Readme

This online supplement contains computer codes used in the paper:

An Improved Iterative Proportional Scaling Procedure for Gaussian Graphical Models. *Journal of Computational and Graphical Statistics.*

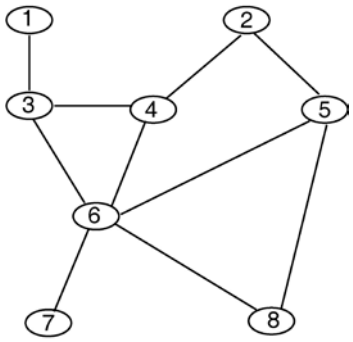
First, we introduce the representation of a graph in C++ codes. Then we will give a brief description of each file.

(1) Representation of graph

A graph is represented by its adjacent lists. For example, the moral graph of Bayesian network Asia (Lauritzen and Spiegelhalter, 1988) is in the file "MoralGraphAsia.txt". The first two numbers are the number of vertices and the number of edges. Then we list each vertex and its neighbors, and 0. In our file, 0 represents an end of a list.

```
8 10
1 3 0
2 4 5 0
3 1 4 6 0
4 2 3 6 0
5 2 6 8 0
6 3 4 5 7 8 0
7 6 0
8 5 6 0
```

MoralGraphAsia.txt



The moral graph of Asia network.

(2) Description of each file

(a) The file “graph.h” is a C++ Header file that gives some programs for graph operations, for example, finding all cliques of a given graph, constructing a minimal fill-in triangulation by MCS-M, constructing a junction tree of the triangulation, etc.

(b) “iips.m” is the IIPS procedure.

```
%function [Sigma, iter] = iips(GraphName, samples, threshold)
%IIPS Compute the mle of the covariance of Gaussian graphical model
%
%[Sigma, iter] = iips(GraphName, samples, threshold)
%
%Input:
%   GraphName: a string which is the name of the file containing the graph
%   samples: numeric matrix. Columns are for variables and rows are for
%          samples.
```

```
%   threshold: threshold for convergence. Default value is 1e-5.
%            Iterations stop when max(max(abs(Sigma^{t+1}-Sigma^{t})))
%            is less than threshold
%Output:
%   Sigma: the mle of covariance matrix of the model
%   iter:  the total number of iterations
```

(c) "ips1.m" is the conventional IPS procedure by adjusting the covariance matrix

```
%function [sigma, iter] = ips1(GraphName, samples, threshold)
%IPS The conventional IPS procedure by adjusting the covariance matrix
%    for computing mle of Gaussian graphical model
%[sigma, iter] = ips(GraphName, samples, threshold)
%
%Input:
%   GraphName: a string which is the name of the file containing the graph
%   samples: numeric matrix. Columns are for variables and rows are for
%            samples.
%   threshold: threshold for convergence. Default value is 1e-5.
%            Iterations stop when max(max(abs(sigma^{t+1}-sigma^{t})))
%            is less than threshold
%Output:
%   sigma: the mle of covariance matrix of the model
%   iter:  the total number of iterations
```

(d) "ips2.m" is the conventional IPS procedure by adjusting the concentration matrix (inverse of covariance matrix)

```
%function [omega, iter] = ips2(GraphName, samples, threshold)
%IPS2 The conventional IPS procedure by adjusting the concentration matrix
%   (inverse of covariance matrix) for computing mle of Gaussian
%    graphical model
%[omega, iter] = ips2(GraphName, samples, threshold)
%
%Input:
%   GraphName: a string which is the name of the file containing the graph
%   samples: numeric matrix. Columns are for variables and rows are for
%          samples.
%   threshold: threshold for convergence. Default value is 1e-5.
%            Iterations stop when max(max(abs(omega^{t+1}-omega^{t})))
%            is less than threshold
%Output:
%   omega: the mle of concentration matrix (inverse of covariance matrix)
%         of the model
%   iter:  the total number of iterations
```

(e) The file “RandomSigmaSamples.m” is used to construct normal distributions that satisfy Markov property with respect to a given graph.

(f) In the folder “graphs” are some graphs constructed by “constrcutRandomGraph.cpp”.

(g) The file “example.m” shows how to use above functions.

Note that, the graph input to the “RandomSigmaSamples.m”, “iips.m”, “ips1.m” and “ips2.m” must be connected. All files *.m are written in Matlab 2007a.