Automated generation of virtual cities with GIS data using:

Motivation

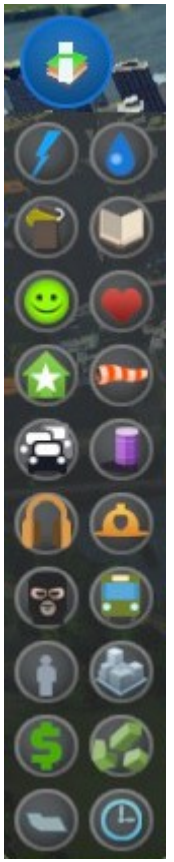
The ability to use GIS data to simulate cities in real-time

New York save mod: http://steamcommunity.com/sharedfiles/filedetails/?id=414935405

What Cities Skylines gives us

It is a platform that provides (in real-time):

- Traffic analysis
- Pollution analysis
- Services analysis
  - Services range
  - Services demand
- Construction costs
  - Money
  - Satisfaction of neighbors (change in happiness)
- And much more



Modding

- Has a maximum map size of 10km x 10km
- API (Application programming interface)
  - Is in C# (programming language)
  - has no documentation
  - has a lot of code
    - 100's of 1000's of lines of code
    - most was precompiled in .dll files (no source code)

The way it was

People hand place every building, every road.

- Very time/labor intensive
- Very inaccurate, not based on GIS data

Not practical for any use other than entertainment

Challenges to automation

- Skylines uses a vector based map system
  - Specifically, the UnityEngine.Vector3 object to define all locations
  - Needed to convert from GPS data (decimal degrees) to UnityEngine.Vector3
- No one had used the API to build buildings and roads

SkylinesGIS

A mod for importing KML files into City Skylines

Current Status:

- Over a thousand lines of code (excluding external libraries used)
- Imports streets and building locations based on GPS coordinates

KML Format

The tags used:

- <LineString>
  - Used for roads, defines a connected set of line segments.
- <Placemark>
  - Used for buildings

Both use <description> to map to an in-game object

Sample KML

```
<Placemark>
   <name>Navan Firehouse</name>
   <description>Fire House</description>
   <point>
      <coordinates>
         -75.42543094797206,45.42131939106098,0
      </coordinates>
   </point>
</Placemark>
<Placemark>
   <name>Navan Road</name>
   <description>Basic Road</description>
   <LineString>
      <coordinates>
         -75.42669453695652,45.42103774885076,0
         -75.42543094797206,45.42131939106098,0
         -75.40868156349399,45.42318532487945,0
      </coordinates>
   </LineString>
</Placemark>
```

← Building Placemark

← Road Placemark

GPS to Vector3 objects

1. Define the top left corner of the map in decimal degrees

2. Use a variation on the haversine formula to find the latitude and longitude displacement from the corner to the building/road point

3. Once the latitude and longitude displacement is known, it is trivial to convert.

Lessons Learned

- Open Source
  - is a blessing...
    - Worked with people around the world to solve these problems
    - Libraries like the KML-library save time
    - The answers are out there, if you are asking a question, chances are someone else was/is
  - And a curse...
    - Many bugs found in KML-library (had to fix a few)
    - Sometimes the projects you want to use are broken
- Learning C# at the same time as the Unity and City Skylines API is time consuming

Dependencies

- Steam (Free)
  - Video game service
  - http://store.steampowered.com/about/
- Cities Skylines ($32.99)
  - Framework for city building (includes Unity3d and API access)
  - http://store.steampowered.com/app/255710/
- Kml-library (Free)
  - Open source KML library in C#
  - https://github.com/Farm8763/kml-library

Development Tools used

- Visual Studio 2013 (Free)
  - It's an IDE (Integrated Development Environment)
    - Where you write and run your C# code
  - https://www.visualstudio.com/en-us/products/visual-studio-express-vs.aspx
    - Note: I used Visual Studio 2013 Professional, but the free one works
- Jetbrains dotPeek (Free)
  - It's a .NET decompiler
    - Allows you to see the code of a compiled .dll file
  - https://www.jetbrains.com/decompiler/
- Git / Github (Free)
  - Source control system and website
    - Allows you to share code and have a record of changes to the code
  - https://github.com/

Source Code and Development Community

Source Code:

- https://github.com/Farm8763/SkylinesGIS
- https://github.com/Farm8763/SpriteDumper

Development Community

- http://www.skylinesmodding.com/

Future Work

It would be even better would be to expand this to work with data sources like OSM (OpenStreenMap).

The hardest parts are done, all that is left is to add some code to parse the OSM format.