Simulation Results Graphs and Cluster Analyses for: “The Influence of Realism on Congestion in Network Simulations”

NIST Technical Note
C. Dabrowski & K. Mills
2015
Table of Contents

• Sec. 5 Graphs for Isolated Nodes ($\chi$) – slides 3-37
• Sec. 5 Graphs for Network Connectivity ($\alpha$) – slides 38-72
• Sec. 5 Graphs for Packet Delivery Effectiveness ($\pi$) – slides 73-107
• Sec 5. Graphs for Packet Delivery Efficiency ($\delta$) – slides 108-142
• Sec. 6 Clustering for Responses ($\chi$, $\alpha$, $\pi$ and $\delta$) – slides 143-147
• Appx A. Graphs for Congested Nodes ($\gamma$) – slides 148-182
• Appx A. Clustering for Congested Nodes ($\gamma$) – slides 183-184
Graphs for Isolated Nodes ($\chi$) Figure 21
(Dabrowski & Mills NIST)
C0: LSS Isolated Nodes
C1: LSS Isolated Nodes
C2: LSS Isolated Nodes
C3: LSS Isolated Nodes

\[ \chi \]

\[ p \]

0

0.25

0.5

0.75

1

0

500

1000
C10: LSS Isolated Nodes
C19: LSS Isolated Nodes
C22: LSS Isolated Nodes
C23: LSS Isolated Nodes
C27: LSS Isolated Nodes
C30: LSS Isolated Nodes
C31: LSS Isolated Nodes
C54: LSS Isolated Nodes
C62: LSS Isolated Nodes
C63: LSS Isolated Nodes
C114: LSS Isolated Nodes
C118: LSS Isolated Nodes
C119: LSS Isolated Nodes
C122: LSS Isolated Nodes
C126: LSS Isolated Nodes
Graphs for Network Connectivity ($\alpha$) Figure 22
(Dabrowski & Mills NIST)
C0: LSS Reachable Nodes
C1: LSS Reachable Nodes
C2: LSS Reachable Nodes

\( \alpha \)

\( p \)
C3: LSS Reachable Nodes
C7: LSS Reachable Nodes
C10: LSS Reachable Nodes

\[ \alpha \]

\[ p \]

The graph shows a plot of \( \alpha \) against \( p \), where \( \alpha \) decreases sharply as \( p \) increases.
C11: LSS Reachable Nodes
C14: LSS Reachable Nodes
C15: LSS Reachable Nodes
C18: LSS Reachable Nodes
C19: LSS Reachable Nodes
C22: LSS Reachable Nodes
C23: LSS Reachable Nodes

The figure shows a plot of $\alpha$ vs. $\rho$. The x-axis represents the parameter $\rho$, while the y-axis represents $\alpha$. The graph appears to illustrate the relationship between these two variables, possibly indicating a diminishing return or a threshold effect as $\rho$ increases.
C26: LSS Reachable Nodes
C27: LSS Reachable Nodes
C30: LSS Reachable Nodes
C31: LSS Reachable Nodes
C50: LSS Reachable Nodes
C51: LSS Reachable Nodes

![Graph showing the relationship between \( \alpha \) and \( p \)]
C55: LSS Reachable Nodes
C58: LSS Reachable Nodes
C59: LSS Reachable Nodes
C62: LSS Reachable Nodes

- $\alpha$ vs $p$
- The graph shows the relationship between $\alpha$ and $p$ for LSS reachable nodes.
C63: LSS Reachable Nodes
C114: LSS Reachable Nodes
C115: LSS Reachable Nodes
C118: LSS Reachable Nodes
C119: LSS Reachable Nodes
C122: LSS Reachable Nodes
C123: LSS Reachable Nodes
C126: LSS Reachable Nodes
C127: LSS Reachable Nodes
Graphs for Packet Delivery Effectiveness ($\pi$) Figure 23
(Dabrowski & Mills NIST)
C0: Packets Delivered

\[ \pi \]

\[ p \]

\[ 0 \quad 500 \quad 1000 \quad 1500 \quad 2000 \quad 2500 \]
C1: Packets Delivered

\[ \pi \]

\[ p \]
C2: Packets Delivered
C7: Packets Delivered

\[ \pi \]

\[ p \]

Graph showing the relationship between \( \pi \) and \( p \). The curve indicates a decreasing trend as \( p \) increases.
C10: Packets Delivered
C15: Packets Delivered

\( \pi \) vs. \( p \)

- \( \pi \) decreases as \( p \) increases.
- The curve approaches a limit as \( p \) increases.
C18: Packets Delivered
C19: Packets Delivered

\[ \pi \]

\[ p \]

0 0.25 0.5 0.75 1

0 500 1000
C23: Packets Delivered
C30: Packets Delivered

\[ \pi \]

\[ p \]
C31: Packets Delivered

\[ \pi(p) \]
C51: Packets Delivered
C54: Packets Delivered
C55: Packets Delivered

The graph shows the relationship between the variable $\pi$ and $p$.

The function appears to be decreasing as $p$ increases, indicating that the probability of packets being delivered decreases with larger values of $p$. The y-axis represents $\pi$, ranging from 0 to 1, while the x-axis represents $p$, ranging from 0 to 2500.
C58: Packets Delivered

\[ \pi \]

\[ p \]

0 0.25 0.5 0.75 1

0 500 1000
C59: Packets Delivered
C63: Packets Delivered

\[ \pi \]

\[ p \]

0 500 1000 1500 2000 2500
C123: Packets Delivered
C126: Packets Delivered
C127: Packets Delivered
Graphs for Packet Delivery Efficiency ($\delta$) Figure 24
(Dabrowski & Mills NIST)
C0: Packet Delay

\[ \delta \]

\[ p \]

0  500  1000  1500  2000  2500

0  0.2  0.4  0.6  0.8  1.0
C1: Packet Delay

\[ \delta \]

\[ p \]

Values on the y-axis range from 0 to 1, and the x-axis values range from 0 to 2500.
C6: Packet Delay

\[ \delta \]

\[ p \]
C7: Packet Delay

\[ \delta \]

\[ \rho \]
C11: Packet Delay
C18: Packet Delay

\[ \delta \]

\[ p \]

0

500

1000

0

0.2

0.4

0.6

0.8

1
C19: Packet Delay

\[ \delta \]

\[ p \]

\[ 0 \quad 500 \quad 1000 \]

\[ 0 \quad 0.2 \quad 0.4 \quad 0.6 \quad 0.8 \quad 1 \]
C22: Packet Delay
C23: Packet Delay
C26: Packet Delay

\[ \delta \]

\[ p \]

\[ 0 \] \quad \[ 500 \] \quad \[ 1000 \]

\[ 0 \] \quad \[ 0.2 \] \quad \[ 0.4 \] \quad \[ 0.6 \] \quad \[ 0.8 \] \quad \[ 1.0 \]
C27: Packet Delay
C30: Packet Delay

\[ \delta \]

\[ p \]

\[ 0 \]

\[ 500 \]

\[ 1000 \]

\[ 1500 \]

\[ 2000 \]

\[ 2500 \]

\[ 0 \]

\[ 0.2 \]

\[ 0.4 \]

\[ 0.6 \]

\[ 0.8 \]

\[ 1.0 \]
C54: Packet Delay

\[ \delta \]

\[ p \]
C55: Packet Delay
C58: Packet Delay
C59: Packet Delay

\[ \delta \]

\[ p \]

0

0.2

0.4

0.6

0.8

1

500

1000

1500

2000

2500
C62: Packet Delay

\[ \delta \]

\[ \rho \]

Graph showing the relationship between \( \delta \) and \( \rho \).
C63: Packet Delay
C114: Packet Delay
C115: Packet Delay

\[ \delta \]

\[ \rho \]

0 500 1000 1500 2000 2500

0 0.2 0.4 0.6 0.8 1
C118: Packet Delay
C119: Packet Delay

\[ \delta \]

\[ \rho \]

0  500  1000  1500  2000  2500
Clustering for Each Response ($\chi$, $\alpha$, $\pi$ and $\delta$) Figures 27-30
(Dabrowski & Mills NIST)
Hierarchical Clustering  2500 Series GCC Isolated Nodes (χ)
Hierarchical Clustering  2500 Series GCC Reachable Nodes ($\alpha$)
Hierarchical Clustering 2500 Series Proportion of Packets Delivered ($\pi$)
Hierarchical Clustering 2500 Series Scaled Packet Delays ($\delta$)
Graphs for Congested Nodes (Y) Figure A1
(Dabrowski & Mills NIST)
C0: LSS Congested Nodes
C1: LSS Congested Nodes
C6: LSS Congested Nodes
C7: LSS Congested Nodes
C14: LSS Congested Nodes
C15: LSS Congested Nodes
C23: LSS Congested Nodes
C27: LSS Congested Nodes
C30: LSS Congested Nodes
C51: LSS Congested Nodes
C55: LSS Congested Nodes
C59: LSS Congested Nodes
C62: LSS Congested Nodes
C63: LSS Congested Nodes
C118: LSS Congested Nodes
C119: LSS Congested Nodes

\begin{axis}[
    xlabel={$p$},
    ylabel={$\lambda$},
    xmin=0, xmax=2500,
    ymin=0, ymax=1,
]
\end{axis}
C123: LSS Congested Nodes
C126: LSS Congested Nodes
C127: LSS Congested Nodes
Clustering for Congested Nodes (Y) Figure A2
(Dabrowski & Mills NIST)
Hierarchical Clustering  2500 Series Congested Nodes (γ)