Verification of the Statistical Model for Multi-Stage Message Distribution

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1 Monte Carlo Simulation

As in the first paper, we use a monte carlo simulation to verify the correctness of the statistical model developed for multi-stage message distribution. A high-level overview of the simulation algorithm is detailed in Algorithm **??**. Both the Matlab source code for the simulation and Java source code for the model should be linked to in the final paper.

Due to the computational complexity of the model, the current unoptimized code can not go beyond $n = 9$ nodes and $n, m >= 3$. The recursive process of generating candidate transition matrices from a particular D^a subspace to D^{a+1} is very expensive. I think it can be optimized by a simple pruning scheme to remove redundant branches of the search space, though this has yet to be explored.

A list of the times from the model and simulation for $T = 10000$ runs, along with the simulation standard deviation and standard error, is shown in the attached spreadsheet. The model and simulation appear to match.

Data: T, k, m, n, p_1, and p_2

Result: Expected time

$A_c \leftarrow zeros[1 \ldots n][1 \ldots n]$;

$A_m \leftarrow zeros[1 \ldots k][1 \ldots n][1 \ldots n]$;

$n_c \leftarrow 0$;

$C_l \leftarrow zeros[1 \ldots n]$;

$total \leftarrow 0$;

for $T_i = 0 \rightarrow T$ **do**

    $t \leftarrow 0$;

    while $n_c < n - 1$ **do**

        Build a list of candidate child nodes ready to receive a new message (i.e. those unconnected and not receiving a message already). Filter the list by randomly discarding each candidate node with probability $1 - p_1$ **for** $m_i = 0 \rightarrow m$ **do**

            With probability p_2, advance each child node in stage S_{m_i} to $S_{m_{i+1}}$. If a node advances to stage S_m, set them as connected in C_l, update their connection with the parent in A_c, and discard their message trace in A_m.;

        end

        Randomly assign each child node in the message ready list to an available parent. If the number of available parents is less than the number of ready children, then a subset of those in the ready list begin a communication trace. Else, every children begins a communication trace.;

        $t \leftarrow t + 1$;

    end

    $total \leftarrow total + t$;

end

output $total/T$

Algorithm 1: Monte carlo simulation to verify the statistical model