**Homework 8: Due June 7**

**Entanglement and Tensor Networks, Spring 2016, Prof. White**

1. **Infinite MPS**

(a) Implement the infinite TEBD algorithm (iTEBD) in julia or ITensor for the $S = 1/2$ Heisenberg chain. Starting with a Neel state (up-down-up-down), evolve in real time ($\exp(-i\tau H)$, complex wavefunctions). Choose a truncation error of $10^{-6}$, letting the number of states kept increase. Evaluate $S^z$ on even and odd sites as a function of time and plot them versus time. Run your program for as long as you can, up to about 1 hour, to go to as large a $t$ as possible. Evaluate the von Neumann entanglement entropy as a function of time and plot that.

(b) Look up the adiabatic theorem of quantum mechanics. We can use this to get the ground state of a nontrivial model from a trivial one. Starting with your code from (a), now make the Hamiltonian vary in time, $H(\lambda(t))$, where $\lambda$ is an additional coefficient in front of the $S^+S^-$ and $S^-S^+$ terms, so that $\lambda = 0, 1$ correspond to the Ising and Heisenberg models, respectively. Let $\lambda(t) = t/T$ and evolve from 0 to $T$ (with $T \gg 1$). This adiabatic evolution should keep you approximately in the ground state. By varying $T$, the time step, and how many states you can keep, see how close to the ground state of the Heisenberg model (evaluating $\vec{S} \cdot \vec{S}$) you can get with this adiabatic evolution.