

Use of the program SIENA for fitting ERGMs

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SIENA is a computer program
for analysing

1. network dynamics
– not treated here
2. ERGMs

(**SIENA** =
Simulation Investigation for
Empirical
Network Analysis)



SIENA is embedded in the StOCNET package
(StOCNET provides a user interface)
which can be downloaded from

<http://stat.gamma.rug.nl/stocnet/>

There is a special **SIENA** page at

<http://stat.gamma.rug.nl/snijders/siena.html>

There are separate manuals for **SIENA** and StOCNET.

SIENA can also be run independently of StOCNET
(with model specification file).

The basis of the use of **SIENA** for estimating parameters in ERGMs has been to take the existing structure in **SIENA** (for dynamic modeling) and use this for estimating ERGM parameters.

Various separate additions were and will be made.

The algorithm for ERGMs implemented in **SIENA** is described in Snijders (*JoSS* 2002).

The methods for simulating draws from the ERGM are the same in *statnet* and **SIENA**; the estimation algorithms are different.

The algorithm is based on the mathematical property that for exponential family models, the Maximum Likelihood Estimator (MLE) is also defined as the solution of the ‘moment equation’

$$E_{\theta}\{s(X)\} = s(x)$$

where $s(x)$ is the observed value of the sufficient statistic and $s(X)$ is a random value generated from parameter θ .

This solution is approximated by *stochastic approximation* which is a stochastic iteration procedure:

1. for the current parameter value $\theta^{(t)}$, generate a random network giving the value $s(X^{(t)})$;
2. then update the parameter value by the equation

$$\theta^{(t+1)} = \theta^{(t)} - a_n D^{-1} \left(s(X^{(t)}) - s(x) \right) .$$

$(a_n \downarrow 0)$

This sequence $\theta^{(t)}$ will converge to the MLE.

Comparing the Newton-Raphson type algorithm in *statnet* with the stochastic approximation algorithm in StOCNET:

SIENA is better in getting to the vicinity of the MLE;
statnet is faster in getting from there to the precise solution.

(Both programs may move toward a hybrid algorithm:
first NR, then SA).

SIENA operates in three phases:

phase 1: obtain rough estimate of sensitivity (D) of $E_{\theta}\{s(X)\}$ to θ

phase 2: stochastic approximation with updates as described

phase 3: convergence check & calculation of standard errors

Knobs to turn are the factor a_n , the *initial gain parameter*: smaller values lead to smaller steps, more stability if you are close; and the frequency for sampling the simulated networks, the *multiplication factor*: larger values lead to more nearly independent draws, enhancing stability of the algorithm but taking more time.

Features

- * score test (tests parameters without having to estimate the model with corresponding parameters included)
- * possibilities of structural zeros / structural ones
- * parameters can be fixed
- * inference can be done conditional on degrees
- * comes with a manual
(jointly for longitudinal and ERGM models;
manual could be further improved)
- * StOCNET users' group

Advantages

- * easy environment
- * features mentioned on preceding page
- * robust algorithm
- * available

Disadvantages (but work is in progress!)

- * may be slow
- * excellent convergence can be hard to obtain.