

# Small-World Graph Simulation & Analysis Projects

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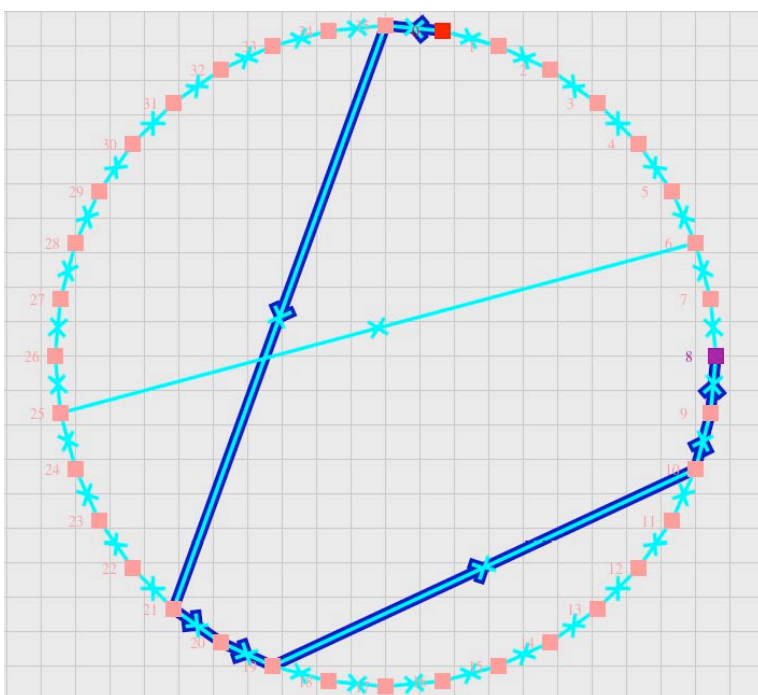
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Graphs – or “stick and ball relationships” can be used to represent and analyse many interesting phenomena. A relatively recent set of ideas involves making shortcuts across parts of a graph in ways that can drastically change its properties. Small-World graphs are most famous for the notion of connectedness in sociological relationships. You may have heard of the “**Six Degrees of Kevin Bacon**” a game that hinges around the observation that Mr Bacon has worked with many other actors and that one can find surprisingly short connection chains (often less than 6) that will link Mr Bacon and almost any other actor. This small-world phenomenon is also behind ideas in recent science fiction, such as the **wormholes in space** idea. In fact a wormhole can be modelled in a mesh model by simply adjusting the mesh links.

This project is to **implement graph-theoretic analysis metrics in a software tool**, so that various graphs and meshes can be generated and automatically analysed when small-world shortcuts are applied. Additional work could involve building software that can aid visualisation of graphs or networks that are embedded in 3-dimensions. **Colour and other effects can be used to highlight graph features** and to illustrate the effects of small-world or shortcut links. Metrics like graph clustering or nearness measures can be used to categorise graphs as to whether they are in the “small-world regime” or not.

The project can use Java or C/C++ programming languages to build a tool for graph generation and analysis. Parts of this project could be carried out at **undergraduate, honours or masters level** with obviously more work required to implement more of the aspects of the system at higher levels of study. This project would best suit student(s) with interest in building software for enabling interactive calculations. It will be possible to build on past work in graph visualisation and small-world graph representations. Since this project involves detailed and complex programming it would be ideal to have passed papers 159.234 and 159.235 and their pre-requisites before attempting this work. Java program demonstration examples from 159.235 may be used as a starting code base.

Some applications of these sort of calculations and analysis includes studies of **scatter networks** where **sensors or other deployed devices form a network (graph)** in a physical space. We can then look for optimisations to make best use of limited resources such as number of devices or power consumption. The small-world clustering analysis technique is also becoming an important method for studying other arbitrary datasets that can be represented as graphs.



A graph is drawn as a ring of connected nodes.