OMNeT++ - Tutorial 2

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OMNeT++

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Where we left off

- Basic OMNeT++/Inet intro
  - Installing
  - Basics of a simulation model
  - TicToc example
  - (very basic) Analysis

What Now?

- Create a new project with Inet support
  - Needed for HW2
- Learn how to run batch simulations
  - Needed for HW2
- Learn more analysis
  - ... Needed for HW2?
    - Yes!
- Bonus!
  - Initial node position

Creating a New Project

- File->new->OMNeT++ Project...
  - Create a name, and keep the default location
  - Select blank project, then finish
- Link Inet project
  - Right-click on your project
  - Select 'properties' → Project References
  - Select Inet from the list
  - What if Project References is not an option?
    - Make sure project is open (right-click project → Open Project)

Creating a New Project

- Can I use an existing project?
  - Sure, just make sure it is linked to Inet
- Can I create a folder within the Inet project and use that as my project?
  - Technically, yes
    - This would not be a 'project' (simply a folder within the Inet project)
    - Inet makefile would need to be regenerated
    - Your project would not be standalone, would now be part of Inet

Running Your Project

- What is required?
  - package.ned: defines package for your project
  - omnetpp.ini: configuration file
- Two methods to run:
  - IDE
    - Click the green circle arrow button
  - Command-line
    - Directly run project executable with appropriate args
    - opp_runall

Command-line Issues

- Executable won't load
  - Libraries missing
    - In Windows, add the following to your PATH:
      - <omnet-root>\lib;<omnet-root>\samples\inet\src
    - Alternatively, run from IDE (preferred)
  - Cannot find NED files
    - Executable by default only search for NED files in CWD
      - -n and then paths to other NED files (prolly in Inet folders)
      - Copy and paste these args from IDE console
        - Alternatively, run from IDE (preferred)

Command-line Issues

- I tried using opp_run instead, and now the simulation can't find my classes
  - opp_run is used if project compiled as library
    - Since you compiled as a standalone executable, there is no library with your classes

Batch Simulations

- This is process of executing multiple *runs*
  - What's a run?
    - A single instance of a simulation, using some set of values for parameters
  - Multiple runs are usually used for two reasons:
    - To run the same configuration with different values for parameters
    - To run the same configuration with same parameter values but with different seeds

Running Batch Simulations

- Command-line only
  - Hey, you told us to use the IDE!!

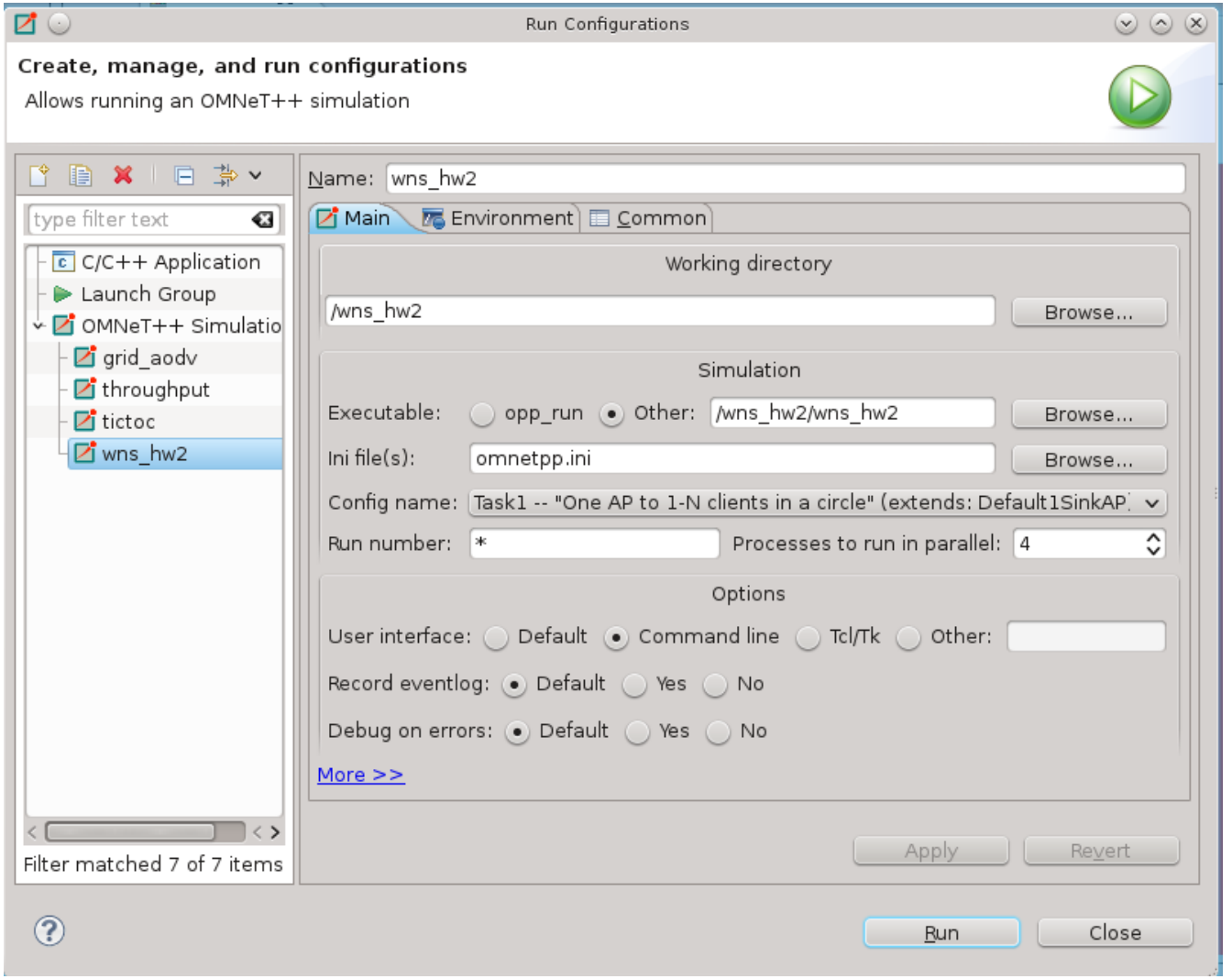
But, there is a catch...

Running Batch Simulations

- IDE can act as front-end for command-line launcher!
  - This is accomplished by changing the run configuration
  - Run --> Run Configurations
    - Select appropriate configuration
    - Select 'Command Line' for user interface
    - Put '*' for run number (all runs)
    - (optional) match the processes to run in parallel with your CPU's core count

Running Batch Simulations

- IDE can act as front-end for command-line launcher!



Running Batch Simulations

- Changing the run configuration is persistent
  - If you need to go back to the GUI (Tkenv), switch configuration in the ini, or anything else, you need to go back to the Run Configurations dialog...

Setting up a Batch Simulation

- This is done in the omnetpp.ini file
  - We can setup loops, with each loop being one run
    - This is done using *iteration variables*

Iteration Variables

- Syntax: *module.parameter = ${var_name=range* step *step_num}*
  - *module.parameter* is the same syntax as for any parameter assignment in the ini
  - *var_name* is the name of the iteration variable
  - *range* is the set of numbers we iterate over
    - 1..10 means a range from 1 to 10
    - 1,2,5,8..10 means step through 1,2,5,8,9,10
  - step is optional, specifies to use *step_num*
    - Default step is 1
    - 1..11 step 2 would step through 1,3,5,7,9,11

Iteration Variables

- We declare iteration variables in configuration blocks
  - We reference them using this syntax: ${*var_name*}
- For each value of the iteration variable, that block is run once with that value
  - Consider this example:
    [Config Task1]

    WifiNetwork.numClients = ${N=1..10 step 1}
  - Doing a batch simulation of Task1 over all runs, we will execute Task1 10 times, for each ${N} (N = iteration variable)

Iteration Variables

- Multiple iteration variables can be declared in the same block
  - Consider this example:
    [Config Task1]

    WifiNetwork.numClients = ${N_Cli=1..10 step 1}

    WifiNetwork.numAPs = ${N_APs=1..5 step 1}
  - Doing a batch simulation of Task1 over all runs, we will execute Task1 50 times:
    - For each ${N_Cli}, we execute 5 times for each ${N_APs}
    - ${N_APs} is nested inside ${N_Cli} due to declaration ordering

Iteration Variables

- Unique seed per run
  - *seed-set* = ${*repetition* | *runnumber*}
    - Default is *runnumber*
      - Produces a unique seed per run
    - *Repetition* produces a unique seed per repetition
      - What is a repetition?
        - A run with a unique value for the repetition iteration variable
        - Declared with *repeat*
          - *Repeat = 20* would cause each run to repeat 20 times
          - Repetitions are in themselves runs, just have a reserved name and meaning in OMNeT++

Iteration Variables

- Multiple runs of a specific configuration, with unique seed per repetition:
  - Using the same example:
    [Config Task1]

    WifiNetwork.numClients = ${N=1..10 step 1}

    repeat = 20

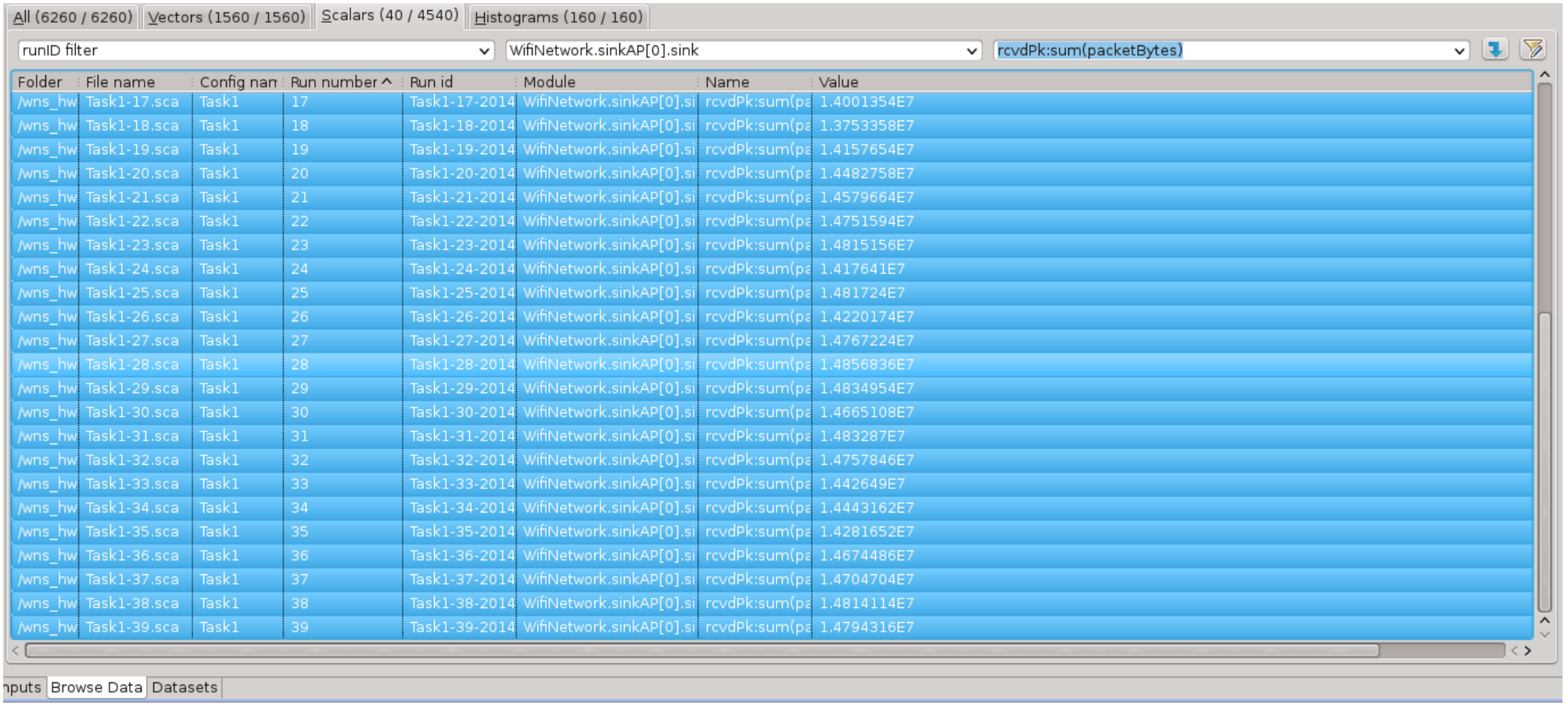
    seed-set = ${repetition}
  - For each ${N}, run 20 times, each time using a different seed
    - 200 runs in total
    - When using *repeat*, ${repetition} will always be nested lowest

Grabbing Statistics

- After a batch run, click on any of the *.vec or *.sca files to create an ANF
  - Notice how the ANF name does not append a specific run
    - They are grouped together (awesome)!
  - How do I average the data?
    - Use the filters to narrow down the module and scalar you need
      - Select everything, and plot
        - Watch the magic

Grabbing Statistics

- For example, using the HW2 scenario, with 2 clients and a single AP:



Grabbing Statistics

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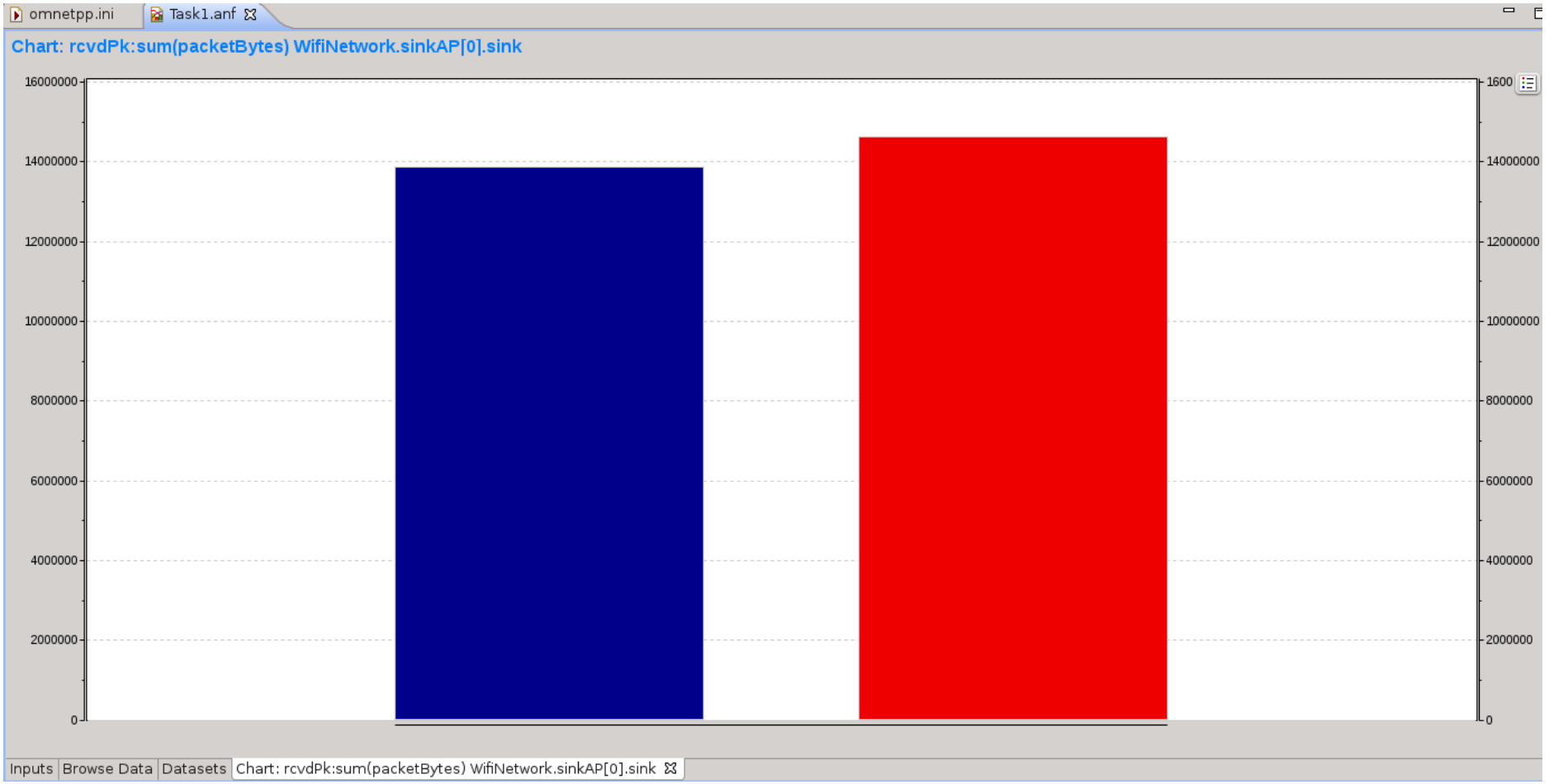


Grabbing Statistics

- For example, using the HW2 scenario, with 2 clients and a single AP:
  - It's magic! It even split up the data by client!
    - Well, not really magic. OMNeT++ groups the data by non-repetition iterator variables (client count being one), and averages according to repetition.
    - Makes your job much easier!*

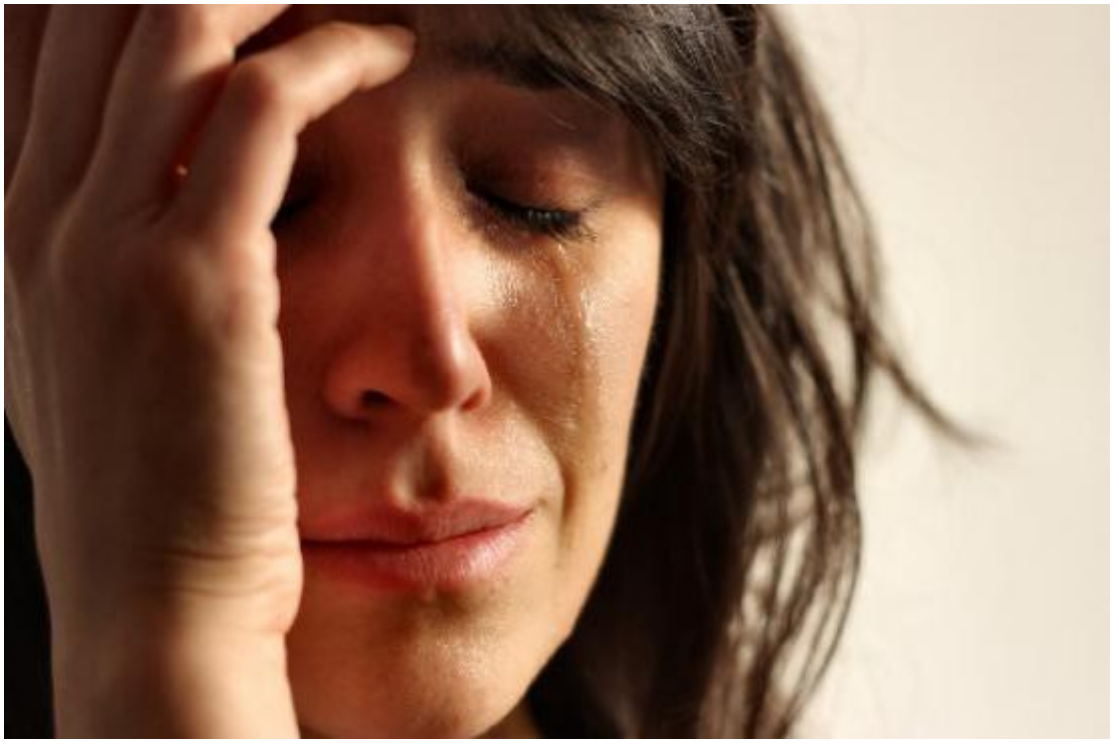
*Only if paying attention right now

Initial Node Position

- Suppose you want to position your nodes in a circle, but lets say the number of nodes is variable
  - Also suppose they need to be evenly spaced
- Does OMNeT++ have a really easy way to set this up?
  - Yes! Automatic layouts. One tag in the display string will accomplish this.
    - The 'p' tag, third argument is the layout.
      - 'ri' gives a nice ring layout

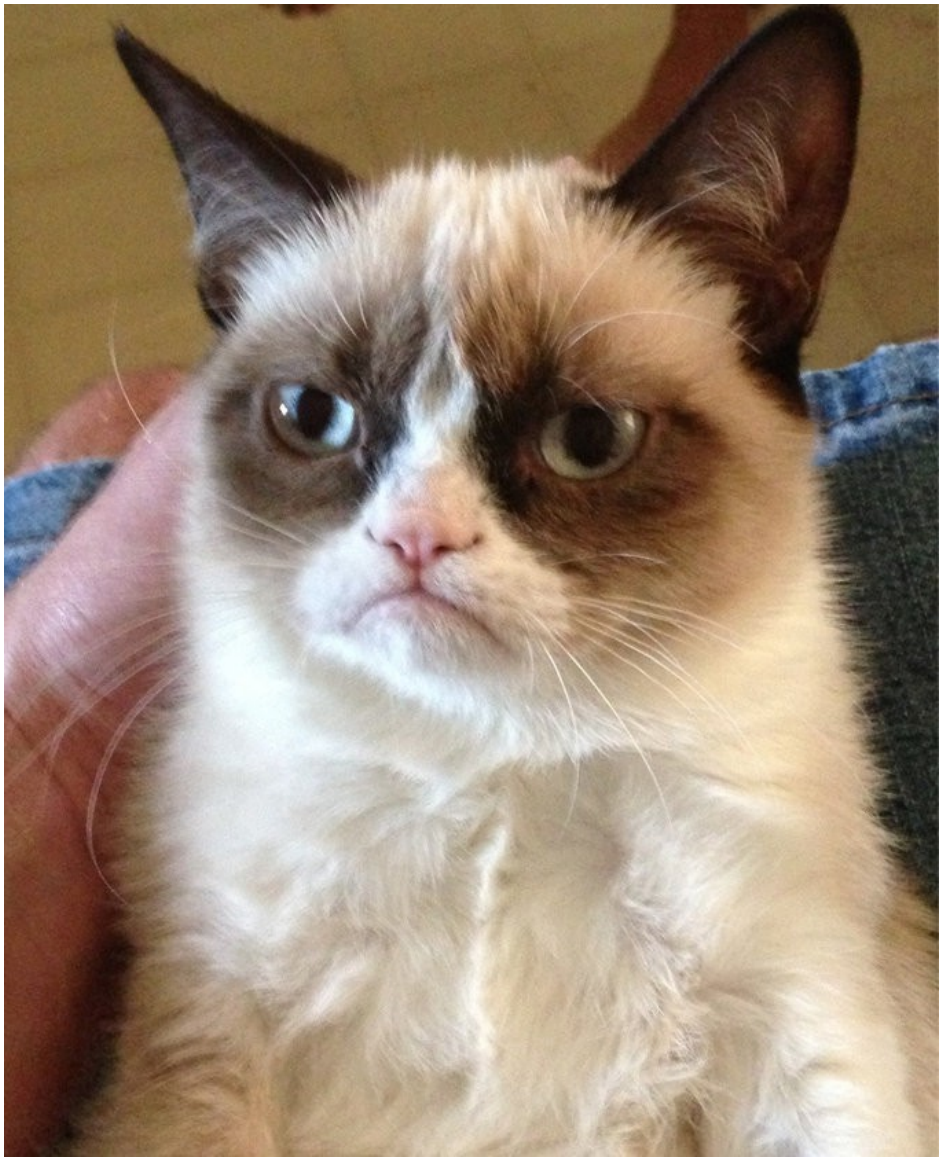
Initial Node Position

- Does this work in Inet?
  - No



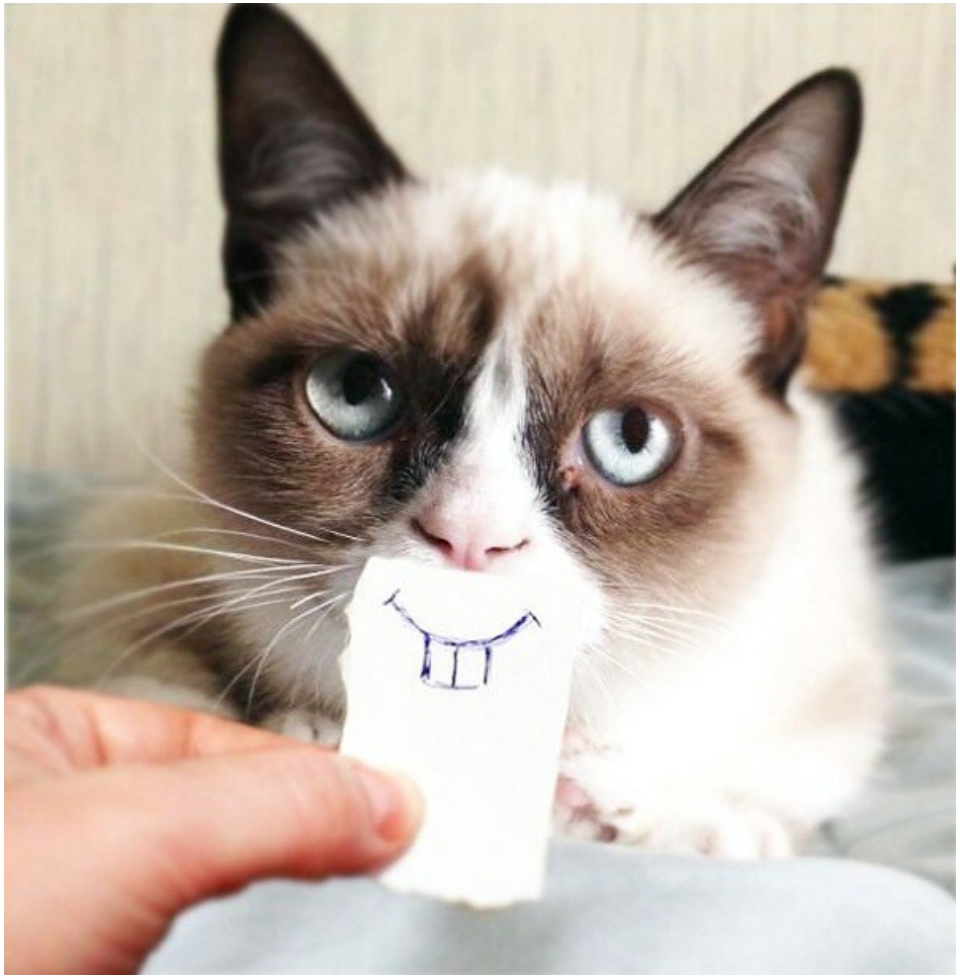
Initial Node Position

- Why not?
  - Laziness



Initial Node Position

- Fortunately, there are other ways



Using CircleMobility Module

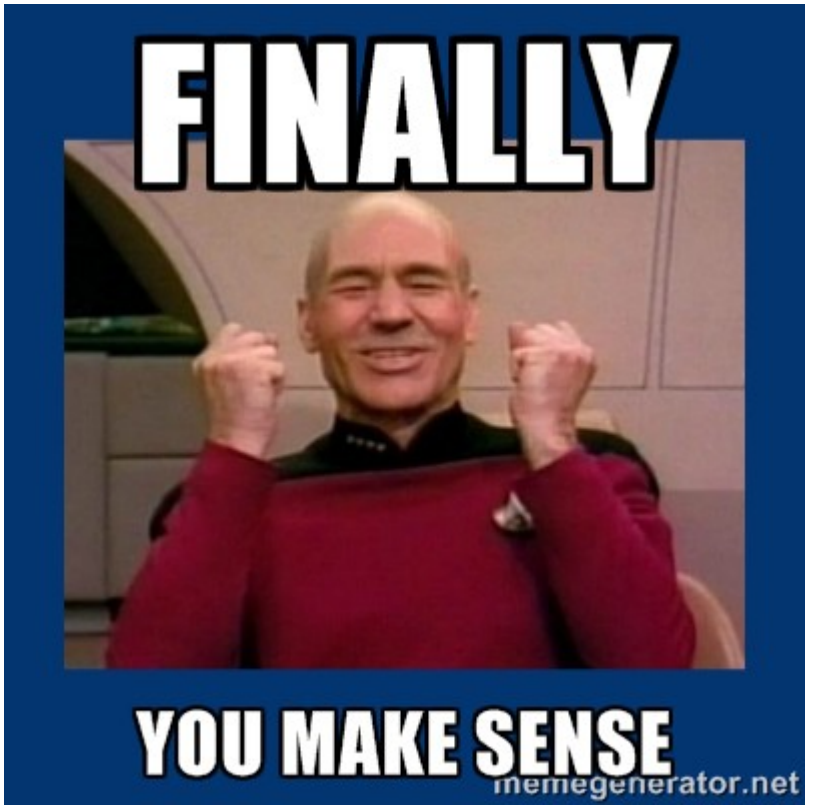
- Make sure your nodes are using this module instead of say StationaryMobility
  - For example, the Throughput module's mobility module would need to be changed to CircleMobility

Using CircleMobility Module

- Parameters of interest:
  - cx, cy, cz: defines center of the circle
    - So to have a circle of clients around an AP, the circle center will have the same coordinates as the AP
  - r: defines radius of the circle
  - StartAngle: defines initial angle of node, in degrees

Using CircleMobility Module

- How can we have the startAngle for each client unique such that they are equally spaced?
  - Pretty awesomely



Using CircleMobility Module

- There are 360 degrees in a circle

Using CircleMobility Module

- There are 360 degrees in a circle
  - Divide by number of nodes, and we get equal slices around the circle
    - Multiply this by a node's index, and we get a unique slice per node

Using CircleMobility Module

- For example:
  - WifiNetwork.node[*].mobility.startAngle = parentIndex() * 360deg/${N}
    - The '*' means to apply the assignment to all nodes in the vector
    - parentIndex() is a NED function which returns the current index of the node being assigned
    - ${N} is an iteration variable which holds the number of nodes
      - Refer to earlier slides on iteration variables (${N} does not refer to the node vector size, though here they are the same)

Another Method

- What if I don't want to use CircleMobility?
  - Useful if you don't want to mess with inet modules which don't use CircleMobility (most of them)
  - Also useful if you want your nodes in a circle initially but want to use a different mobility model
- Define initial position of nodes using circle equations for x,y pos, given radius and circle center.

Another Method

- For example:

  WifiNetwork.node[*].**.initialX = 100m + 95m * cos(parentIndex() * (6.283185 / ${N}))

  WifiNetwork.node[*].**.initialY = 100m + 95m * sin(parentIndex() * (6.283185 / ${N}))

  - 100m = X,Y pos of circle center
  - 95m = radius of circle
  - cos(), sin() = NED functions, they take radians
    - Hence why we multiply the parentIndex() by 2PI approximately

THE END (for now)