Establishment of Model

Technical term

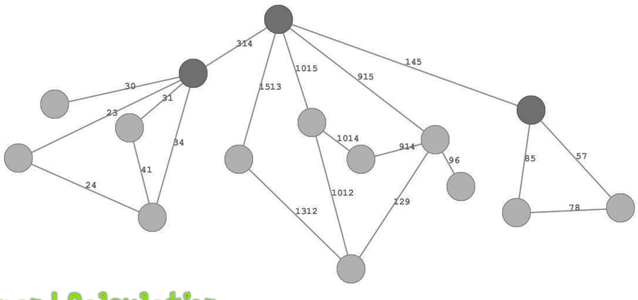
1. Graph is weighted undirected connected simple dynamic graph
2. Dynamic graph is graph which edges can be modified by using 2 operations
   - Add an edge from $\mathbf{u}$ to $\mathbf{v}$ with weight $\mathbf{w}$
   - Delete an edge from $\mathbf{u}$ to $\mathbf{v}$
3. Source node is a node which receives donations and has authority to distribute donations.
4. Expiration is state fulfilled demand of an object decrease to zero

Definition

1. Graph is 3-tuples $(\mathbf{V}, \mathbf{E}, \bar{\mathbf{I}} = < \bar{\mathbf{I}}_\mathbf{i} >)$such that
   - $\mathbf{V}$ is set of vertices
   - $\mathbf{E}$ is set of edges
   - $\bar{\mathbf{I}}$ is vector of vector represent vehicles which travel to vertices, sorted by time during transportation process in ascending order
2. Vertex is 5-tuples $(\mathbf{z}, \mathbf{r}, \mathbf{R}, \mathbf{T}, \mathbf{X})$ such that
   - $\mathbf{z} \in \mathbb{R}_0^+$ is initial demand
   - $\mathbf{r} \in \mathbb{R}^+$ is increasing demand rate
   - $\mathbf{R}$: $\mathbb{R}_0^+ \to \mathbb{R}_0^+$ is function which $\mathbf{R(0) = 0}$
   - $\mathbf{R}$: $\mathbb{R}_0^+ \to \mathbb{R}_0^+$ is the vector represent time received donation
   - $\mathbf{X} \in \mathbb{R}_0^+$ is total fulfilled demand
3. Vehicle is 3-tuples $(\mathbf{s}, \mathbf{l}, \mathbf{b})$ such that
   - $\mathbf{s}$ is sink node index
   - $\mathbf{l} \in \mathbb{R}_0^+$ is time during transportation process
   - $\mathbf{b} \in \mathbb{R}_0^+$ is total utility value
4. Object is pair $(\mathbf{B}, \mathbf{d})$ such that
   - $\mathbf{B} \in \mathbb{R}^+$ is utility value per piece
   - $\mathbf{d} \in \mathbb{R}^+$ is time before expiration since object appear in the model

Description

In the model, disaster area is represented by $\mathbf{m}$ sub graphs denoted by $\mathbf{G_i;\ \forall i \le m}$. These sub graphs called $\mathbf{G_0}$. It has been guaranteed that in case of different sub graphs, there exist only edges between source node. There exist $\mathbf{n}$ types of donation. For each day, there are inputs which determined by user represent incoming donations for every source node.



Demand Calculation

- General demand of node $\mathbf{u}$ at time $\mathbf{t}$

  Let $\boldsymbol{\phi_u(t)}: \mathbb{R}_0^+ \to \mathbb{R}_0^+$ such that

$$\boldsymbol{\phi_u(t) = r_u t + z_u}$$

- Penalty demand of node $\mathbf{u}$ at time $\mathbf{t}$

  Let $\boldsymbol{\Phi_u(t)}: \mathbb{R}_0^+ \to \mathbb{R}_0^+$ such that

$$\boldsymbol{\Phi_u(t) = \sum_{i=1}^{|h|} \int_0^{h_i - h_{i-1}} R_u(T)dT + \int_0^{t-h_{|h|}} R_u(T)dT}$$

- Total demand of node $\mathbf{u}$ at time $\mathbf{t}$

  Let $\boldsymbol{\Phi_u(t)}: \mathbb{R}_0^+ \to \mathbb{R}_0^+$ such that

$$\boldsymbol{D_u(t) = \phi_u(t) + \Phi_u(t)}$$

Objective

The objective of the model is to minimize $\lim_{t\to\infty} \mathbf{P(t)}$ where

$$\boldsymbol{P(t) = \sum_{u \in V} \max^2(0, D_u(t) - X_u)}$$