

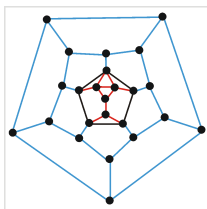


# Intelligent Geographic Transportation Networks

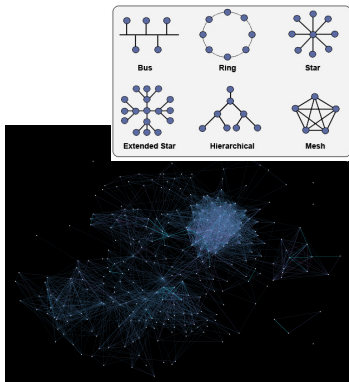
Charlie Croom and Cameron Musco, Advisor: Professor Drew McDermott

Department of Computer Science, Yale University

## Graph and Network Theory - Foundations



Graph theory is used in a wide range of fields - to study social networks, computer networks, biological relationships, etc. Graphs range from very geometric and orderly, to extremely complex.



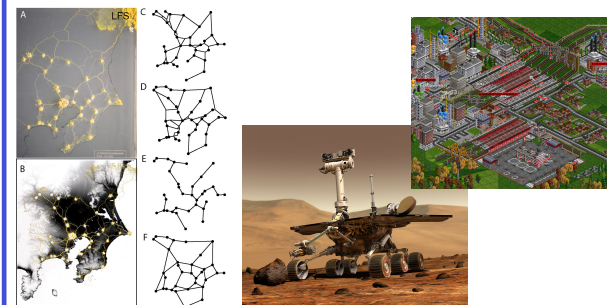
## Open Transport Tycoon Deluxe

- TTD business simulation game originally released in 1995
- OpenTTD is an open source clone, with an API for developing AI programs that can play the game



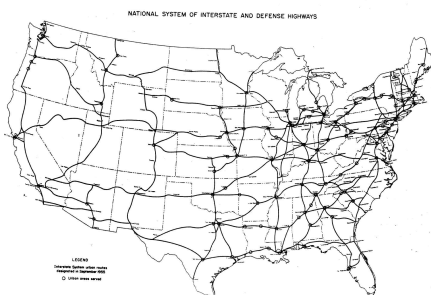
- Players must construct a profitable transportation network, using trains, roadways, airports, etc. over a randomly generated map populated with cities, natural resources, and geographic features
- There are many possible strategies. We chose to focus on using trains and roadways to transport passenger cargo.
- This simplified our AI and allowed us to design a realistic transportation network.

## Further Research Ideas



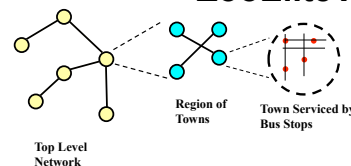
- Possibly incorporate ideas taken from biology on how simple organisms maximize resource obtainment (left)
- A better AI may need more of a generalized system to understand geography and physical relationships (center). This would maybe allow for achievement of highly optimized human designs (right).

## Transportation Networks



- Transportation networks can be modeled as graphs with edges representing transportation routes and nodes representing resource sources and sinks.
- Their structure is dictated by a need for efficient resource flow, but also by underlying constraints (geographic features, budget constraints, etc.) that are not explicitly represented in the graph model of the network.
- They have more 'degrees of freedom' than typical graphs as nodes may represent transfer stations or intermediate stops that may be moved freely around the map. In addition, there is no clear metric for calculating when a transportation network is optimized or when construction of a network is 'complete'.

## ZooElite Artificial Intelligence Program



The program first designs a high level optimized network. This network is then implemented by the 'lower level' of the program. The design is modified to accommodate changing constraints, construction failures, and other events.



At the lower level, implementation required the use of many specialized algorithms: to find train routes that could be built despite geographic constraints, to connect routes with junctions, to place traffic control signals, to construct regional train stations, and to connect these stations to city populations using roads and bus stations.

