Winter 2017 OOP345 Project

Milestone 1.

Write a CSV file reader program. See en.wikipedia.org/wiki/Comma-separated_values. The file name will be a command line parameter. Make the delimiter character a command line parameter. The delmiter may vary between different CSV files. Store the CSV file data in a 2D structure declared as 'vector< vector<string> > data'

Test printing the data three ways

Method 1 - range-based for loop:

```
for(auto line : data) {
  for(auto field : line)
    cout << field << " ";
  cout << "\n";
}
```

Method 2 - conventional for loop

```
for(int line = 0; line < data.size(); line++) {
  for(int field = 0; field < data[line].size(); field++)
    cout << data[line][field] << " ";
  cout << "\n";
}
```

Method 3 - iterator for loop

```
for(auto line = data.begin(); line < data.end(); line++) {
  for(auto field = line->begin(); field < line->end(); field++)
    cout << *field << " ";
  cout << "\n";
}
```

Test your CSV reader on all of the project website data files.

(See https://scs.senecac.on.ca/~oop345/pages/assignments/index.html)

Milestone 2.

Milestone 2 consists of several steps:

1. Using the CSV reader, read the task data files from the project website.
2. Create a file Task.cpp that defines a pair of classes to hold the task data.
3. The task data type requires a 'manager' which contains (composition) a list of all task instances.
4. The task class is the instance of a task, parsing, printing, graphing, and other functions as required.

Milestone 3.

Milestone 3 consists of several steps:

1. Verify each of the item, and order data files from the project website are read successfully by your CSV file reader..
2. Copy Task.cpp to Item.cpp.
3. Hack Item.cpp to process item data: read it, parse it, print it, graph it.
4. Copy Item.cpp to Order.cpp
5. Hack Order.cpp to process order data: read it, parse it, print it, graph it.

Milestone 4.

Milestone 4 consists of several steps:

1. Split Task.cpp into t-test.cpp, t.h, t.cpp. File t-test.cpp contains main and the t.h/t.cpp file pair contains class TaskManager and class Task.
   This is essentially the same process we used to split taskreader.cpp into taskdump.cpp, util.h and util.cpp. Program t-test and task should do the same thing.
   We didn't write any new code or change any of the existing code. All we did is move the code around between three files.
2. Similarily split item.cpp into i-test.cpp, i.h and i.cpp.
3. Also split order.cpp into o-test.cpp o.h and o.cpp.
4. Create a new program iot.cpp. This program reads all three data files. Essentially, t-test.cpp, i-test.cpp, nd o-test.cpp are merged into iot.cpp.
5. Referential integrity (consistency) checking.

   A task may optionally reference pass and fail tasks.
   Item references an installer and a remover task.
   Order data references items.

   We need to verify these references exist.
   All task data pass and fail references must exist as tasks in the task data.
   All item data installer and remover tasks must exist in the task data.
   All order data item references must exist in the item data.

Task Parser

For example, task data can have optionally have 1, 2, 3, or 4 data fields: 'name', 'slots', 'passed', 'failed'.

Field 1, 3, and 4 are task names. The syntax of a task name is not defined. Let's agree a task name starts with an alpha, a digit, or a _ character, followed by alphas, digits, spaces, '-', or '_')

Field 2 is an integer. (one or more digits 0-9)

If there is only 1 field, 'slots' defaults to "1".

Pseudo code for a simple Task parser:

```
declare 'name', 'slots', 'passed', 'failed'
switch(# of CSV fields per line) {
case 4:
```

```
        if(field 4 is a valid task name) 'failed' = field 4
        else syntax error
        // fall through to 3 field case
      case 3:
        if(field 3 is a valid task name) 'passed' = field 3
        else syntax error
        // fall through to 2 field case
      case 2:
        if(field 2 is a valid slot) 'slots' = field 2
        else syntax error
        // fall through to 1 field case
      case 1:
        if(field 1 is a valid task name) 'name' = field 1
        else syntax error
        break; // all done parsing this data row
      default:
        syntax error - not 1, 2, 3, or 4 fields
      }
      store 'name', 'slots', 'passed', 'failed' values into the class 'Task' data
      elements
```

Item Parser

An item has either 4 or 5 fields: 'item name', 'installer task', 'remover task', 'sequential code', optional 'description'

Pseudo code for a simple Item parser:

```
      declare 'item name', 'installer task', 'remover task', 'sequential code',
'description'
      switch(# of CSV fields per line) {
      case 5:
        'description' = field 5 // description can be anything
        // fall through to 4 field case
      case 4:
        if(field 4 is a valid code) 'sequential code' = field 4
        else syntax error

        if(field 3 is a valid task name) 'remover task' = field 3
        else syntax error

        if(field 2 is a valid task name) 'installer task' = field 2
        else syntax error

        if(field 1 is a valid item name) 'item name' = field 1
        else syntax error

        break; // all done parsing this data row

      default:
        syntax error - not 4, or 5 fields
      }

      Store example, 'item name', 'installer task', 'remover task', 'sequential
code', 'description'
      into the class 'Item' data elements
```

Order Parser

A order record must have at least three fields, a customer name and a product name followed by a variable number of items.

Pseudo code for a simple Order parser:

declare 'customer name', 'product name', and an 'item list'

if(# of CSV fields for this line is not 3 or greater)
** syntax error - need at least 3 fields**

if(field 1 is a valid customer name) 'customer name' = field 1
else syntax error

if(field 2 is a valid product name) 'product name' = field 2
else syntax error

for each additional field, if the field is valid item name, add the field to the item list.
If it is not a valid task name, it is a syntax error.

Store example, 'customer name', 'product name' and the item list into the class CustomerOrder data elements.

Sample Task Layout

For each data type, define a class with that data type and a manager class which has list data type instances.

For example:

Create class Task with the data elements you need to capture for a task.

Create class TaskManager which maintains a list of Tasks. If you use a STL vector to build TaskMangaer, there are two ways to do it:

Either with inheritance

```
class TaskManger : public vector<Task> {
public:
  some_function (...) {
    ...
    push_back( move(Task(...)) );
    ...
  }
};
```

or composition

```
class TaskManger {
  vector<Task> taskList;
public:
```

```
        some_function (...) {
          ...
          taskList . push_back( move(Task(...)) );
          ...
        }
      };
```

Do both approaches support

- inheriting vector methods, for example empty() ?
- using a range-based for-loop to walk the vector list ?

You decide which style makes more sense for you. Use that style.

Task Print

Write a member function that prints the data.

Task Graph

It is useful to see a picture of the task routing information.

Graphviz is open source software used to automatically generate graphs with a reasonable looking layout. The package is available from **graphviz.org.** It is very popular and it is used almost everywhere by many programs whenever an automatically layed out graph image is required.

Write a member function that generates a **graphviz** graph description of the task data.

This function is very similar to print. Write the task data to a file in **graphviz** format.

Copy your working print member function to a new member function. Call it something like ‘writeGraph’. You decide on the name.

Here is how:

A graph consists of two sets.

The first set is a set called 'nodes' or 'vertices'. (Vertices is plural of vertex.)

The second set is called 'edges' or 'arcs'.

Edges are pairs of nodes.

A graph where the order, or direction, of an edge from Node i to Node j is significant is a directed graph.

Directed graphs are commonly referred to as a **digraph** (directed graph).

Digraph edges have directions. For example head to tail, source to destination, start to finish, etc. Digraph edges are usually drawn as arrows.

Consider a twitter social graph (user A follows user B). A twitter graph is a digraph. Tom can follow Sally. Sally need not follow Tom.

A node in a digraph is called a source if it impossible to reach this node from other nodes.

A node in a digraph is called a sink if it impossible to reach another node from this node.

The graphviz software can be downloaded from **http://www.graphviz.org**. Please download and install the stable release, version 2.38. The new releases my work but I have not tested them.

There are run-time versions for Linux, Windows, and Mac. Download, install, and test graphviz for your platform.

I installed and tested **graphviz-2.38.msi** for windows 10. It works.

Linux knows about graphviz. Ubuntu users can run "s**udo apt-get install graphviz**" from a bash shell window. Redhat users can run "**yum install graphviz**".

Here are the available packages for Mac OSX users.

OSX Release	current stable release
mountainlion	graphviz-2.36.0.pkg
lion	graphviz-2.40.1.pkg
snowleopard	graphviz-2.38.0.pkg
leopard	graphviz-2.28.0.pkg

Graphviz consists of series of programs.

Each program reads an ASCII description of a graph (nodes and arcs), automatically generates a layout for the given graph, and writes a graph picture to file stream cout.

The graph description language is trivial. Here are some examples:

A graph starts off with the word 'graph' or 'digraph'.

Nodes can be declared by the keyword 'node', a list of names and a semicolon.

Single nodes can be specified without the 'node' keyword.

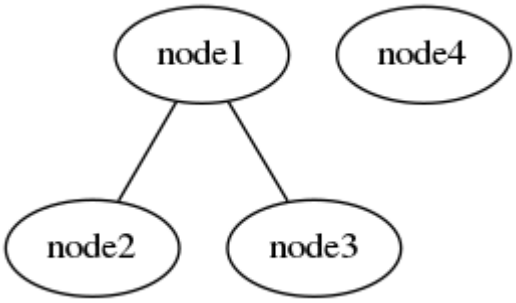
Edges are declared by a node-name , a '--' for graphs or '-> for digraphs, a node-name, and a ';'.

```
graph G {
  node1 -- node2;  # an edge from node 1 to node 2
  node1 -- node3;  # an edge from node 1 to node 3

  node4;           # an isolated node or a destination only node: no edges starting from this node.
  // node node4;   # using the optional node keyword <-- not required
}
```

The first line says it is to be graph and the graph name is 'G'. The name can be anything.

Comments can start with a '#', a C++ style '//' or C style /* ... */.

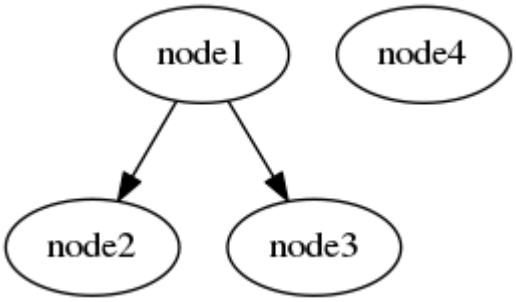


A digraph layout is similar:

```
        digraph DG {
          node1 -> node2;  # a directed edge from node 1 to node 2
          node1 -> node3;  # a directed edge from node 1 to node 3

          node4;           # an isolated node or a destination only node: no edges
starting from this node.
        }
```

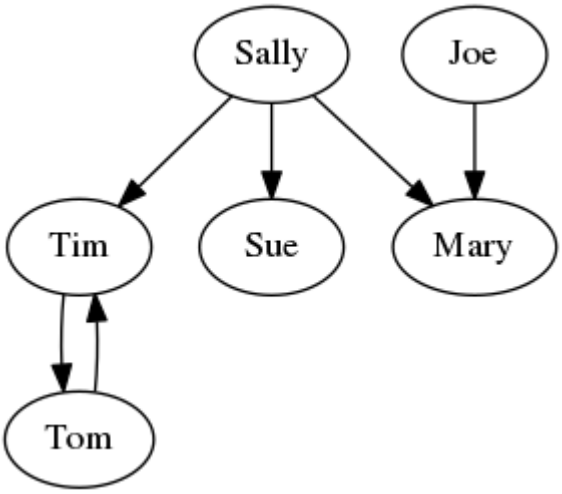
The first line says it is to be digraph and the graph name is 'DG'.



Consider a twitter graph where an edge denotes 'follows':

```
      twitter.gv:

        digraph twitter {
          Tim     ->    Tom;
          Tom     ->    Tim;
          Sally   ->    Mary;
          Joe     ->    Mary;
          Sally   ->    Tim;
          Sally   ->    Sue;
        }
```



Graphviz can figure out node names from the edge information.

Attributes can be assigned to nodes or edges:

Here is an example of running graphviz program dot that reads a .gv file spec and produces a .png output file:

dot -Tpng twitter.gv > twitter.gv.png

See http://graphviz.org/Documentation.php for more details on how to run dot.

(Note: The graphiz package is installed on matrix. The package includes graphviz programs 'dot', 'neato', 'circo', ...)

The path to graphviz program **dot.exe** for Windows is often something like "C:\PROGRAM FILE (X86)\Graphviz2.38\bin\dot.exe".

The graphviz program '**dot**' reads a graph description file and produces an picture of the graph on file stream cout (FILE stdout, or file descriptor 1).

The command '**dot -Tpng myGraphDescription.gv > myGraphDescription.gv.png**' produces a .png picture of the graph in the .gv description.

One can execute (run) a program from your C++ program by using the system command:

NAME
system - execute a shell command

SYNOPSIS
#include <stdlib.h>

int system(const char *command);

Notice the argument to function **system** is **char***. Recall to access the **char*** data in a **std::string**, use the **c_str()** string member function.

On Unix, iOS, Android, Linux, this code suffices:
```
string cmd = "dot -Tpng myGraphDescription.gv > myGraphDescription.gv.png";
system(cmd.c_str());
```

On Windows, something like this works:
```
string cmd = "C:\\Program Files (886)\\Graphviz2.38\\bin\\dot.exe -Tpng
myGraphDescription.gv > myGraphDescription.gv.png";
system(cmd.c_str());
```

The only difference is the operating system dependent location and file suffix for program dot.

Colors and shapes can be assigned to nodes and edges. See the following example or the graphviz.org documentation for details.

A .gv graph for TaskList_Clean.dat

```
Power Supply|4|Motherboard
Motherboard|3|CPU|Remove CPU
Remove CPU|1|CPU
CPU|5|Memory|Remove CPU
Remove CPU|1|CPU
Memory|4|SSD|Remove Memory
Remove Memory|1|Memory
SSD|4|GPU|Remove SSD
Remove SSD|1|SSD
GPU|3|Test
Test|4|Approve|Repair
Approve
Repair
```

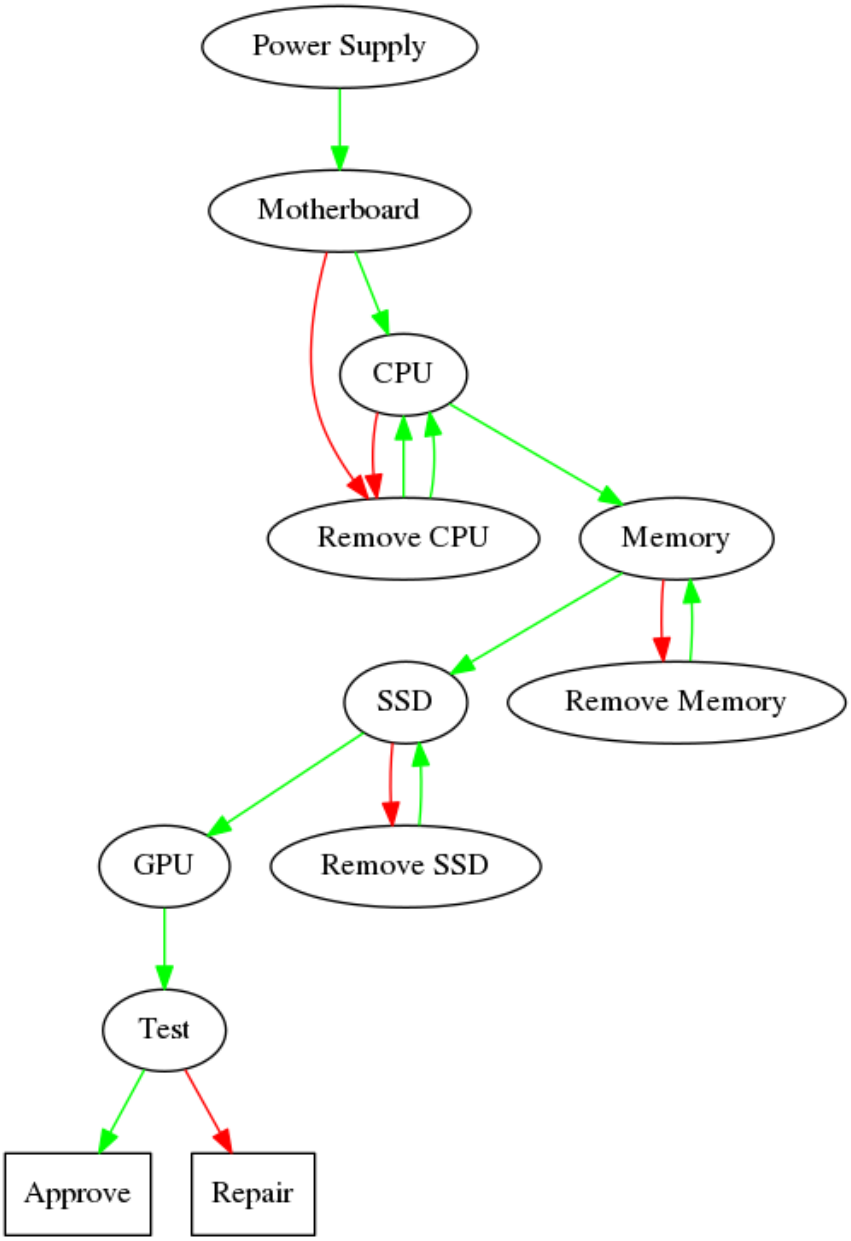
file TaskList_Clean.dat.gv looks like this:

```
digraph task {
  "Power Supply"->"Motherboard" [color=green];
  "Motherboard"->"CPU" [color=green];
  "Motherboard"->"Remove CPU" [color=red];
  "Remove CPU"->"CPU" [color=green];
  "CPU"->"Memory" [color=green];
  "CPU"->"Remove CPU" [color=red];
  "Remove CPU"->"CPU" [color=green];
  "Memory"->"SSD" [color=green];
  "Memory"->"Remove Memory" [color=red];
  "Remove Memory"->"Memory" [color=green];
  "SSD"->"GPU" [color=green];
  "SSD"->"Remove SSD" [color=red];
  "Remove SSD"->"SSD" [color=green];
  "GPU"->"Test" [color=green];
  "Test"->"Approve" [color=green];
  "Test"->"Repair" [color=red];
  "Repair" [shape=box];
  "Approve" [shape=box];
}
```

Since task node names can have embedded spaces, double quotes are required.

Note the last two lines. They are not edges. They are nodes. One can follow an edge to these nodes but there is no edge leaving these nodes.
It should be apparent the task data files are graphs.

Here is the graph:


Power Supply
Motherboard
CPU
Remove CPU
Memory
SSD
Remove Memory
GPU
Remove SSD
Test
Approve
Repair

Similarly the Fishtank.dat file, .gv file, and graph are:

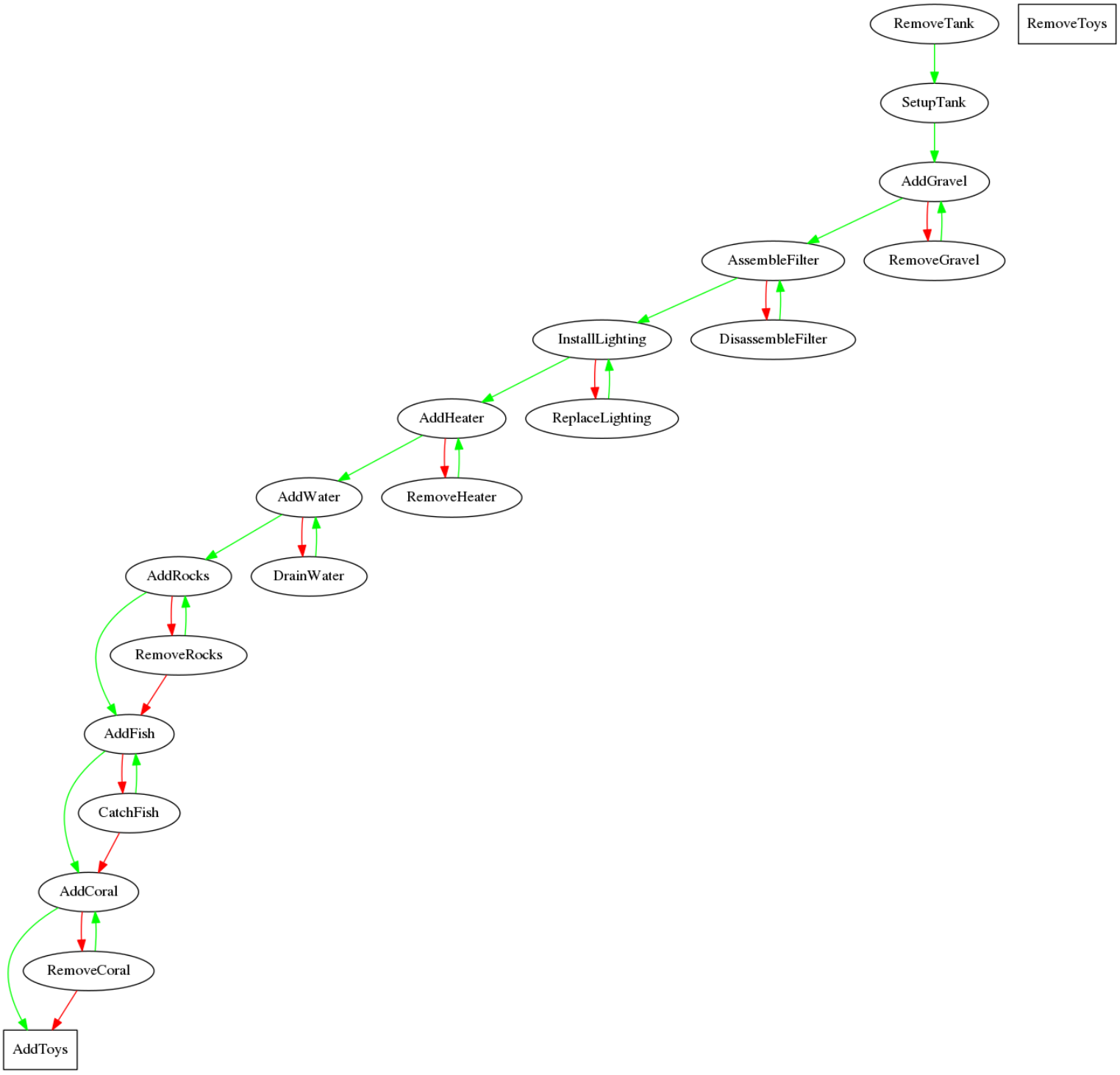
FishTankTasks.dat

```
SetupTank, 2, AddGravel
RemoveTank, 1, SetupTank
AddGravel, 5, AssembleFilter, RemoveGravel
RemoveGravel, 1, AddGravel
AssembleFilter, 5, InstallLighting, DisassembleFilter
DisassembleFilter, 1, AssembleFilter
InstallLighting, 2, AddHeater, ReplaceLighting
ReplaceLighting, 1, InstallLighting
AddHeater, 5, AddWater, RemoveHeater
RemoveHeater, 1, AddHeater
AddWater, 5, AddRocks, DrainWater
DrainWater, 1, AddWater
AddRocks, 8, AddFish, RemoveRocks
RemoveRocks, 1, AddRocks, AddFish
AddFish, 10, AddCoral, CatchFish
CatchFish, 1, AddFish, AddCoral
```

```
      AddCoral, 5, AddToys, RemoveCoral
      RemoveCoral, 1, AddCoral, AddToys
      AddToys, 4
      RemoveToys, 1

FishTankTasks.dat.gv
      digraph task {
        "SetupTank"->"AddGravel" [color=green];
        "RemoveTank"->"SetupTank" [color=green];
        "AddGravel"->"AssembleFilter" [color=green];
        "AddGravel"->"RemoveGravel" [color=red];
        "RemoveGravel"->"AddGravel" [color=green];
        "AssembleFilter"->"InstallLighting" [color=green];
        "AssembleFilter"->"DisassembleFilter" [color=red];
        "DisassembleFilter"->"AssembleFilter" [color=green];
        "InstallLighting"->"AddHeater" [color=green];
        "InstallLighting"->"ReplaceLighting" [color=red];
        "ReplaceLighting"->"InstallLighting" [color=green];
        "AddHeater"->"AddWater" [color=green];
        "AddHeater"->"RemoveHeater" [color=red];
        "RemoveHeater"->"AddHeater" [color=green];
        "AddWater"->"AddRocks" [color=green];
        "AddWater"->"DrainWater" [color=red];
        "DrainWater"->"AddWater" [color=green];
        "AddRocks"->"AddFish" [color=green];
        "AddRocks"->"RemoveRocks" [color=red];
        "RemoveRocks"->"AddRocks" [color=green];
        "RemoveRocks"->"AddFish" [color=red];
        "AddFish"->"AddCoral" [color=green];
        "AddFish"->"CatchFish" [color=red];
        "CatchFish"->"AddFish" [color=green];
        "CatchFish"->"AddCoral" [color=red];
        "AddCoral"->"AddToys" [color=green];
        "AddCoral"->"RemoveCoral" [color=red];
        "RemoveCoral"->"AddCoral" [color=green];
        "RemoveCoral"->"AddToys" [color=red];
        "AddToys" [shape=box];
        "RemoveToys" [shape=box];
```

}


RemoveTank
RemoveToys
SetupTank
AddGravel
AssembleFilter
RemoveGravel
InstallLighting
DisassembleFilter
AddHeater
ReplaceLighting
AddWater
RemoveHeater
AddRocks
DrainWater
RemoveRocks
AddFish
CatchFish
AddCoral
RemoveCoral
AddToys

Item Data and Order Data Graphs

It was meaning to plot graphs for the task data. The relationships between data lines representing tasks was instantly comprehensible.

It is also useful to plot graphs for the item and order data files.

Plot graphs for the item and order data.

The Consistency Check

Check the data for consistency.

1. Task data - ensure all passed or failed task references exist

   As can be readily identified from the graph for **TaskList_Clean.dat**, there are two duplicate lines:

   Remove CPU|1|CPU

   This line occurs in line 3 and again in line 5.
   Another issue may be if the mother board fails, remove the CPU. However the CPU has not been installed.

2. Item data - ensure all install and remove task references exist.

3. CustomerOrder data - ensure all of the items ordered exist.

Simplify Testing

You are welcome to generate meaningful data files with referential integrity for testing.

For example:

SimpleTask.data:

```
Install Power Supply|4|Install Motherboard|Remove Power Supply
Remove Power Supply|2|Install Power Supply
Install Motherboard|3|Install CPU|Remove Motherboard
Remove Motherboard|1|Install Motherboard
Install CPU|5|Install Memory|Remove CPU
Remove CPU|1|Install CPU
Install Memory|4|SSD|Remove Memory
Remove Memory|1|Install Memory
Install SSD|4|Install GPU|Remove SSD
Remove SSD|1|Install SSD
Install GPU|3|Test
Remove GPU|1|Install GPU
Test|4|Approve|Repair
Approve
Repair
```

SimpleItem.dat:

```
I5  | Install CPU | Remove CPU | 300 | Intel I5 Central Processing Unit
I7  | Install CPU | Remove CPU | 400 | Intel I7 Central Processing Unit
A12 | Install CPU | Remove CPU | 500 | AMD A12 Central Processing Unit
DDR 266 | Install Memory | Remove Memory | 125 | Samsung DDR 266 Memory
Stick
DDR 400 | Install Memory | Remove Memory | 940 | Samsung DDR 400 Memory
Stick
Geforce 750M | Install GPU | Remove GPU | 395 | Nvidia Geforce 750M GPU
Nano | Install GPU | Remove GPU | 30 | AMD Nano GPU
Power Supply - 200 Watt | Install Power Supply | Remove Power Supply | 1100
Power Supply - 300 Watt | Install Power Supply | Remove Power Supply | 9100
```

SimpleCustomerOrder.dat:

Biance | Dell 123 | DDR 266 | I7 | DDR 266 | Nano | Power Supply - 300 Watt
Salt-N-Pepa | HP 345 | A12 | DDR 400 | Geforce 750M | DDR 400 | Power Supply - 300 Watt
Brianna | Acer 567 | I5 | Power Supply - 200 Watt | DDR 266 | Nano

A Special Note for Visual Studio Users

MSVS IDE WOES

The default Visual Studio project set up is for building a single .exe program file. It is possible to configure a Visual Studio project that builds multiple .exe programs. A quick search of msdn.microsoft.com does not readily show how to do this. Companies such as AMD don't bother coercing the VS to support multiple .exe targets. They have hundreds of source files. Everything changes breaking the build procedure whenever they upgrade the compiler. They use another build system, scons (scons.org), to manage running the Microsoft Visual Studio compiler where multiple .exe targets are required. You can experiment with scons, but there is a far easier solution that meets our needs.

MSVS IDE WOES SOLUTION – USE THE COMMAND LINE COMPILER

It is trivial to build multiple programs using the command line compile. Run the compiler for each program you need to build. The Visual Studio compiler is a command line program called **cl.exe**. VS uses **cl.exe** to compile code. You can also call it from a **cmd.exe** command line window. A few things need to be set up before it will work. The program needs to know the location of the include files (for example <vector> or <iostream>) and the location of the library files which contain the compiled code for the c++ library functions. There is a file in the **C:\Program Files (x86)\Microsoft Studio xx.x\VC** folder tree called something like **vcvars.bat, vcvars32.bat, vcvarsx86.bat** or some similar name. The batch file name changes from release-to-release or patch-to-patch. Run this batch file from a **cmd.exe** window. It will set up the environment so **CL.EXE** knows the location of the include and library files required to compile and link your program.

I installed the 2016-Nov-23 version of the free MSVC IDE system on a Windows 10 machine. What an ordeal. It ran all night installing 22 Gbytes of bloat. Further more, once installed, it refused to create a new project, citing a setup error. The installation process ran error free. What was I thinking?

So the 2016-Nov-23 version of free MSVC IDE project system is broken. The IDE is not important to us since we want to bypass it and use the command line compiler directly to build multiple targets.

Where is **VCVARSxxx.BAT**? Running UNIX find on the '**C:/Program Files (x86)**' folder we see:

```
C:/Program Files (x86)/Microsoft Visual Studio
14.0/Common7/Tools/VCVarsPhoneQueryRegistry.bat
C:/Program Files (x86)/Microsoft Visual Studio
14.0/Common7/Tools/vcvarsqueryregistry.bat
C:/Program Files (x86)/Microsoft Visual Studio 14.0/VC/bin/amd64/vcvars64.bat
C:/Program Files (x86)/Microsoft Visual Studio
14.0/VC/bin/amd64_arm/vcvarsamd64_arm.bat
```

```
C:/Program Files (x86)/Microsoft Visual Studio
14.0/VC/bin/amd64_x86/vcvarsamd64_x86.bat
C:/Program Files (x86)/Microsoft Visual Studio 14.0/VC/bin/vcvars32.bat
C:/Program Files (x86)/Microsoft Visual Studio 14.0/VC/bin/vcvarsphoneall.bat
C:/Program Files (x86)/Microsoft Visual Studio 14.0/VC/bin/vcvarsphonex86.bat
C:/Program Files (x86)/Microsoft Visual Studio
14.0/VC/bin/x86_amd64/vcvarsx86_amd64.bat
C:/Program Files (x86)/Microsoft Visual Studio
14.0/VC/bin/x86_arm/vcvarsphonex86_arm.bat
C:/Program Files (x86)/Microsoft Visual Studio
14.0/VC/bin/x86_arm/vcvarsx86_arm.bat
C:/Program Files (x86)/Microsoft Visual Studio 14.0/VC/vcvarsall.bat

File 'C:/Program Files (x86)/Microsoft Visual Studio 14.0/VC/vcvarsall.bat' looks
promising.

To compile your code, this works:
      Start up a CMD.EXE window.
      > C:
      > CD \Program Files (x86)\Visual Studio 14.0\VC
      > vcvarsall.bat
      > CD \Users\<your-name>\<your 345 project files>
      > CL csvreader.cpp
      > CL csvdump.cpp util.cpp
      > CL task.cpp util.cpp
      > CL item.cpp util.cpp
      > CL order.cpp util.cpp
      > CL t-test.cpp t.cpp util.cpp
      > CL i-test.cpp i.cpp util.cpp
      > CL o-test.cpp o.cpp util.cpp
      > CL iot.cpp i.cpp o.cpp t.cpp util.cpp
      > ...
```

Running Windows dot.exe from C++.

First install graphviz for windows from graphviz.org, http://graphviz.org/Download.php. I used the .MSI installer. It created the graphviz family of programs in folder **C:/Program Files (x86)/Graphviz2.38/**. Program **dot.exe** is in sub-folder '**bin**'.

This O/S agnostic Windows/UNIX code runs dot on each of its command line arguments.

```
// File dot-runner.cpp
// Author Greg Blair, November 24, 2016
#include <iostream>
#include <string>
using namespace std;

int main(int argc, char*argv[])
{
  #ifdef __unix
    string dot = "dot";
  #else
    string dot = "C:/\"Program Files (x86)\"/Graphviz2.38/bin/dot.exe";
  #endif

  for(int arg = 1; arg < argc; arg++) {
```

```
            string file(argv[arg]);

            cmd = dot + " -Tpng " + file + " > " + file + ".png";

            cout << "Running command -->'" << cmd << "'\n";

            cout << "The operating system says dot returned '"
                 << system(cmd.c_str())
                 << "' (0 is good --> dot executed successfully)\n";
          }
        }
```

I tested this program on Windows 10 and Ubuntu 16.04. It works.

So there you go. The magic line for '**dot.exe**' is
"C:/\"Program Files (x86)\"/Graphviz2.38/bin/dot.exe".