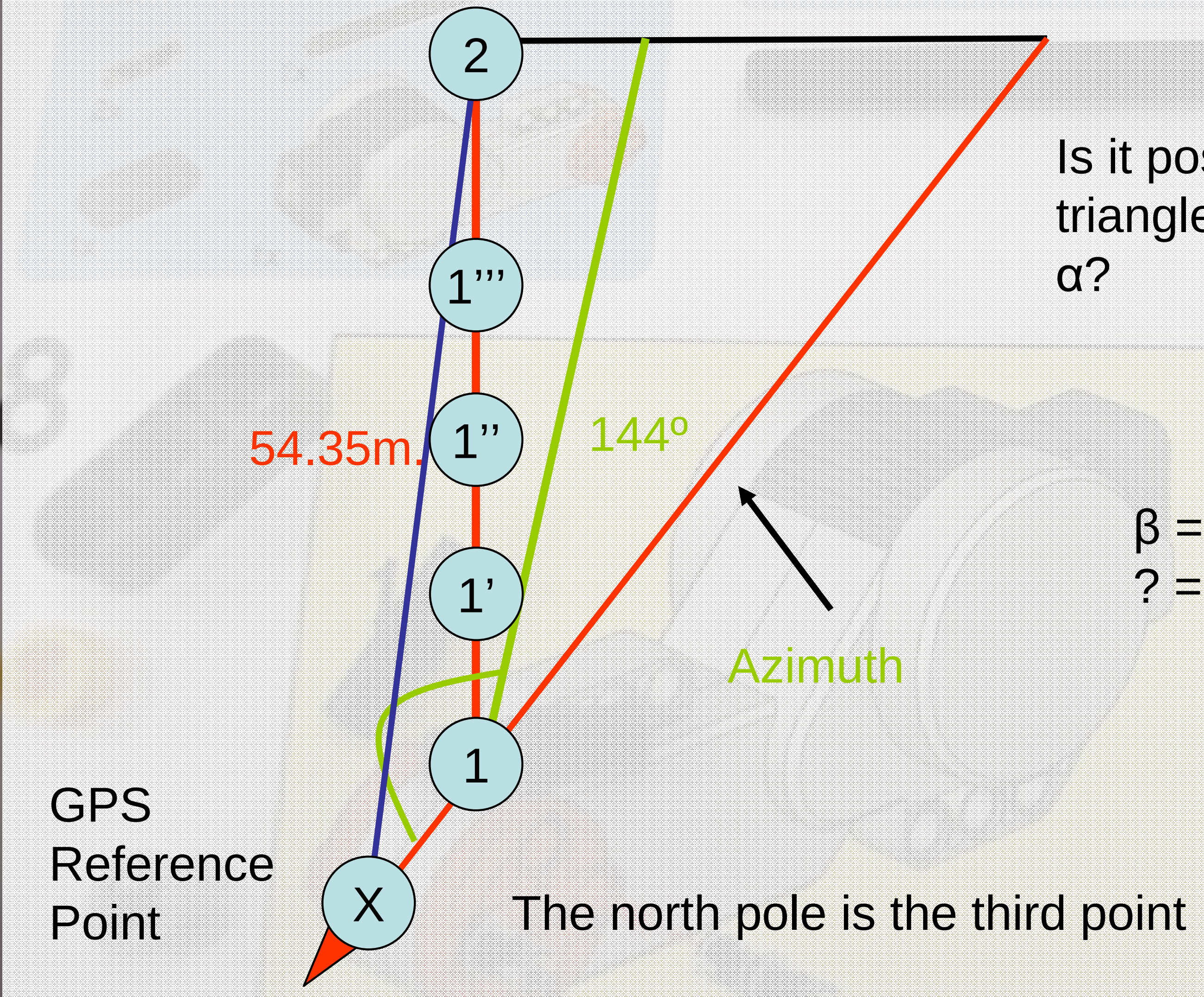


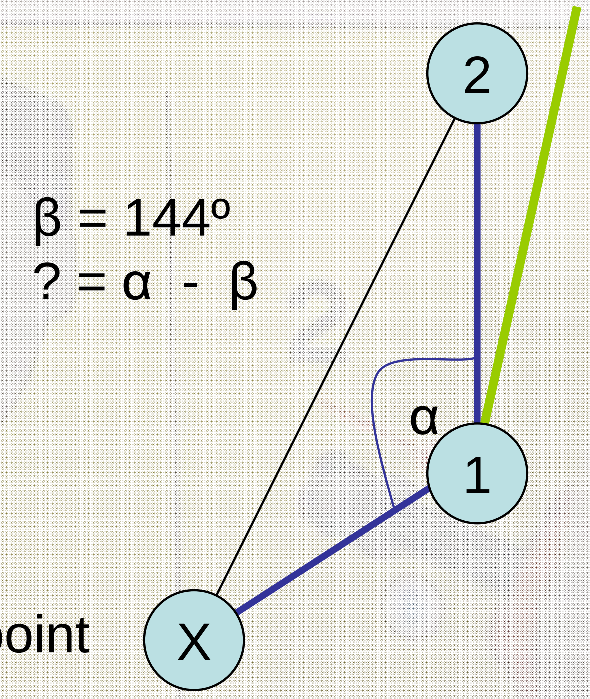
#2 Problem


Back
Next
Y
A
(2,3)
X=5
4
x
x
C
B
(-1,-1)
3
(2,-1)
Let $\overline{AC}$ = X
$X^2 = 3^2 + 4^2$
$X = \sqrt{3^2 + 4^2} = 5$
Task #1
Plot points A, B and C.
A has coordinates (2,3)
B has coordinates (2,-1)
C has coordinates (-1,-1).
Task #2
Then count the distance
between A and B: 4
between B and C: 3
Task #3
Use the distance formula to
calculate the distance
between A and C: 5
2
1'''
54.35m.
1''
144º
1'
Azimuth
GPS
Reference
Point
X
1

#2 Problem

Is it possible to calculate the triangle X-2-1? To calculate α?





#3 Questions

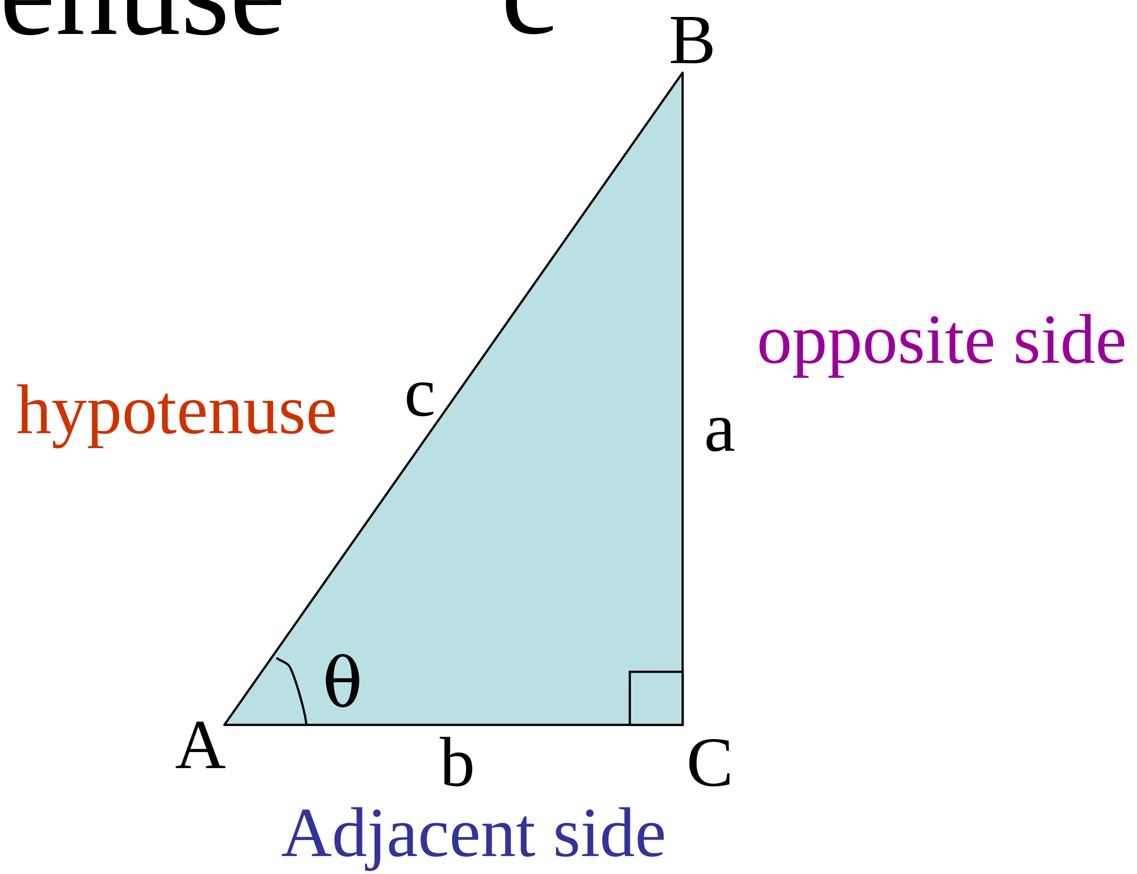
I have written some questions about how to use Coordinates object:

1. Is correct the way to calculate azimuth?

   current.azimuthTo(goal) [Current way] or ***goal.azimuthTo(current); ?***
2. If my way is correct how to understand the value 144º? How to manage?
3. Take a look about a video to understand my problem:
   1. http://www.youtube.com/watch?v=3nA0v8rrpXU
   2. If you see, I walk on the street while azimuth try to lead to another angle out of the street (green line)
   3. How to calculate red line?

Trigonometric ratios in a right-angled triangle

$$\sin\theta = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{a}{c}$$



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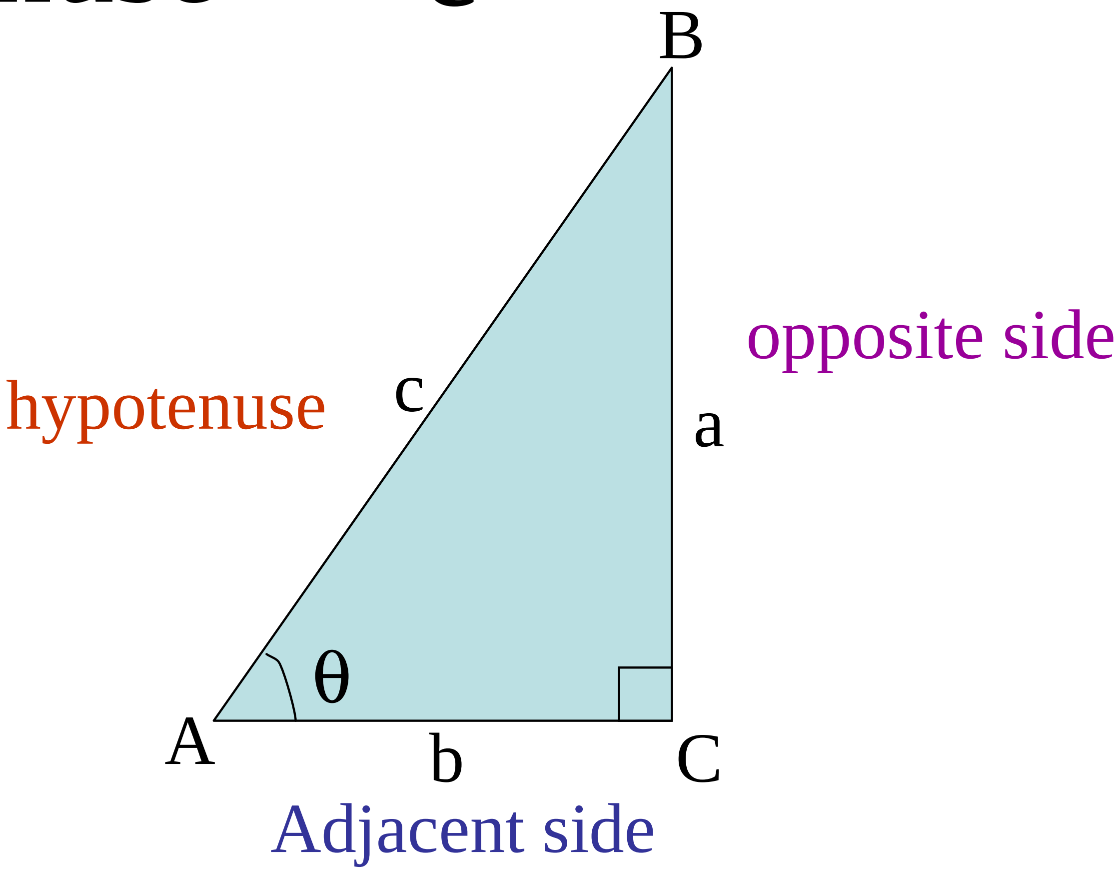
Trigonometric ratios in a right-angled triangle

$$\cos\theta = \frac{\text{adjacent side}}{\text{hypotenuse}} = \frac{b}{c}$$



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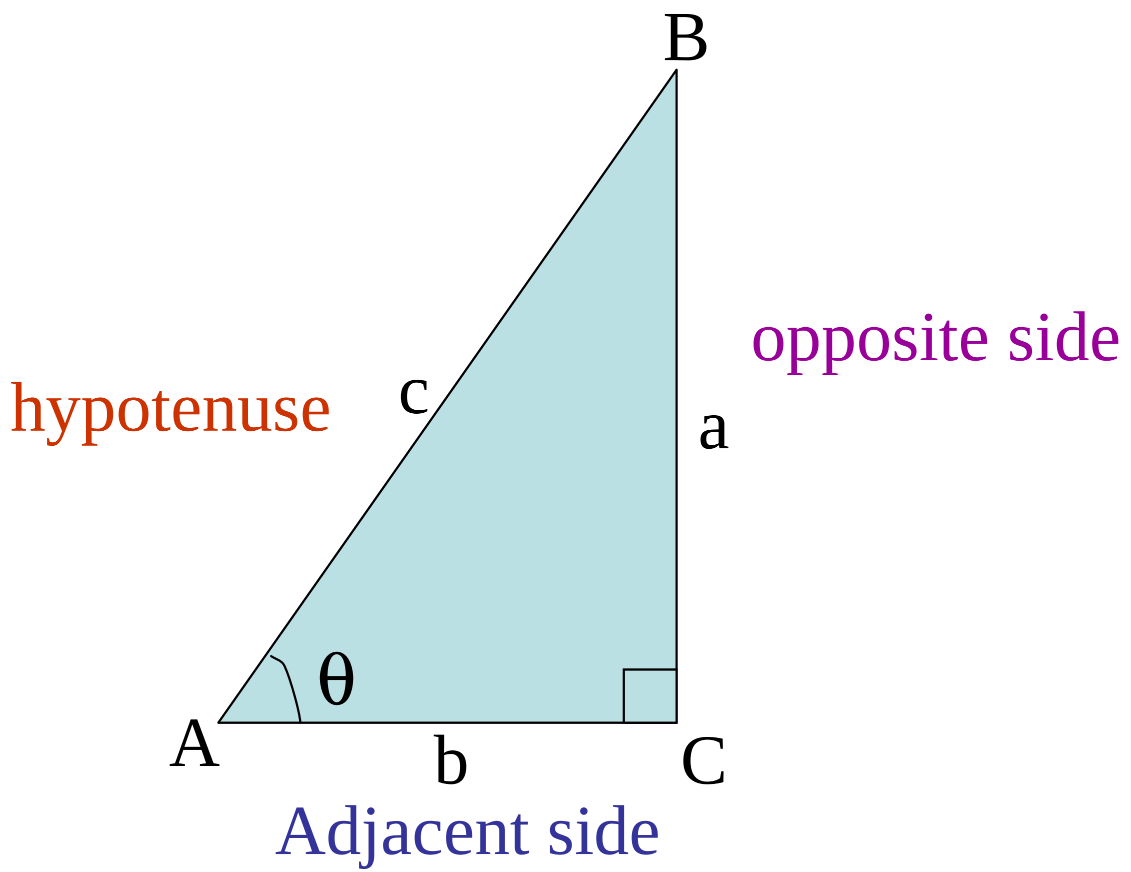
Trigonometric ratios in a right-angled triangle

$$\tan\theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{a}{b}$$



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Simple trigonometric identities

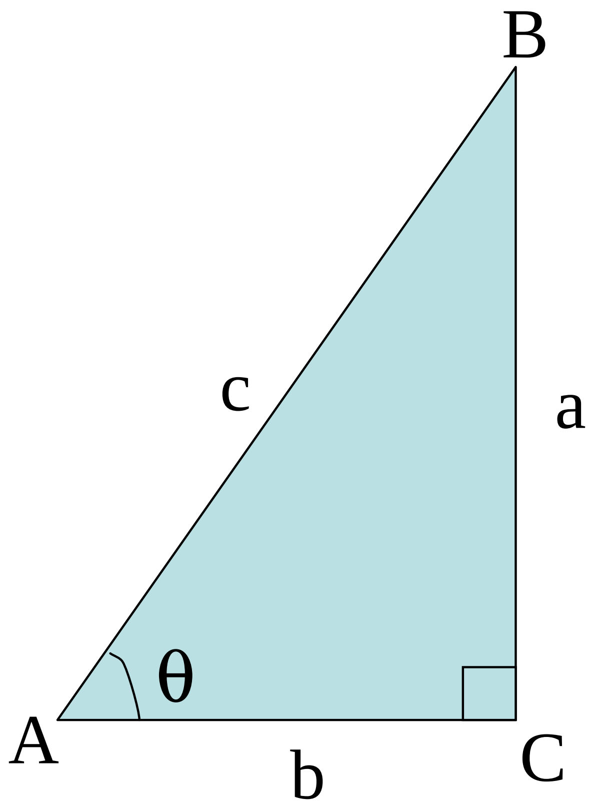
$$\because \sin^2\theta + \cos^2\theta$$

$$= \left(\frac{a}{c}\right)^2 + \left(\frac{b}{c}\right)^2$$

$$= \frac{a^2}{c^2} + \frac{b^2}{c^2}$$

$$= \frac{c^2}{c^2} = 1$$

$$\therefore \sin^2\theta + \cos^2\theta = 1$$



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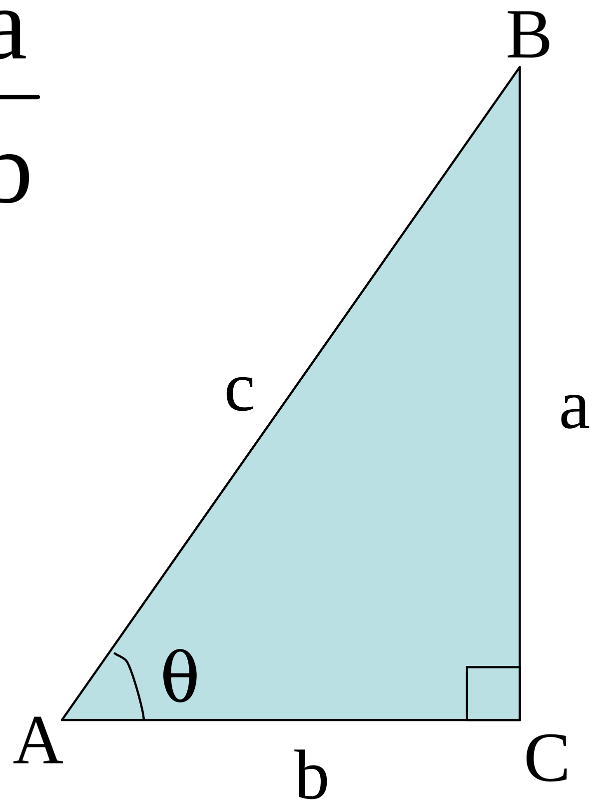
Simple trigonometric identities

$$\because \ \frac{\sin\theta}{\cos\theta} = \frac{\dfrac{a}{c}}{\dfrac{b}{c}} = \frac{a}{c}\cdot\frac{c}{b} = \frac{a}{b}$$

$$\tan\theta = \frac{a}{b}$$

$$\therefore \ \tan\theta = \frac{\sin\theta}{\cos\theta}$$



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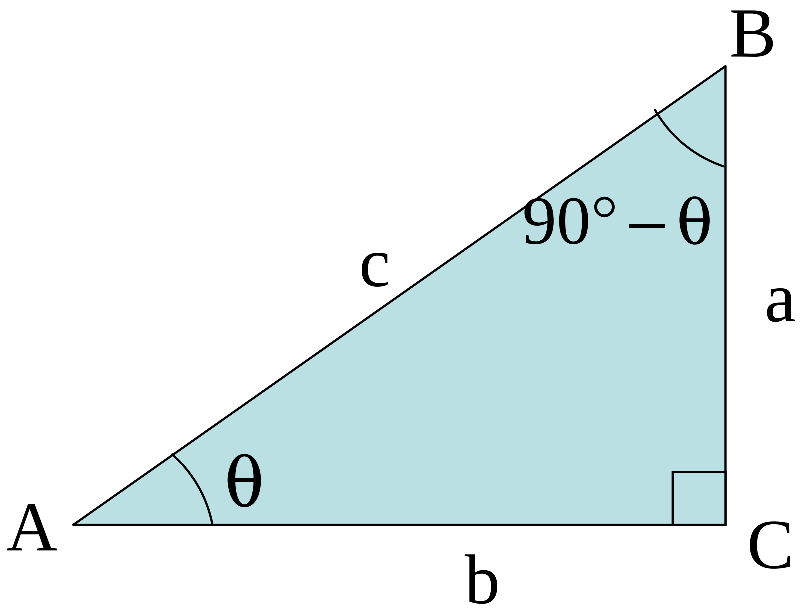
Simple trigonometric identities

$$\because \cos\theta = \frac{b}{c}$$

$$\sin(90° - \theta) = \frac{b}{c}$$

$$\therefore \sin(90° - \theta) = \cos\theta$$



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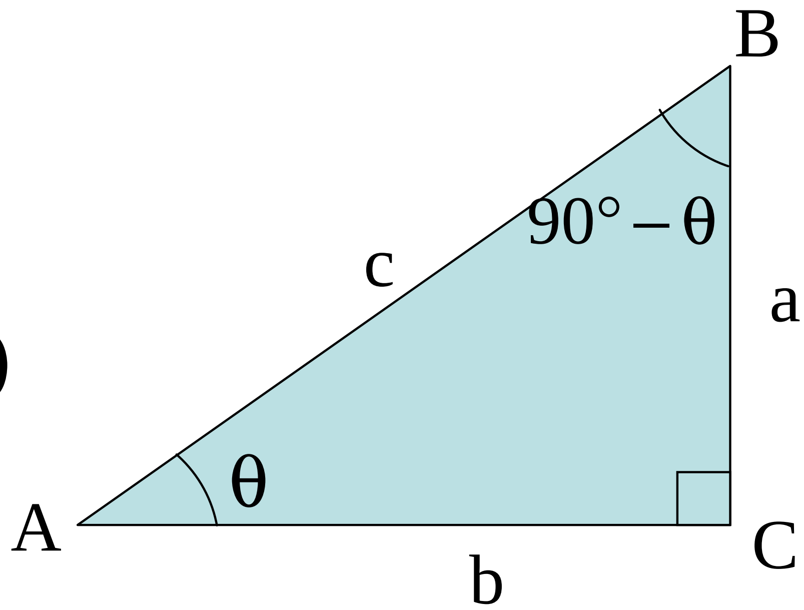
Simple trigonometric identities

$$\because \ \sin\theta = \frac{a}{c}$$

$$\cos(90^\circ - \theta) = \frac{a}{c}$$

$$\therefore \ \cos(90^\circ - \theta) = \sin\theta$$



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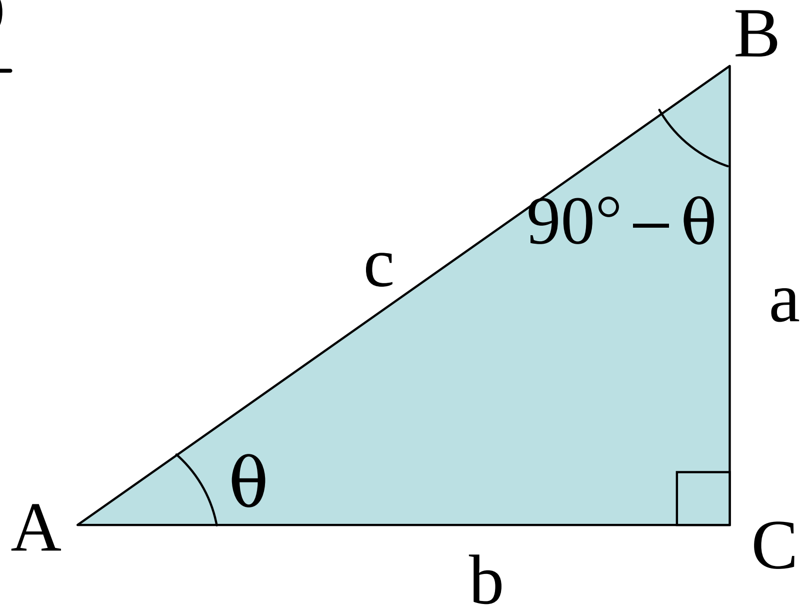
Simple trigonometric identities

$$\because \quad \tan\theta = \frac{a}{b}$$

$$\tan(90^\circ - \theta) = \frac{b}{a}$$

$$\therefore \quad \tan(90^\circ - \theta)$$

$$= \frac{1}{\tan\theta}$$



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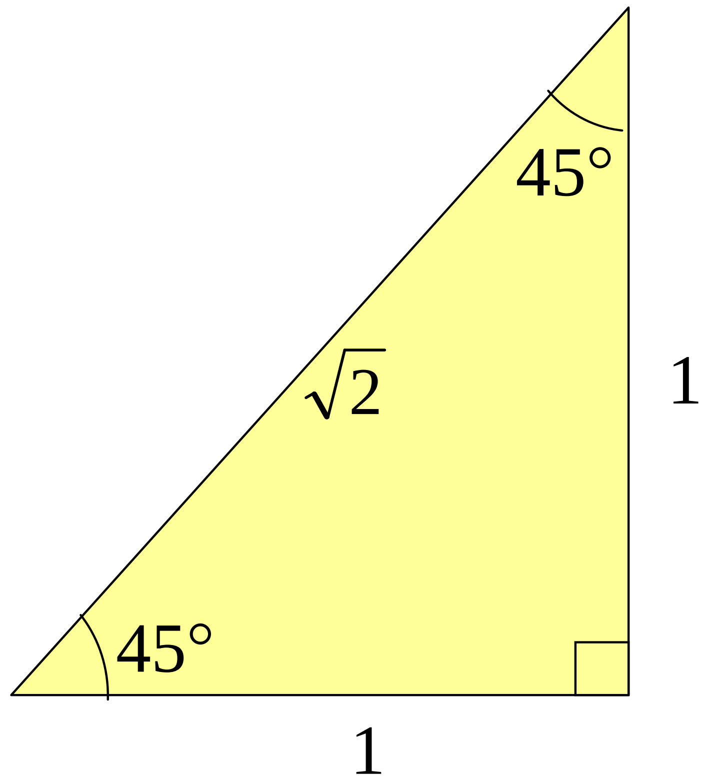
Trigonometric ratios of special angle 45°

$\because x^2 = 1^2 + 1^2 = 2$ $\therefore x = \sqrt{2}$

$\sin 45° = \dfrac{1}{\sqrt{2}}$

$\cos 45° = \dfrac{1}{\sqrt{2}}$

$\tan 45° = 1$



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Trigonometric ratios of special angle 30^{o} ,60^{o}.

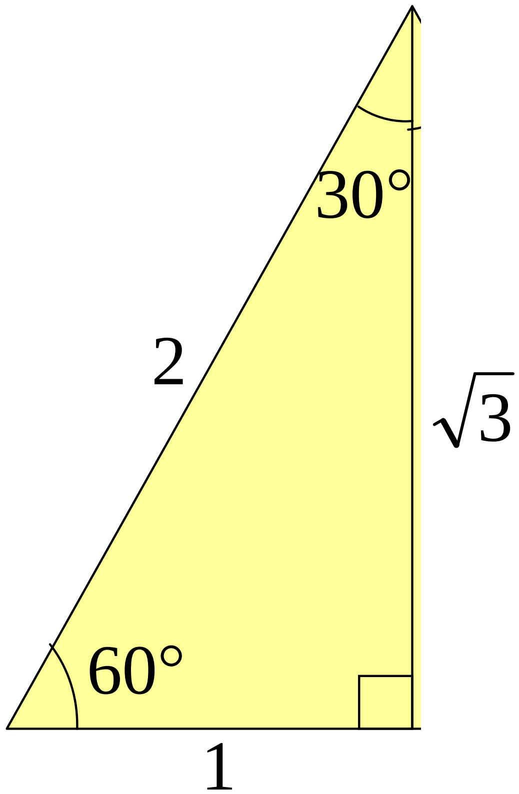
$$\because y^2 + 1^2 = 2^2 \qquad y^2 = 2^2 - 1^2 = 3 \qquad \therefore y = \sqrt{3}$$

$$\sin 60° = \frac{\sqrt{3}}{2} \qquad \sin 30° = \frac{1}{2}$$

$$\cos 60° = \frac{1}{2} \qquad \cos 30° = \frac{\sqrt{3}}{2}$$

$$\tan 60° = \frac{\sqrt{3}}{1} \qquad \tan 30° = \frac{1}{\sqrt{3}}$$

$$= \sqrt{3}$$



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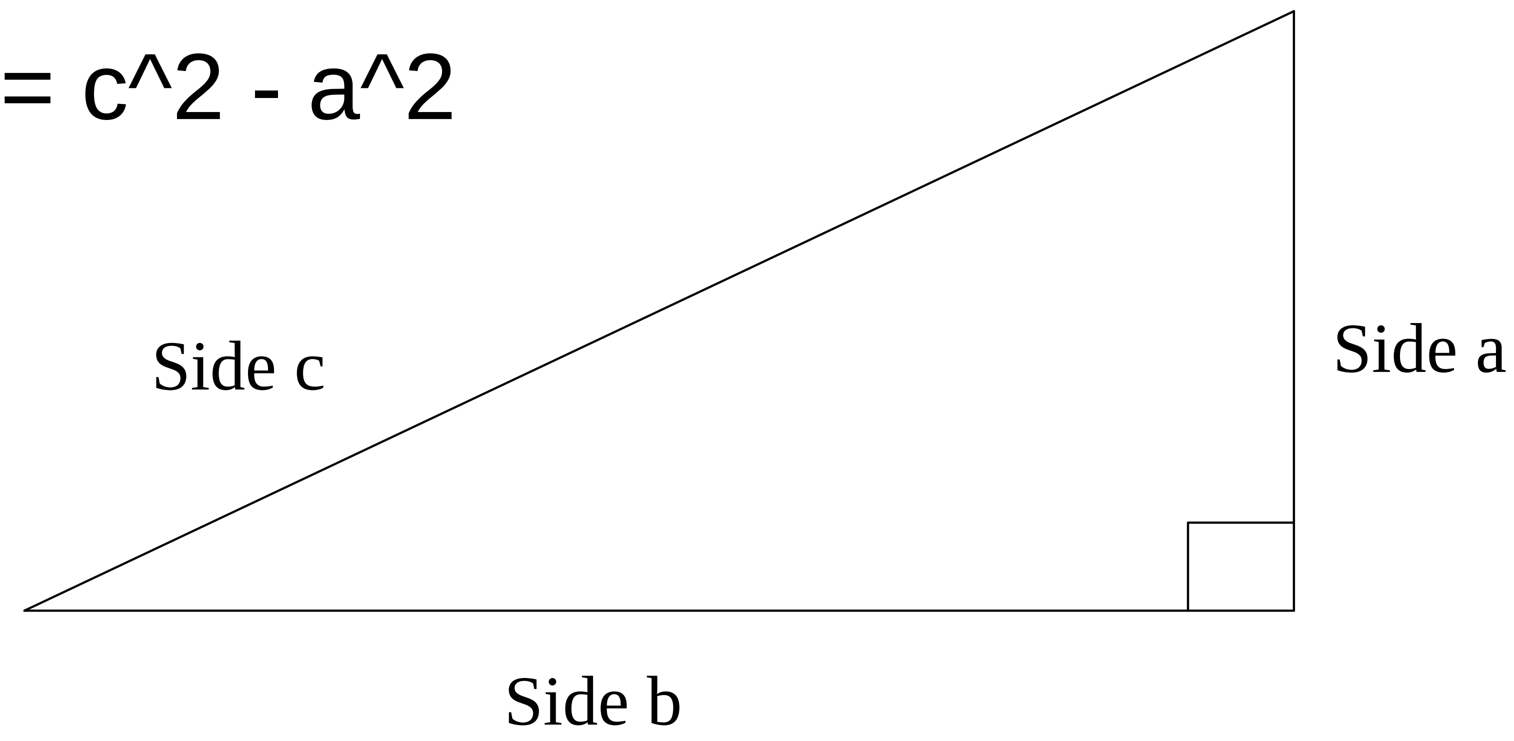
Pythagorean Theorem

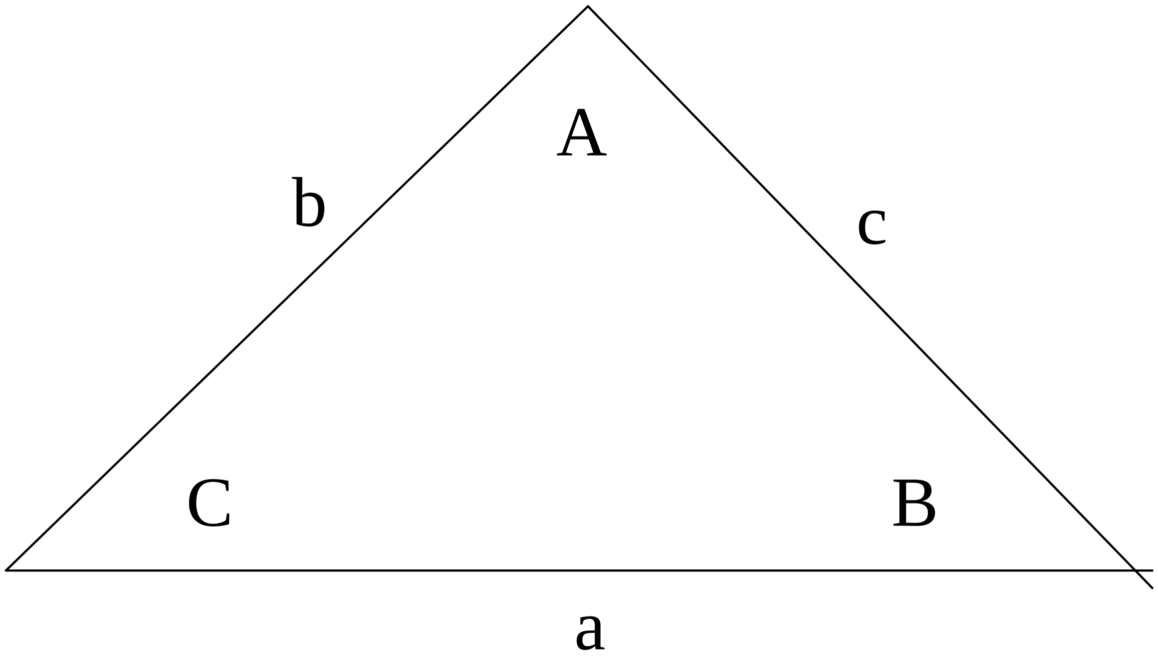
- $c^2 = a^2 + b^2$
- $a^2 = c^2 - b^2$
- $b^2 = c^2 - a^2$

Relationship among the lengths of sides.



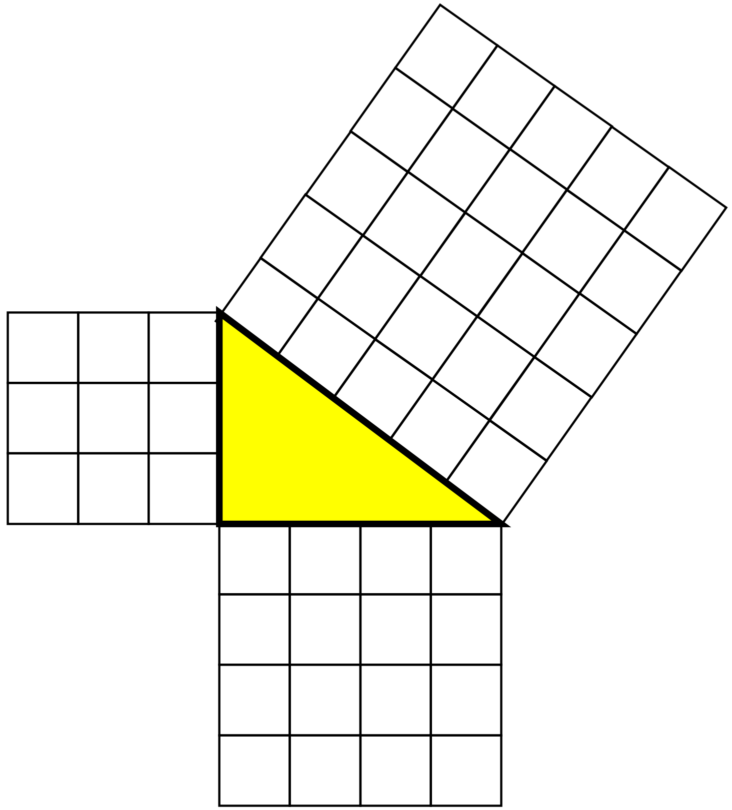
Law of Sines

- Says: a / Sin A = b / sin B = c / sin C
- Where A, B, and C are interior angles
- and a, b, c are lengths of sides.



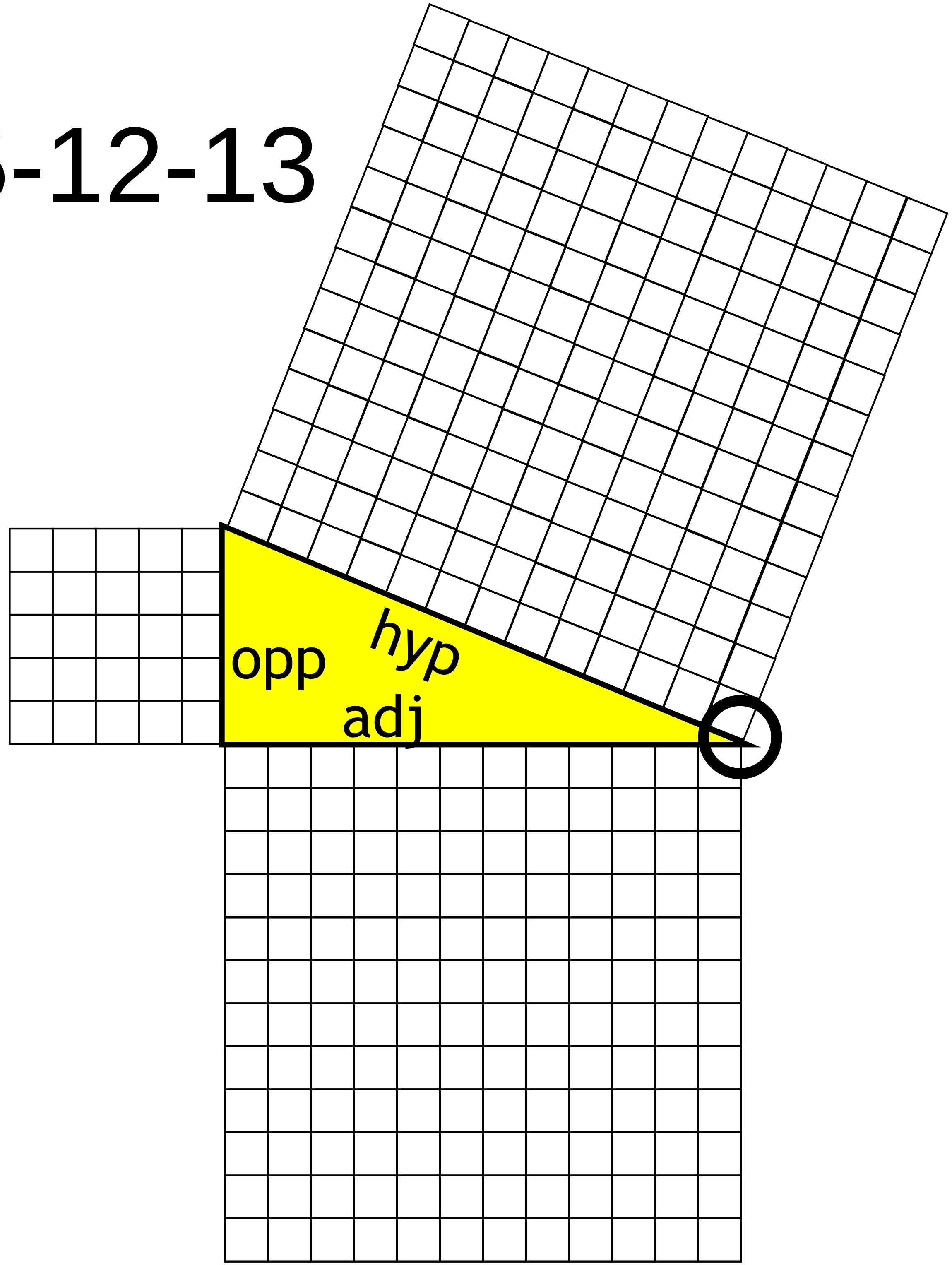
The Pythagorean Theorem

- If you square the length of the two shorter sides and add them, you get the square of the length of the hypotenuse
- $3^2 + 4^2 = 5^2$, or $9 + 16 = 25$
- $adj^2 + opp^2 = hyp^2$
- $hyp = sqrt(adj^2 + opp^2)$
- $5 = sqrt(9 + 16)$



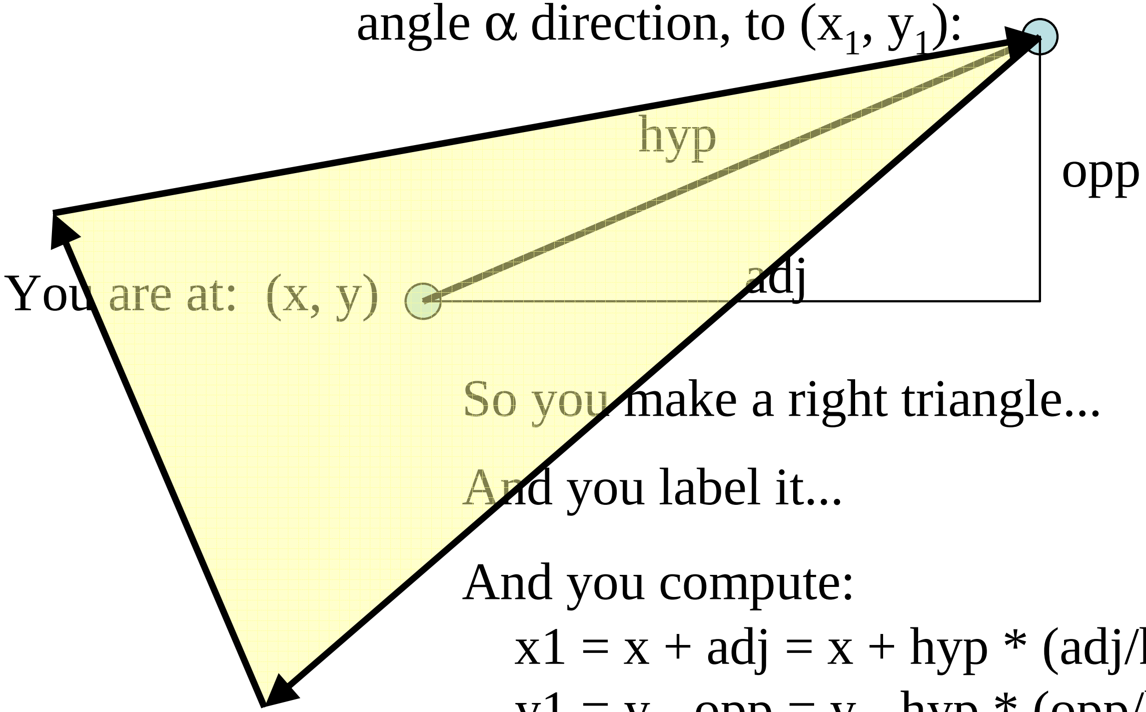
5-12-13

- There are few triangles with integer sides that satisfy the Pythagorean formula
- 3-4-5 and its multiples (6-8-10, etc.)
  are the best known
- 5-12-13 and its multiples form another set
- 25 + 144 = 169



Drawing a "Turtle"

You want to move h units in the angle α direction, to (x_1, y_1):



So you make a right triangle...

And you label it...

And you compute:

$x1 = x + adj = x + hyp * (adj/hyp) = x + hyp * \cos \alpha$

$y1 = y - opp = y - hyp * (opp/hyp) = y - hyp * \sin \alpha$

This is the first point in your "Turtle" triangle

Find the other points similarly...