Stress concentration in the local load sharing fiber bundle model

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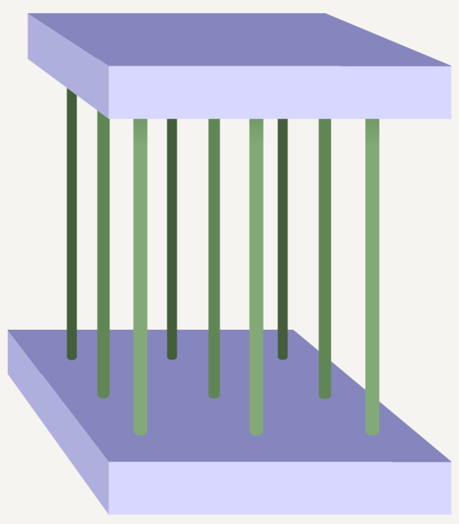
A. INTRODUCTION



A fiber bundle is a system of Hookian springs that pull on two plates. Each fiber has a random threshold value between t and 1 that determines at what point the fiber breaks.

Equal Load Sharing

There are different variations on the fiber bundle model. One of the simpler models is the Equal Load Sharing (ELS). When a fiber breaks, it's force is distributed equally onto all other fibers.

$L = 3$

X	$^9/_8$	$^9/_8$
$^9/_8$	$^9/_8$	$^9/_8$
$^9/_8$	$^9/_8$	$^9/_8$

The grid shows the relative force on the fibers. Note that the sum of all the fibers is always equal to the number of cells in the grid.

Local Load Sharing

In Local Load Sharing (LLS) broken fibers form a cluster and the load of the broken fibers is shared with fibers that boarder the cluster. We call these fibers the outline of a cluster.

The left grid shows a bundle with one broken fiber, and right grid shows how the bundle changes when a second fiber breaks.
s: size of the cluster. L: size of the system.

$L = 4 \quad s = 1$

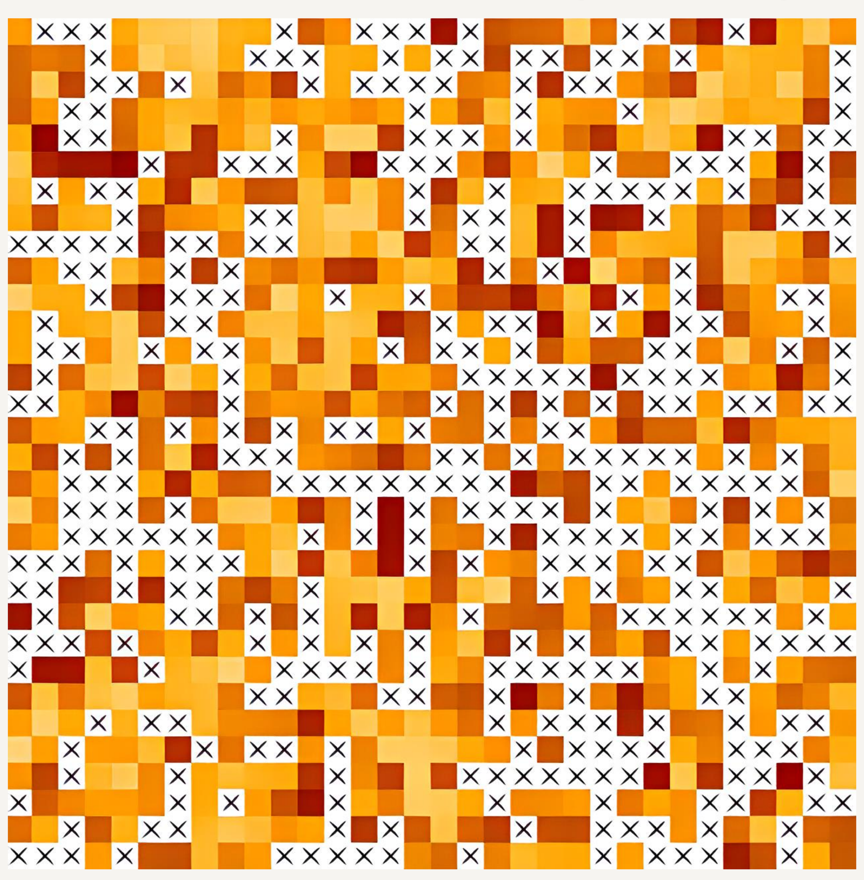
1	$^5/_4$	1	1
$^5/_4$	X	$^5/_4$	1
1	$^5/_4$	1	1
1	1	1	1

$L = 4 \quad s = 2$

1	$^8/_6$	$^8/_6$	1
$^8/_6$	X	X	$^8/_6$
1	$^8/_6$	$^8/_6$	1
1	1	1	1

The LLS is often *more* realistic than the ELS, but to say that either is *realistic* at all might be a stretch. One issue with the LLS we can qualitatively observe is that the way the systems breaks is fractal.

A: Standard (UNR)



B. STRESS CONCENTRATION DETERMINED BY NEIGHBOURHOODS

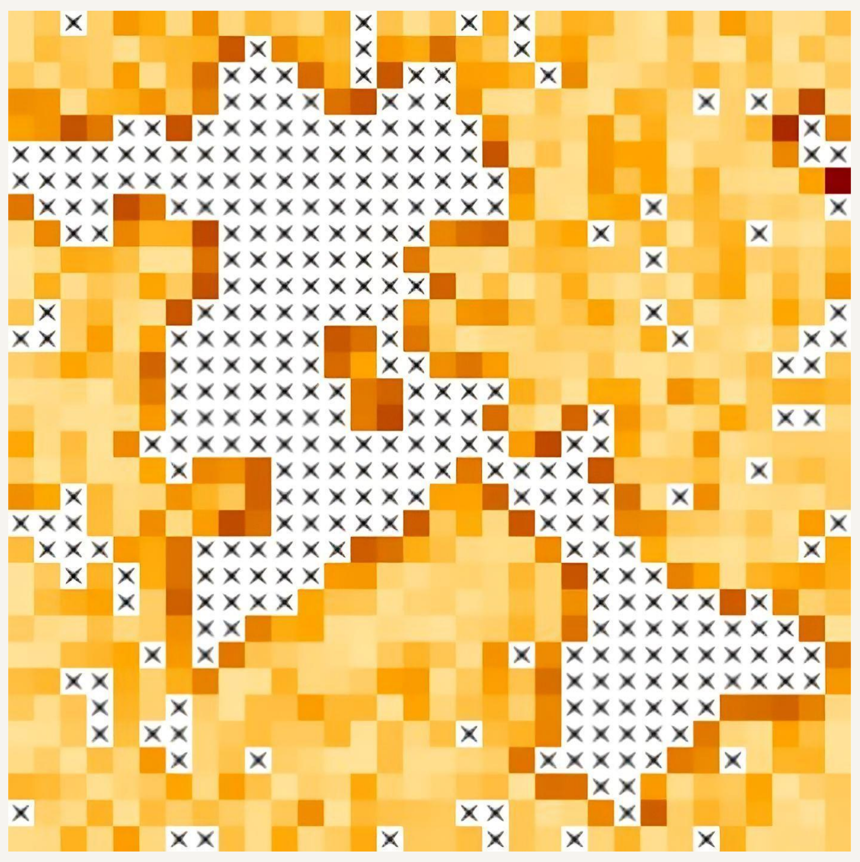
In the standard LLS, load is uniformly distributed on the outline of the cluster. We can shift this distribution depending on the number of neighbours.

The standard LLS uses as uniformly distributed neighbourhood rule (UNR), and that we introduce a stress enhancing neighbourhood rule (SNR).

Summary

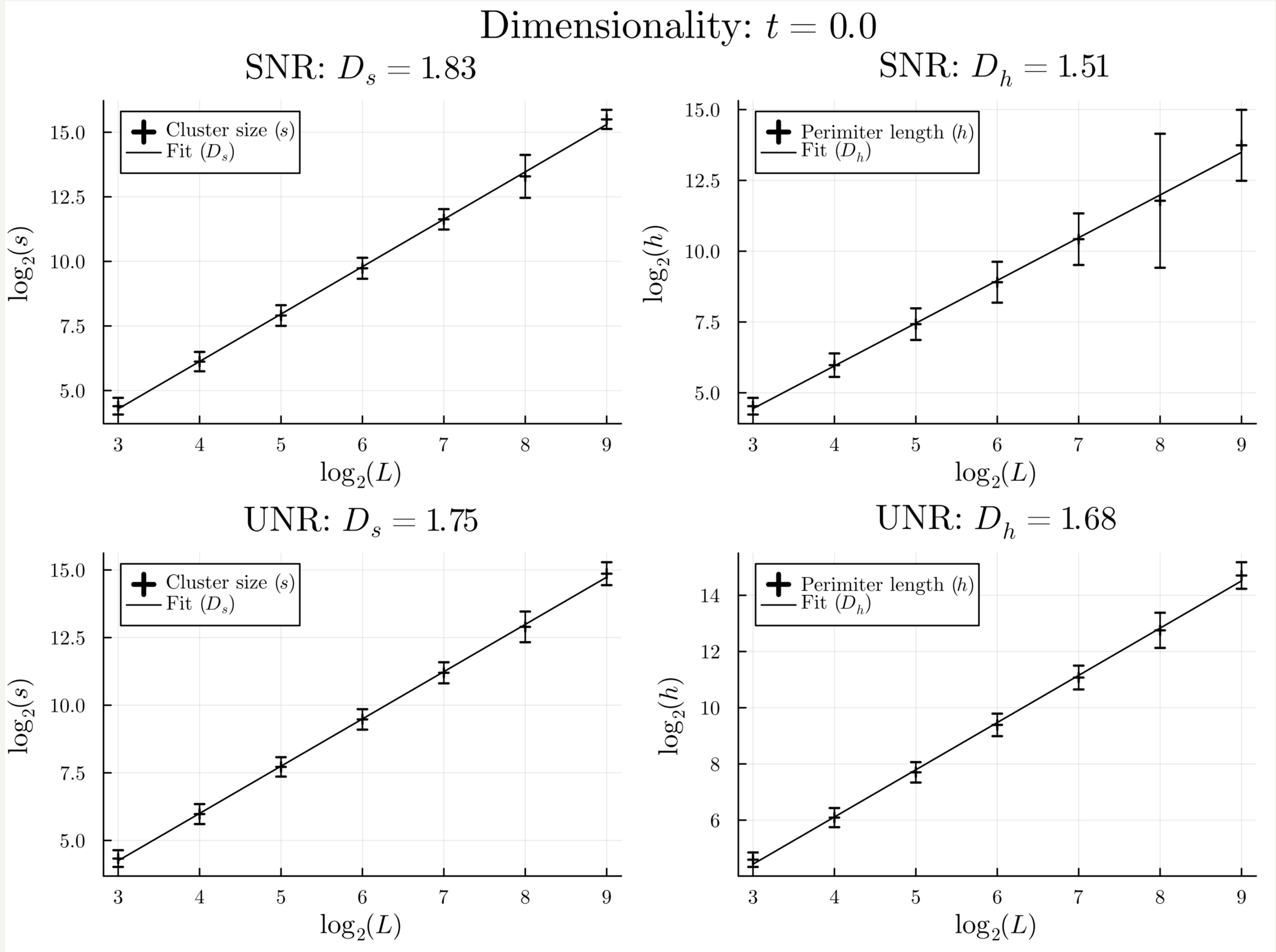
Introducing a neighbourhood dependance makes the bundle break in a less fractal way. Compare the situations depicted in figures A and B.

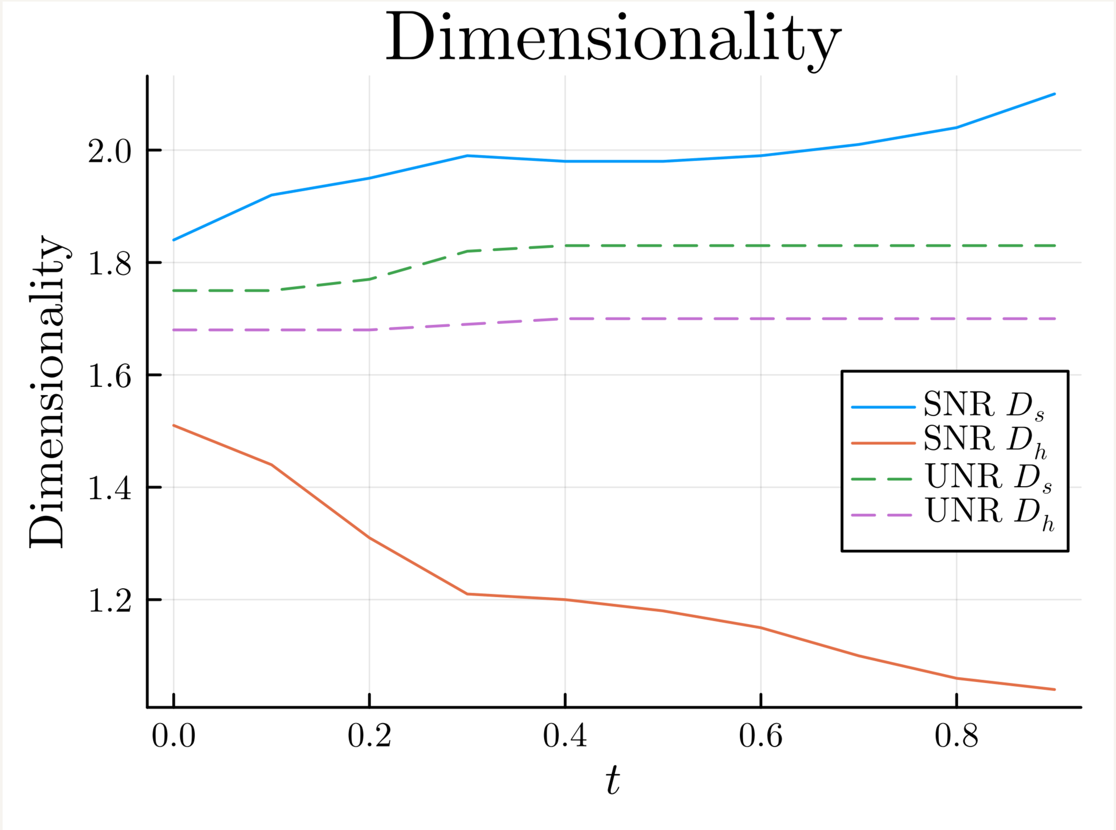
B: SNR



C. DIMENSIONALITY

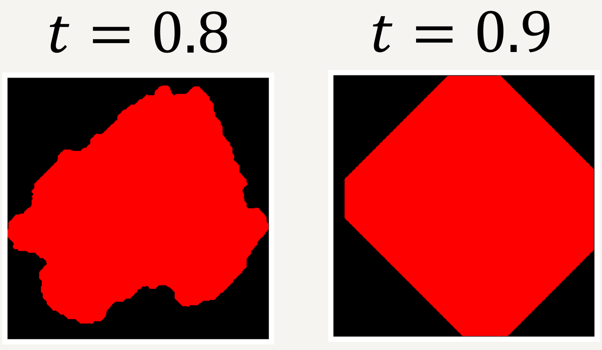
We can quantitatively analyse the effect of this change by looking at the dimensionality of the clusters. We do this by plotting the size of the largest cluster s by the size of the system L in a log plot, and the slope of the line is the dimensionality of the cluster. We do the same for the outline.



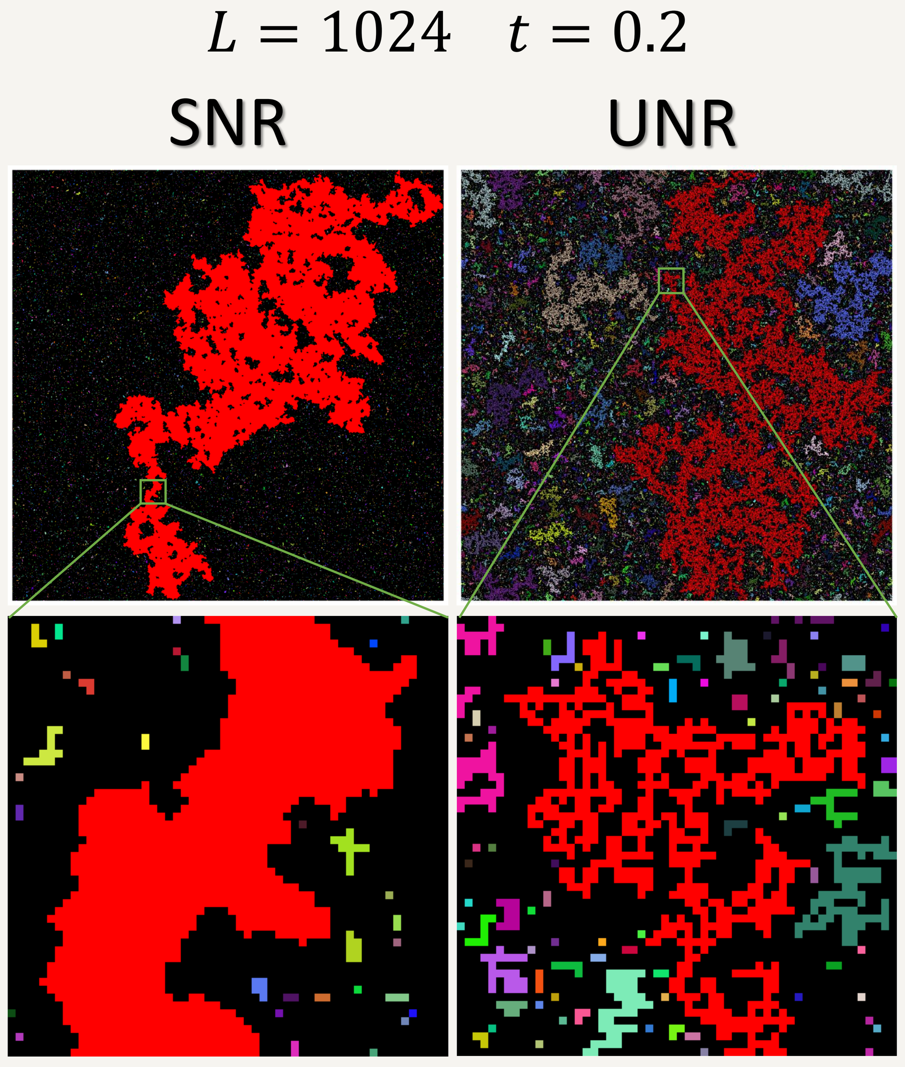


Repeating this process for several values of t gives us somewhat strange and unexpected results that require further investigation. These results are based on 200 samples for all sizes of L.

This shows what happens when t becomes large for SNR systems.



The images below show each cluster in a random color except the largest cluster in red. Note that the UNR is not drawn with a darker red.



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