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Lab Information

1 VINEOPT: Visual Network Optimization

1.1 Introduction

VINEOPT is a program for visualization and optimization of graph and network problems, such as the linear minimum cost flow problem, the maximum flow problem and the shortest path problem, as well as the minimal spanning tree problem, the traveling salesman problem and the Chinese postman problem.

The program supports graphical input of network data and plots the network on the screen. One can change the network in various ways (i.e. change all network data), and change the network picture (zoom, etc.). One can save the changed network. Moreover one can solve the optimization problem, and the solution is visualized in the network or shown in the tables. The program is implemented in Tcl/Tk by Kaj Holmberg, and run as a tclkit.

To run the program, start a terminal window, and write `/course/TAOP88/dine 1`.

1.2 Main window

VINEOPT starts with a window where the majority of operations take place. The window contains the following parts. Under the title bar, there is a main menu bar with the submenus

File "Alt"-f,
Optimize "Alt"-o,
Visual "Alt"-v,
Change "Alt"-c,
Check "Alt"-e,
Selection "Alt"-s,
Sets "Alt"-t,
Help "Alt"-h.

The first status bar under the graphic window displays various information. The second status bar displays what mode is used (see section 1.5.4), then the problem name and size. The last part of the row contains the coordinates for the mouse pointer (with the current scaling). When the coordinate square is red, the program performs computations or is busy with reading/writing data, and one should wait before another command is executed. The third status bar provides brief instructions about what to do in a current situation, and sometimes what has been just done. Finally the forth status bar displays the problem type and whether one has changed the problem without saving it.

1.3 Network types

VINEOPT can deal with many kinds of problems, based on various network types. A fundamental problem type is a linear minimum cost flow problem in a directed network, with the following data.

- Arcs: starting node, ending node, arc costs, lower bounds, upper bounds.
- Nodes: demand (strength of source/sink).
- Coordinates for the nodes (x,y).
- Node names.

1.4 Shortcuts

The following shortcuts are useful.

"Space": OK (instead of Enter/Return).
F4: Quit program.
F3: Close active window.
F10: Open File menu.

Pressing simultaneously "Control" and an arrow button (right/left/up/down) moves the network in the corresponding direction. If also "Shift" is pressed, the movement steps are larger. "Control" together with = gives free zoom. If the mouse is moved with the middle button pressed down, the whole picture of the network is moved. "Control" together with + or - gives zooming (in/out). "Control" together with * yields free move f the picture. Finally, "Control"-(increase node size and "Control"-(decrease node size. ("Autoscale" in "Visualization" is an option to recover the network if you accidentally did something wrong.)

There is a special window for numerical input of data, which can be edited (using standard commands). Write only digits and avoid writing letters, other signs or Enter/Return. "Tab" move mouse to the next box or button.

"Control"-s saves data, which is good to do often, since VINEOPT has no "Undo" command. Simultaneously pressing "Control", "Shift" and the left button on mouse, enables temporary markings in the graphic window.

Avoid Enter/Return completely in VINEOPT. Space bar can often be used for accepting standard answers. A complete list of shortcuts is available in the Help menu.

1.5 Menus

1.5.1 File

Here one can read input data for a problem. (Input data contains information about the network type, which is set automatically.) One can also save data in a current file or in a new one. Also the shortcut "Control"-s can be used to save data. The picture of the graph can be exported as a postscript file, or printed out directly. It is also possible to list and

erase existing network files.

1.5.2 Optimize

VINEOPT contain solvers for (among others) the following optimization problems.

Min cost flow problem. (D)
Max flow problem. (D)
Shortest path between two nodes, from one to all, from all to one. (D,U)
Shortest path between all node pairs. (D,U)
Maximal spanning tree. (U)
Maximal cost 1-tree. (U)
Strongly connected components. (U)
Maximal weighted matching. (U)
Minimal weighted perfect matching. (U)
Chinese postman problem. (D,U)
Rural postman problem. (D,U)
Traveling salesman problem. (D,U)
Traveling salesman problem with repetitions. (U)

Each optimization problem in the list above is marked with D if it can be solved for directed graphs, and with U if it can be solved for undirected graphs. Some of the optimization codes are free for academical (non-commercial) usage. Some of the codes are own implementations.

When the optimal solution is found, VINEOPT displays the total cost in the lower right-hand side corner. A numerical list of the optimal flow can be also displayed, if required.

1.5.3 Visual

Here the graphic presentation of the network is chosen. One can choose whether or not to display nodes, arcs, node names, etc. It is possible to mark arcs with flow, arcs included in the minimum cut, etc. Arc costs, capacities and flow as well as demand data and node prices can be displayed in the network. Shortest paths and maximal spanning tree can be displayed. One can also choose how to draw the connection of the arcs to the nodes.

One can mark a node with a certain name. It is possible to zoom in/out, make nodes larger or smaller, and move the network up/down/right/left by large or small steps. One can also adjust the best scaling. Moreover, all colors can be changed and number for arcs and nodes be moved. A background figure (in gif format) can be displayed in the graphic window (but it will not move with the graph).

One can also see all data and solutions numerically in separate windows, which can be printed out or saved in a file. Shortcut "Control"-f displays the current flow and shortcut "Control"-t displays the current tour.

1.5.4 Change

Here one decides in which mode to change a graph. The chosen set-up holds until it is changed. The following set-ups are available (with a shortcut in brackets):

Move node. F2
Add node. F5
Delete node. F6
Change demand. F7
Add link. F8
Change link. F9
Delete link.
Move link.
Add node in the middle of a link.
Choose starting node. "Control"-a
Choose ending node. "Control"-z
Swap two nodes.
Select a set of nodes.

Data can also be changed in a table format. A directed graph can be made undirected, and an undirected one directed. It is possible to add/remove many arcs in various ways, e.g. to get a complete graph. Multiple data can be changed at a time, e.g. add a constant to all arc costs/capacities or set a particular value to all arc costs/capacities.

Selection of node: The node closest to the cursor when the left button on the mouse is pressed is chosen.

Selection of link: A link is chosen either by clicking on it (which requires precision) or by choosing first its starting node and then its ending node. (VINEOPT does not handle parallel links.)

The following is done in the different modes.

Move node: The node closets to the cursor is chosen when the left mouse button is depressed, and moved as long as the button is held down.

Add node: The new node is place at the cursor when the left mouse button is pressed. The node is given demand zero.

Delete node: The node closest to the cursor is removed when the left mouse button is depressed. All links adjacent to the node are also removed.

Change demand: The node closest to the cursor when pressing the left mouse button is chosen. A small window appears, with the current net demand, where the net demand can be entered.

Add link: The node closest to the cursor when the left mouse button is pressed for the first time is chosen as starting node. The node closest to the cursor when the left mouse button is pressed for the second time is chosen as ending node. When starting and ending nodes have been chosen, a menu appears with a suggested link cost (the Euclidean distance between the two nodes multiplied with the distance factor), a suggested link capacity (very large) and lower bound for flow (zero). All these numbers can be changed, and are saved

by clicking on “Save”.

Change link data: The link is chosen as described above. Then data is changed in the appearing link data form.

Delete link: The link is chosen as above, and is (if it exists) removed immediately.

Move link: The link to be moved is chosen as above. After this, the new starting node and ending nodes are chosen. The link is moved, keeping all its data.

Add a node in the middle of a link: A link is chosen as above. The data of the original link is placed on the first of the two new links. The second link is given link cost zero, large capacity and lower bound equal to zero.

Choose starting node: The node closest to the cursor when the left mouse button is pressed is chosen.

Choose ending node: The node closest to the cursor when the left mouse button is pressed is chosen.

Swap two nodes: The two nodes are chosen as above, and their coordiantes are exchanged.

1.5.5 Check

Network data can be checked in various ways. One can sum up demand (this should be zero in case of a min cost flow problem). One can check whether the triangular inequality holds, examine node degrees and check whether the graph is connected.

1.5.6 Selection

One can select node or link sets, graphically or in tables, in various ways. Then one can perform many different changes in the selected node or link set. (Many changes are the same as in the menu Change, but only for the selected nodes or links.)

1.5.7 Sets

When one has selected certain nodes or links, one can define them as a node or link set. One can define several different node and/or link sets, and let those nodes/links which are not included create a new set. These sets can be saved on file and read from file.

1.5.8 Help

Here one can get a short help text in a separate window, in Swedish or English. One can also get a list of the available shortcuts.

One can choose between two user levels, “novice” and “expert”, where in the later case one gets fewer questions like “Are you really sure to remove this node?”. Shortcut “Control”-e selects user level “expert”. There is also a possibility to remove all temporary files and cancel input phase (e.g. when the program waits for value for an ending node). Shortcut “Control”-i cancel input phase. One can also look at the problem commentaries saved in a logfile together with the problem.

1.6 Right-click menu

By clicking the right button of the mouse while the pointer is in the graphic window, one can make certain changes related to the node closest to the pointer, with the help of a context menu. One can remove the node (and all adjacent links), change its name or demand. Moreover, it is possible to remove or change data for a link adjacent to the node. Then the link is selected in a menu which contains all links adjacent to this node.

If the pointer is at a link (so that the link is blue), then one instead gets a menu for links, with similar options. (It can be difficult to point at a required link exactly, therefore sometimes it could be better to select links with the help of nodes.)

1.7 Finally

VINEOPT is in the process of continuous development. New improvements are added faster than the documentation is updated. Please check the menus in the program. Try not to get too angry if something does not work.

There is no program without bugs. VINEOPT has no “Undo” command, so one can not go back. Therefore save your network often. If the program behaves strangely, the easiest remedy is to quit the program, start it again, read the problem and continue from where you were. Never try to use the program after an error message.