Rescue Simulation

Coordinates, Compass, and Heading

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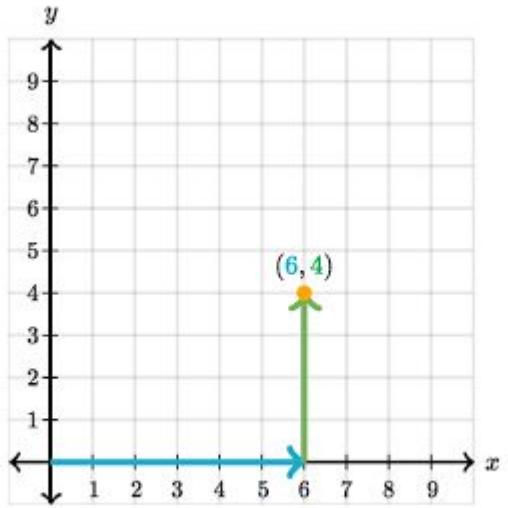
Cartesian Coordinates

A coordinate system that specifies each point uniquely by a pair of numerical **coordinates**, which are the distances to the point from two fixed perpendicular oriented lines (x & y axes), measured in the same unit of length.

In the example shown, we specify a point 6 units along the x-axis. That's x=6.

And 4 units along the y-axis. That's y = 4.

We represent this point as (x, y), or (6, 4)



CoSpace Coordinates - U12/FirstSteps

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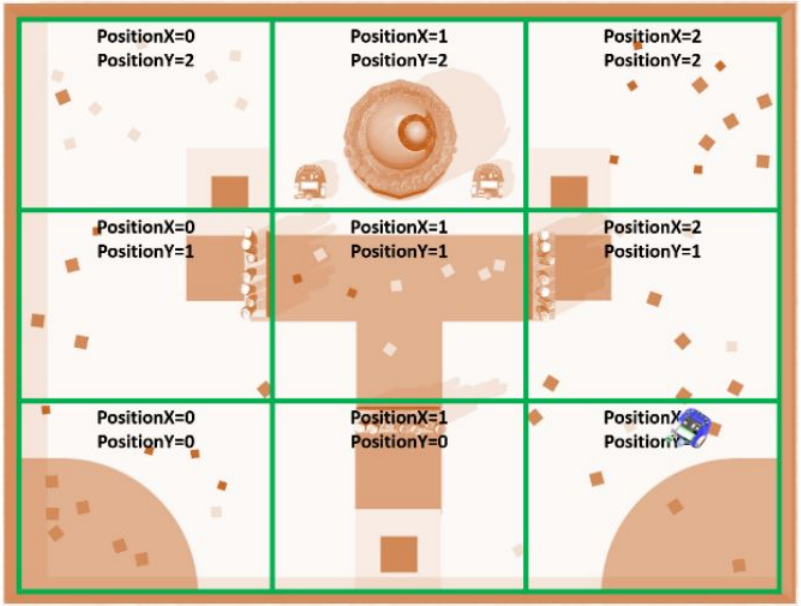
In U12 sub-leagues of CoSpace Rescue Simulation, World 2 maps are subdivided into nine (9) districts overlaying the map.

Each district has a corresponding (x, y) coordinate. For instance, (0,0) corresponds to the bottom left corner, while (2,2) corresponds to the top right corner.

You can also say x = 0 signifies the leftmost districts, while x = 2 signifies the rightmost, and x = 1 the districts in the “middle column”. And so on.



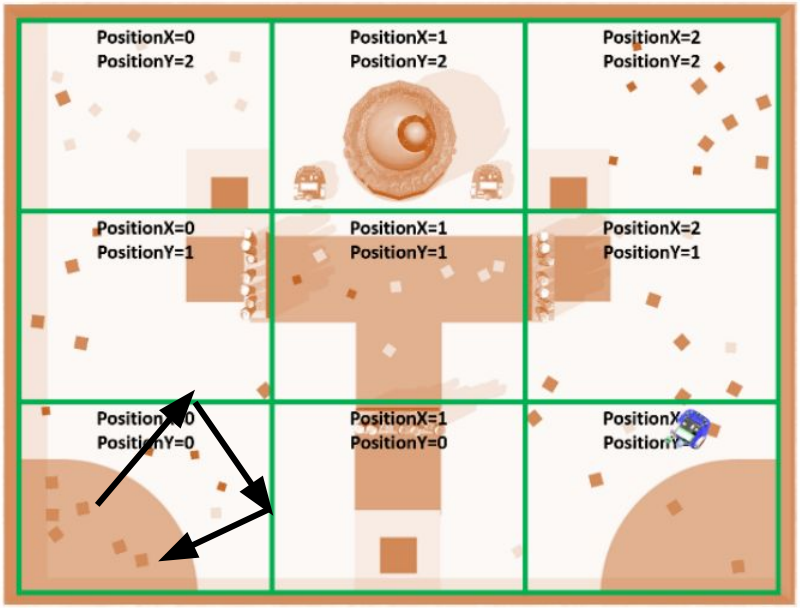
What are the (x,y) coordinates for the blue robot above?

Treat Boundaries as Walls

If you wish your robot to stay in its current District, then you should treat changes to its X or Y position as if you've hit a wall and need to bounce back.

Say you are in District 0,0 (think State):

- Condition: x = 1 **or** y = 1
- Action: Turn back



Treat Boundaries as Walls - Sample Code

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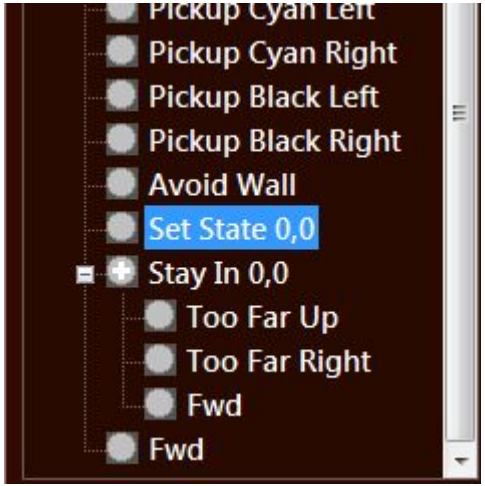
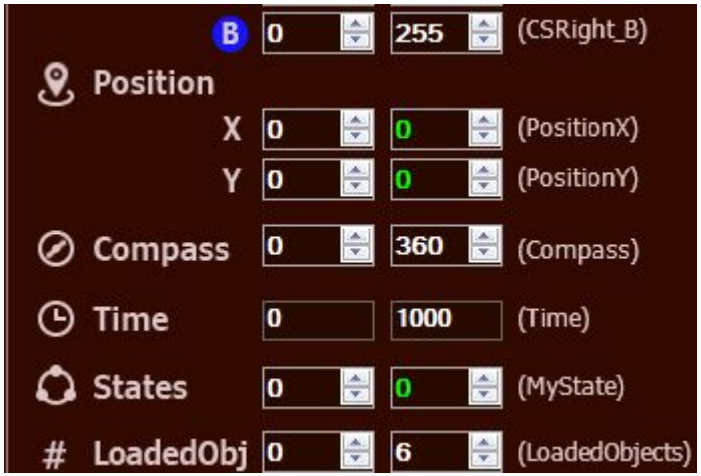
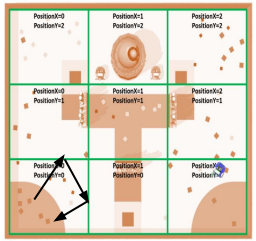
Enter 0,0 State:



If @ (0,0) AND Cur State is 0 (undef)



Set State = 1
(means I want to stay in 0,0)



Treat Boundaries as Walls - Sample Code

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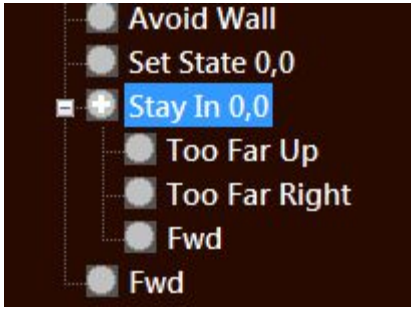
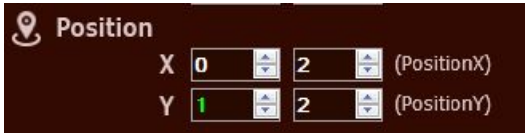
Stay in 0,0 State:



Once you've created a state, you can put all the special statements associated with that state as sub-statements.

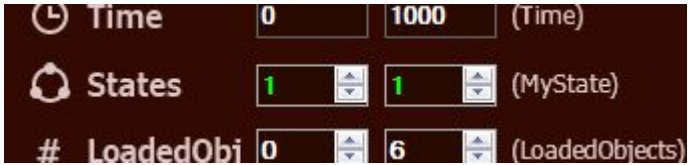
One for going too far up/north, one for going to far right/east, **and one for Fwd**, as the algorithm will SKIP any other statements under this state segment.

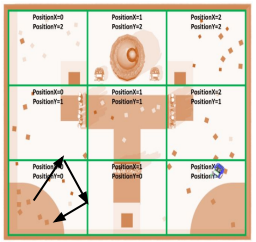
For example, Too Far Up means Y > 0:



In that case, you want to turn robot back, e.g:

As long as State = 1





General Use Cases of Compass Heading

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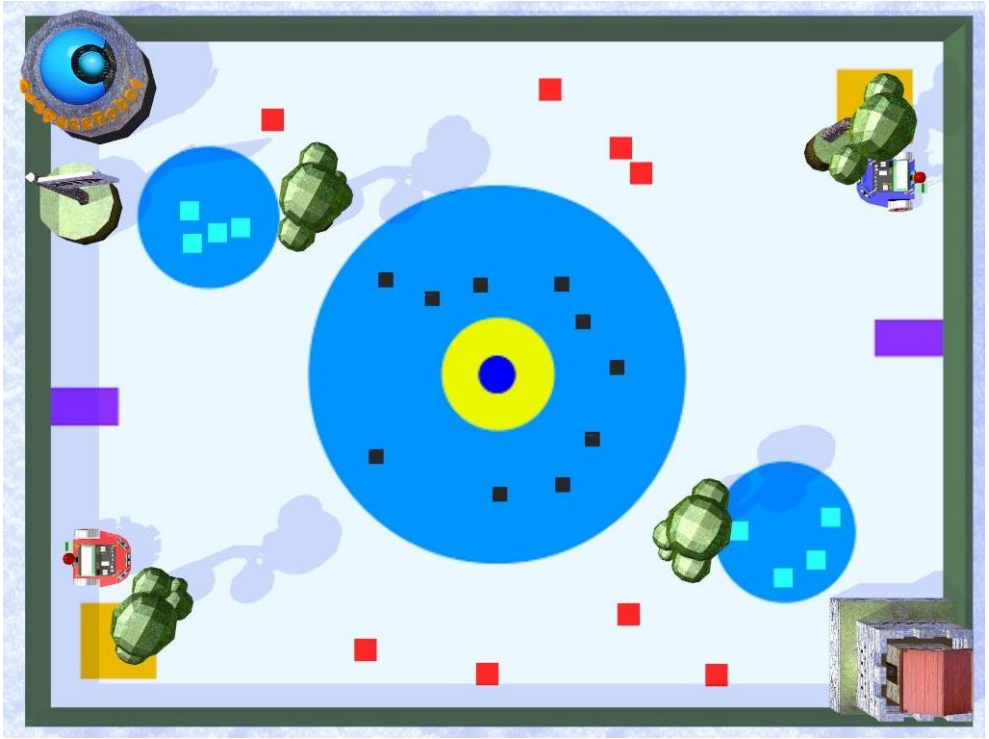
In Maps like this one, it's possible to use a simple "Move Towards Compass Heading" tactic to get to the collection boxes when fully loaded.

So, if you set your heading to North-West or South-East, eventually you would get to the corners with collection boxes. (Hint: watch your wall-avoidance behavior for proper integration)



General Use Cases of Compass Heading

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Or you may wish to drive to 1,1 (middle quadrant) and stay there to collect 2 black and 2 cyan objects in this map.

And then move down to one of the bottom corners, (0,0) or (2, 0) to collect some red objects…

In these cases you can use a state machine to control the robot's heading under varied conditions.

Driving Towards a Coordinate

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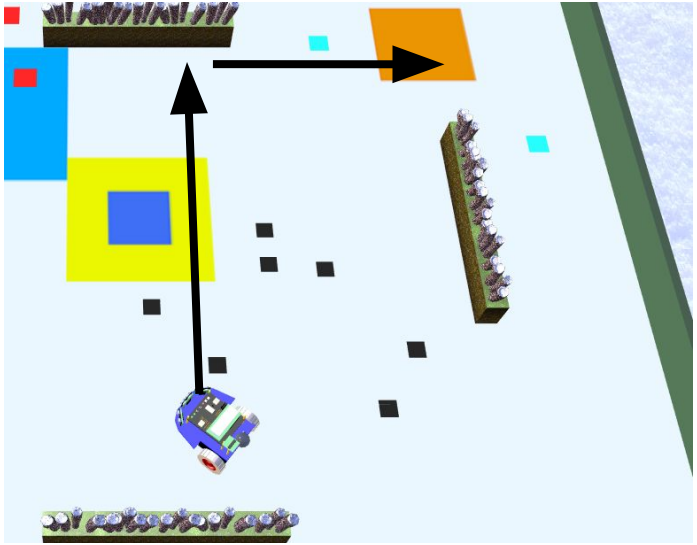
Manhattan Distance - Simple Algorithm

- if $Y_{current} < Y_{heading}$: head North
- Else If $X_{current} < X_{heading}$: head West
- Else if $X_{current} > X_{heading}$: head East
- Else : head South



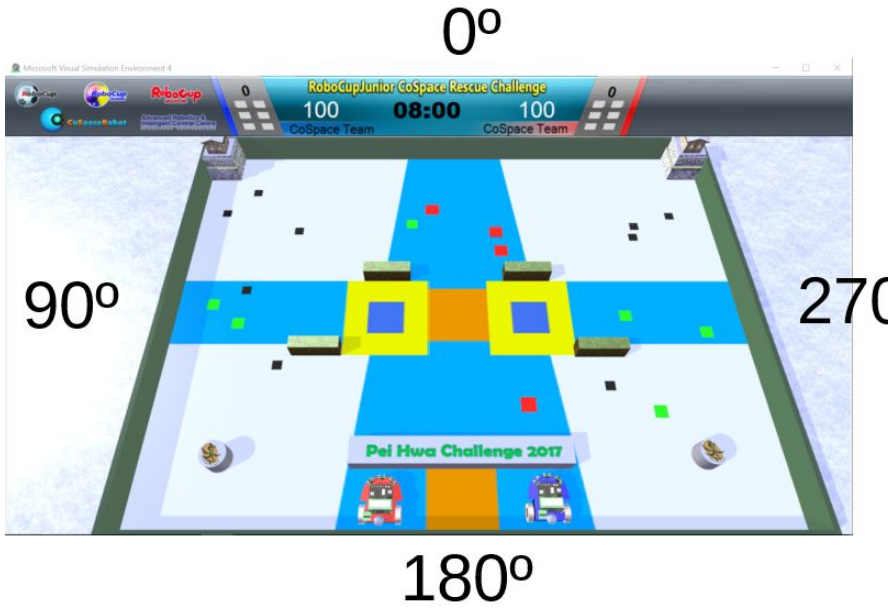
First, let's figure out how to head towards a

Move Towards Compass Heading

We will start with the last step and come up with a way to move towards a particular Compass Heading, because it has general use cases.

The figure here shows the internal compass of the CoSpace world.

0 (and 360) - North
90 - West
180 - South
270 - East



Move Towards Compass Heading

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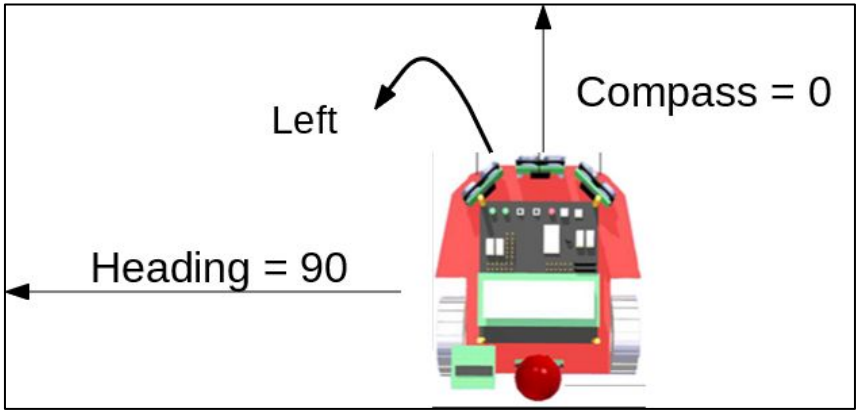
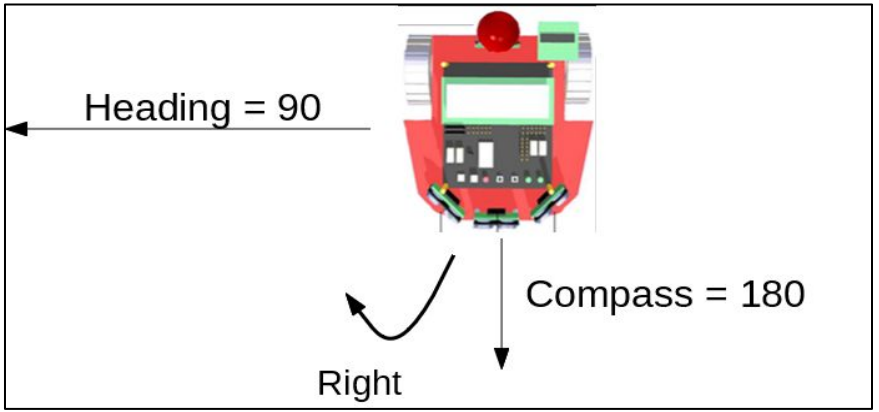
Scenarios:





Move Towards Compass Heading

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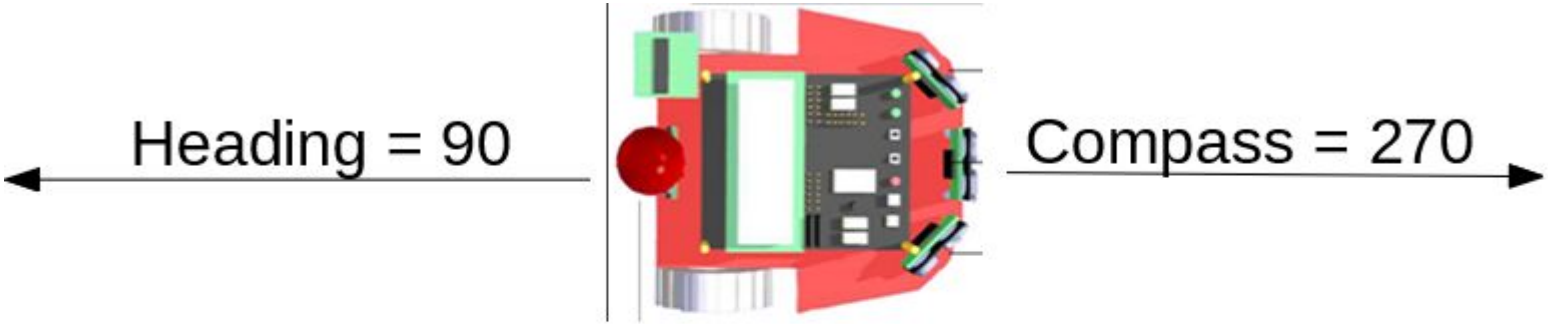
Scenarios:



Move Towards Compass Heading - Example

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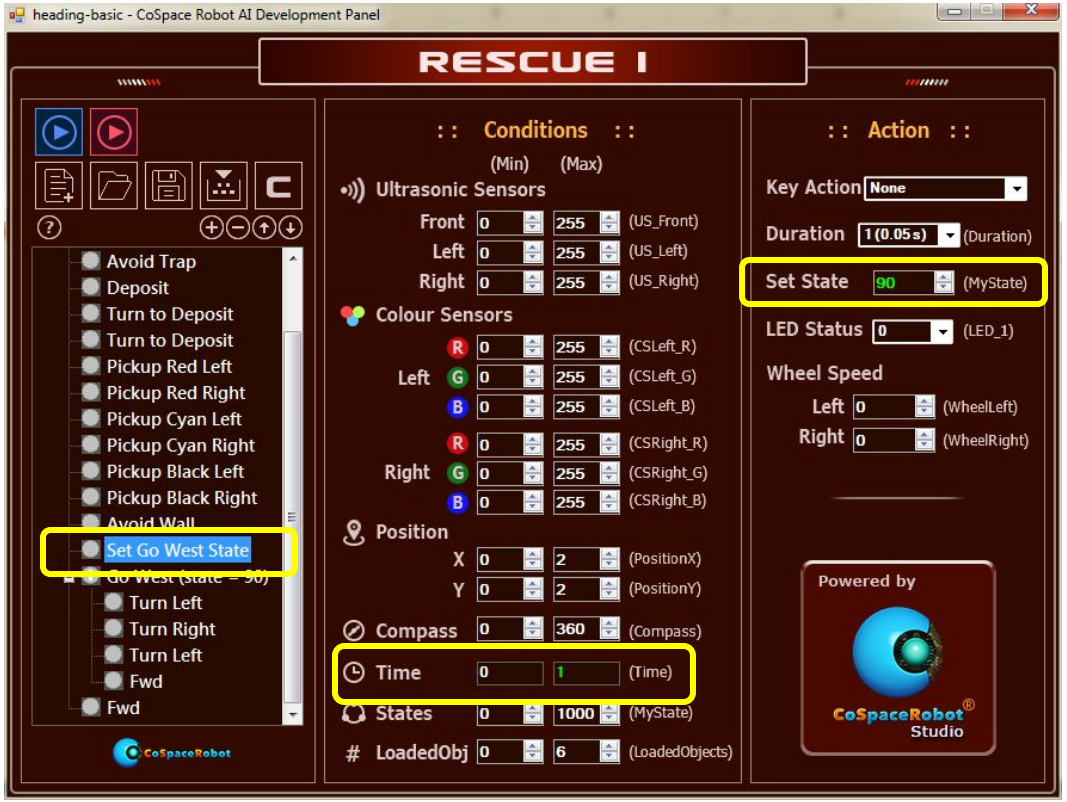
Let's start with creating a State to head West (heading=90).

For testing purposes, we will use the State variable as our heading, and we will just set our state in the first 1sec.

After the first second, State = 90 and unless the robot is depositing or picking up, it will try to go West!



Move Towards Compass Heading - Example

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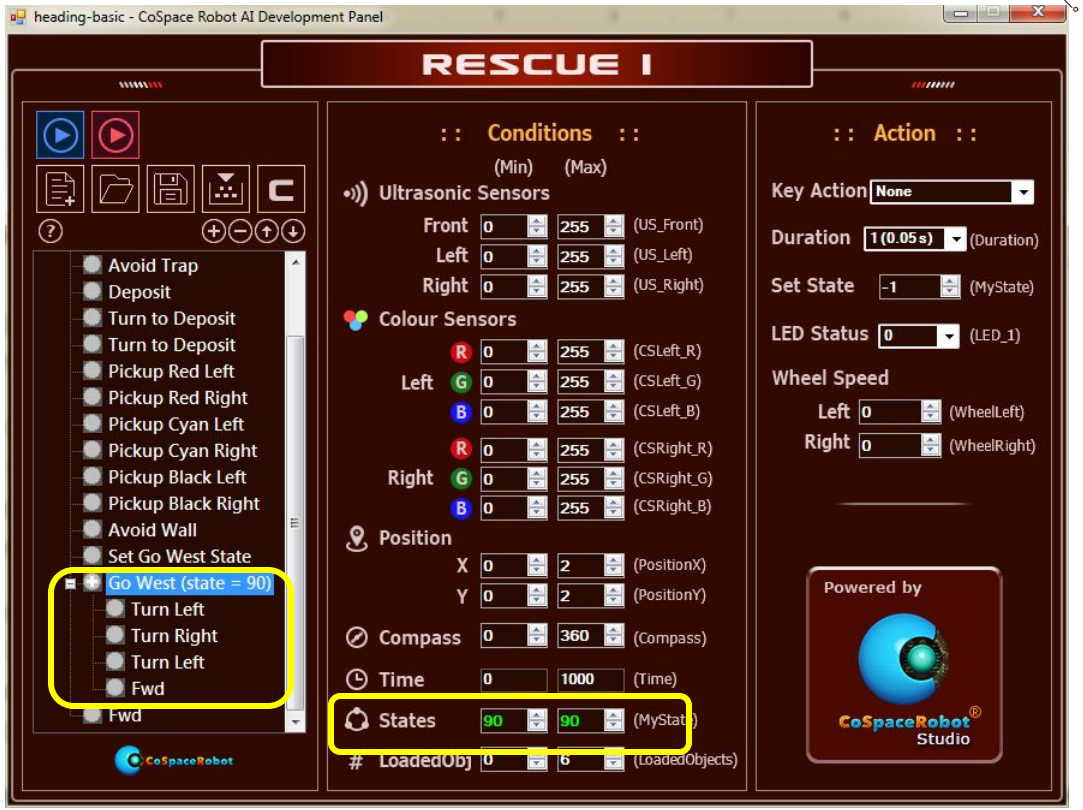
Let's now create the State segment for moving West (heading=90). Any sub-statements here will all be part of this special state.

State segment headings just need a condition, and no action.

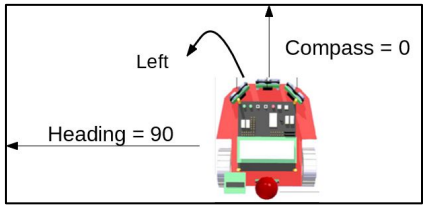
Imagine a nested If statement inside; the action will be determined by sub-statements.

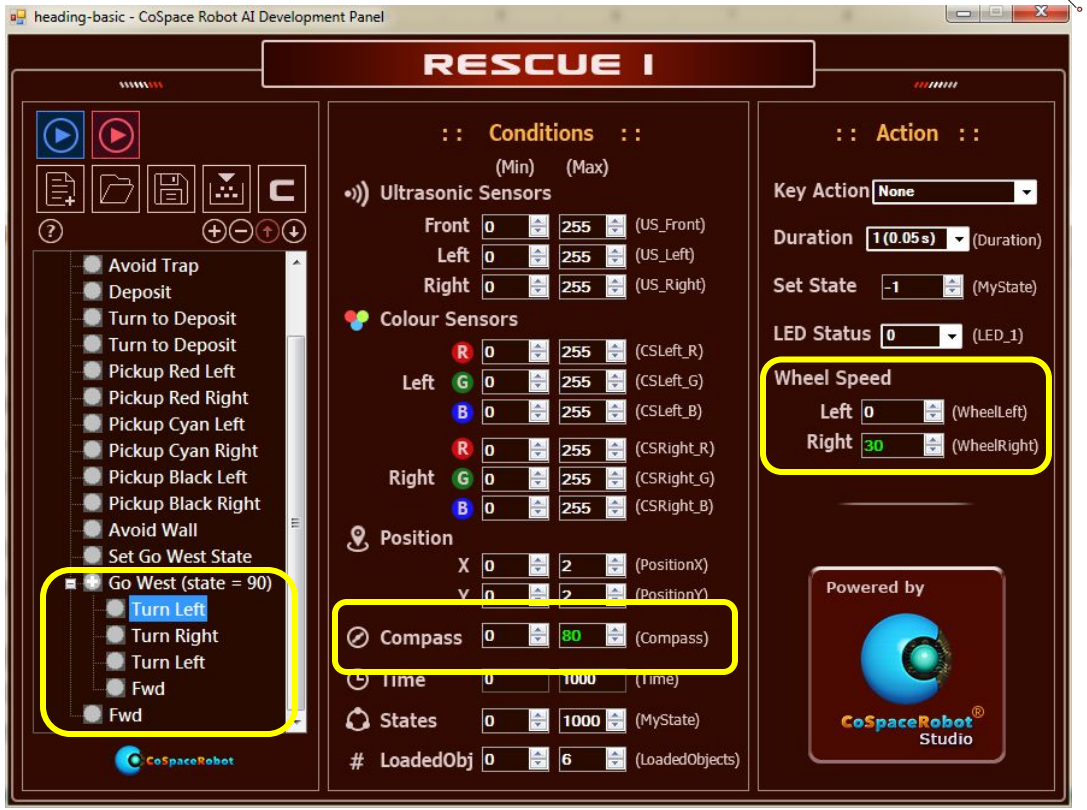


Move Towards Compass Heading - Example

Re-analyze the polar geometry. For instance, if robot is currently pointing towards N/NW - between 0 and ~90 - it needs to turn **left**.

Let's give it a ~20 degree leeway, so between 80-100 we will call that "West".





Move Towards Compass Heading - Example

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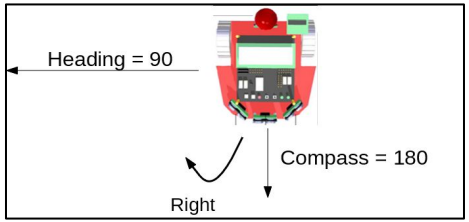
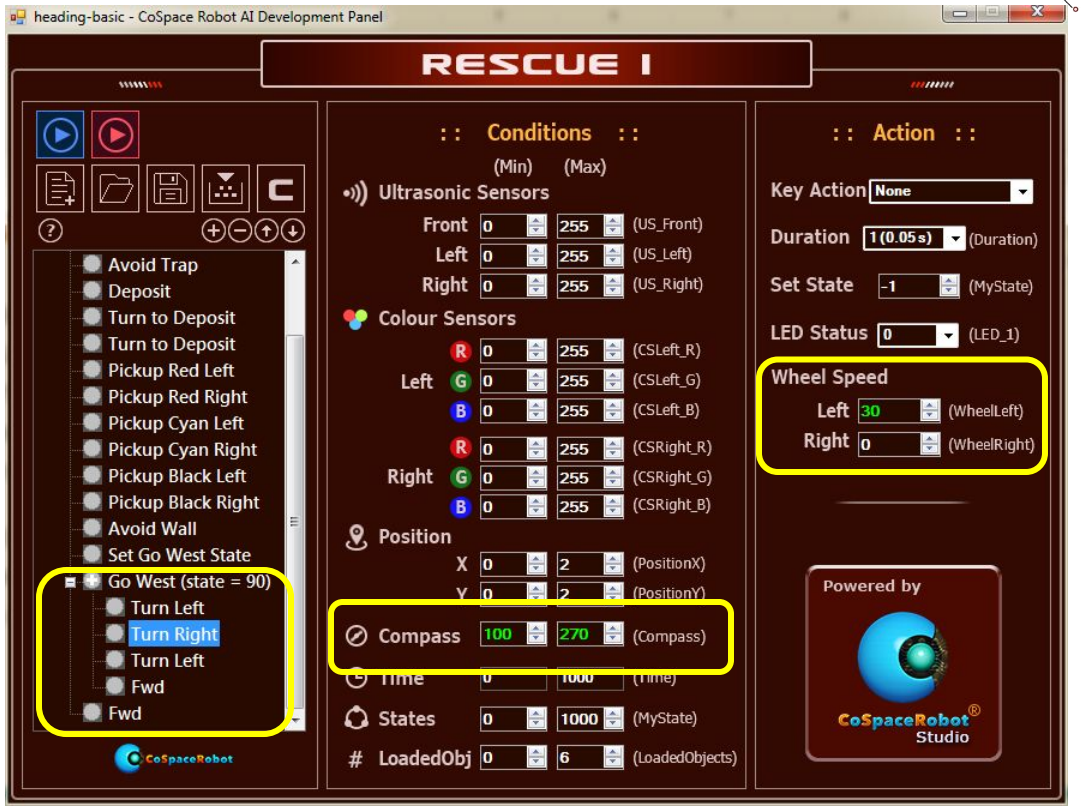
And, if robot is currently pointing towards SW/S and all the way East - between ~90 and 180- it should turn **right**.



How about when it points between 180 and 270?
And 271 to 360?
(Hint: see extra “Turn Left” statement to deal with that last one…)



Move Towards Compass Heading - Example

If the robot is heading in the right direction, in this example 80 to 100, then just go FWD.

Note that once the code deviates into a State's sub-statements it won't go back to the main decision tree. Any states that are below (like Fwd) would need to be considered in the State's segment as well.

Hence, the extra Fwd statement.

Driving Towards a Coordinate

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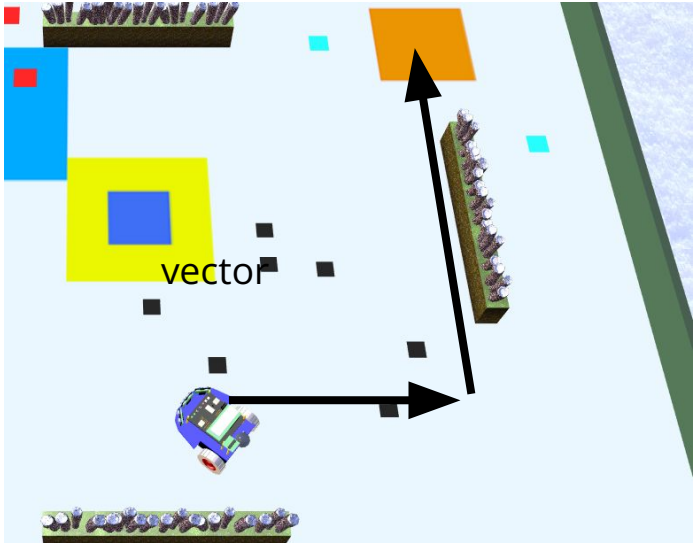
Putting It All Together

In order to go to a particular quadrant using above heading state example, you'd need to setup 4 states, and 4 conditions that guide which heading to follow -

- If $X_{current} < X_{heading}$: head West State
- Else if $X_{heading} < X_{current}$: head East State
- Else if $Y_{current} < Y_{heading}$: head North State
- Else : head South State



Move Towards Heading - Intermediate

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Decision Table:

Compass	Target Heading	Error (Compass-Heading)	Turn
0	90	-90	Left
0	179	-179	Left
0	181	-181	Right
0	270	-270	Right
0	359	-359	Right
90	0	90	Right
179	0	179	Right
181	0	181	Left
270	0	270	Left
359	0	359	Left

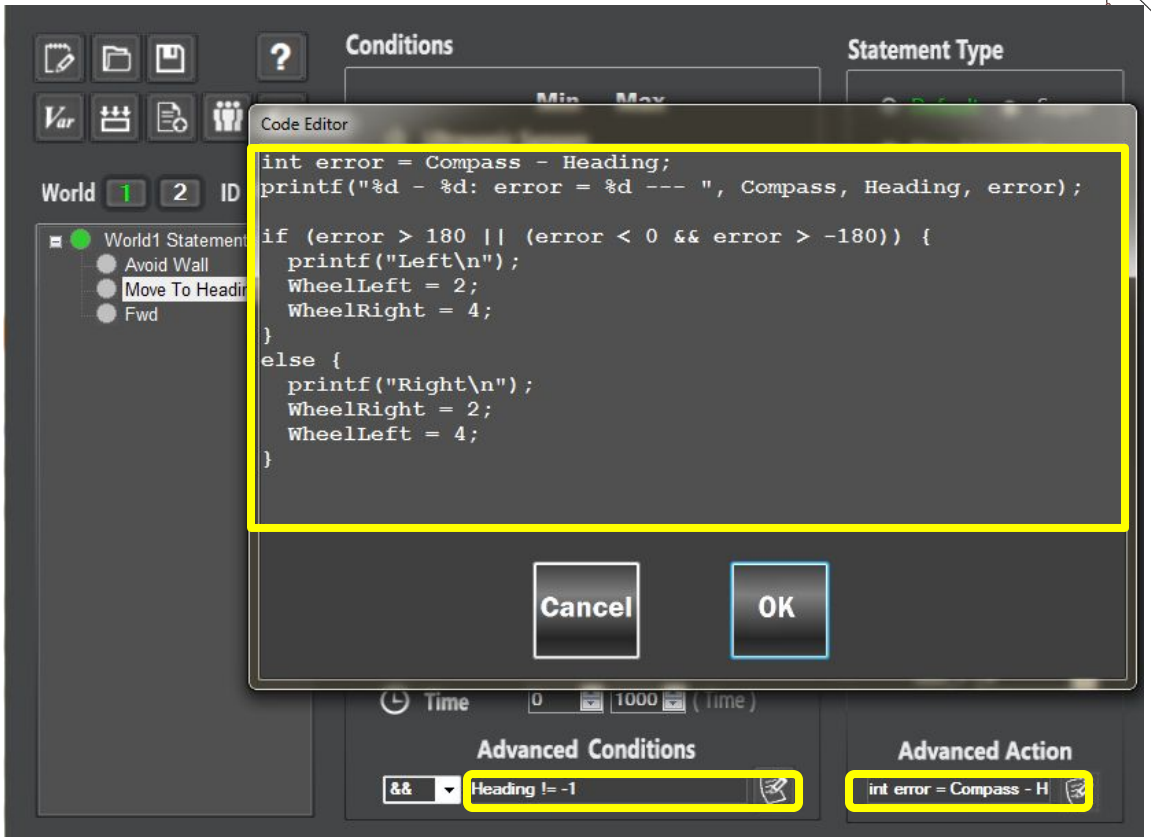
When should the robot just drive straight, if at all?

Move Towards Heading - Intermediate

One general algorithm for heading towards a compass heading can be done in Advanced Action, as shown.

You can also pick an error tolerance and add a FWD state for low errors…

The Advanced Condition is simply: *Heading != -1* (Heading is NOT -1)



The End?

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For FirstSteps and Intermediate (Under 12) CoSpace sub-leagues, this is a good place to stop basic training and start practicing with different maps, scenarios, and strategic algorithms.

Further slides are mostly for Advanced.