Directed Percolation Simulation Example

This notebook demonstrates how to use the `DirectedPercolation` module to simulate the model and visualize the results.

Project Setup

Your directory structure should now look like this:

```
your_project_folder/
├── src/
│   ├── Directed_Percolation.jl
│   ├── State_Evol.jl
│   └── Plots_Helpers.jl
├── example.ipynb
└── Project.toml
```

In [1]:
```
using Pkg
Pkg.activate(".")
Pkg.add(["Plots", "Statistics"])
```

```
 Activating project at `~/GitHub/Directed_Percolation`
  Resolving package versions...
 No Changes to `~/GitHub/Directed_Percolation/Project.toml`
 No Changes to `~/GitHub/Directed_Percolation/Manifest.toml`
```

Loading the Module and Dependencies

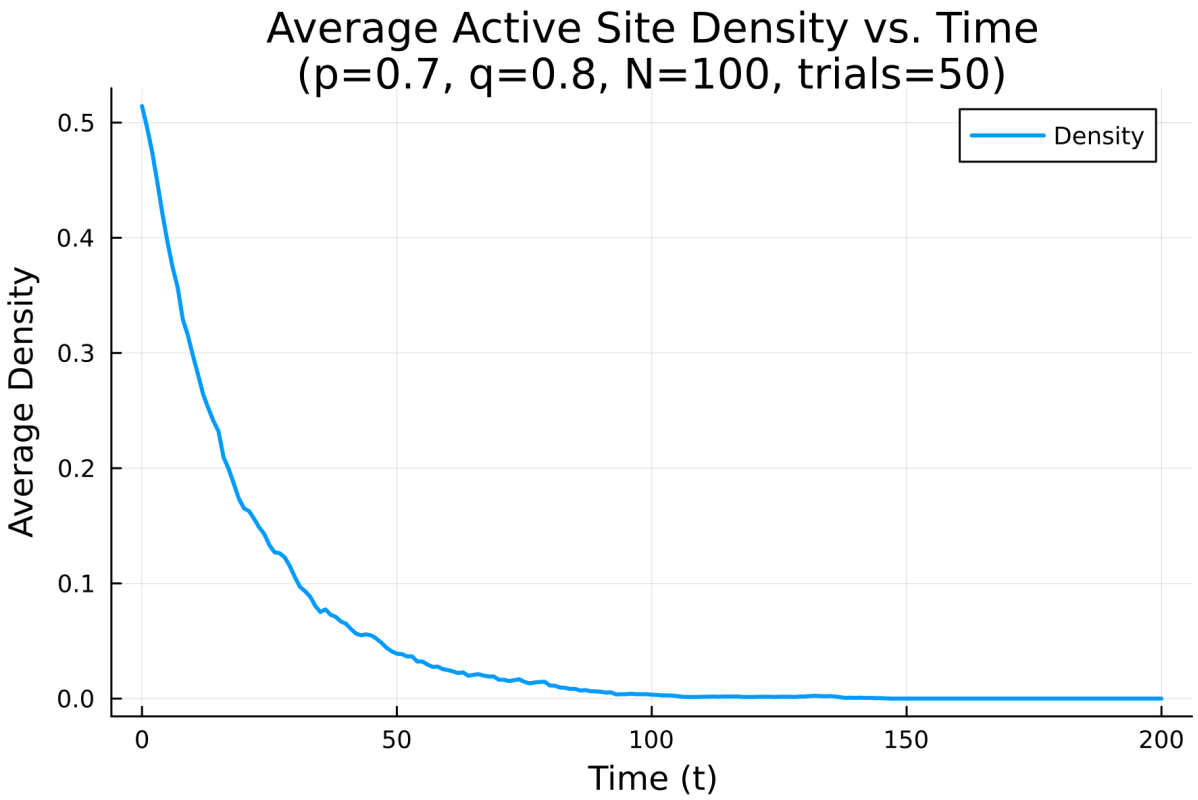
In [2]:
```
include("src/Directed_Percolation.jl")
using .DirectedPercolation
using Random
using Plots
```

Main Execution

In [3]:
```
Random.seed!(1234)

# --- Parameters for the density vs. time plot ---
N_time_plot = 100
p_time_plot = 0.7
q_time_plot = 0.8
t_max_time_plot = 200
num_trials_time_plot = 50

plot1 = plot_density_vs_time(N_time_plot, p_time_plot, q_time_plot, t_max
# savefig(plot1, "density_vs_time.png")
```

```
display(plot1)
```

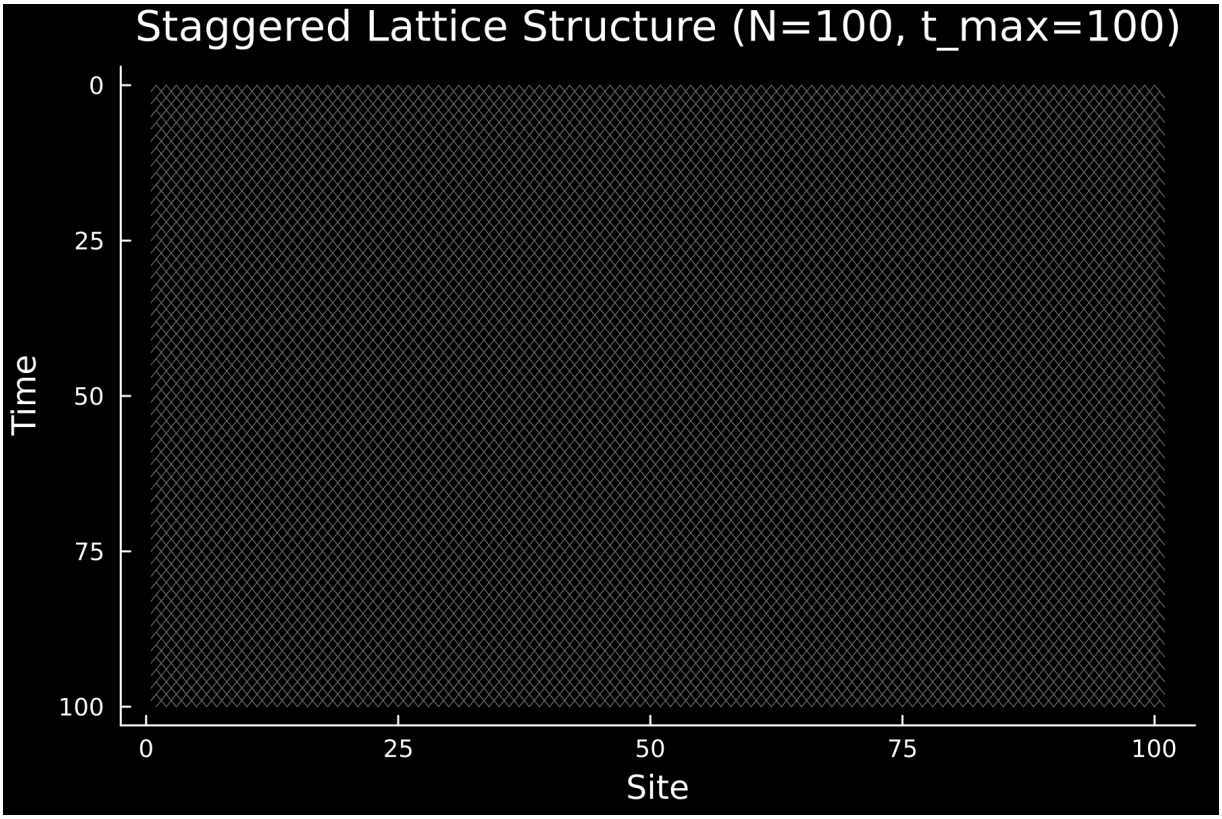
```
Generating plot for p=0.7, q=0.8...
```



Debugging Plot: Staggered Lattice Structure

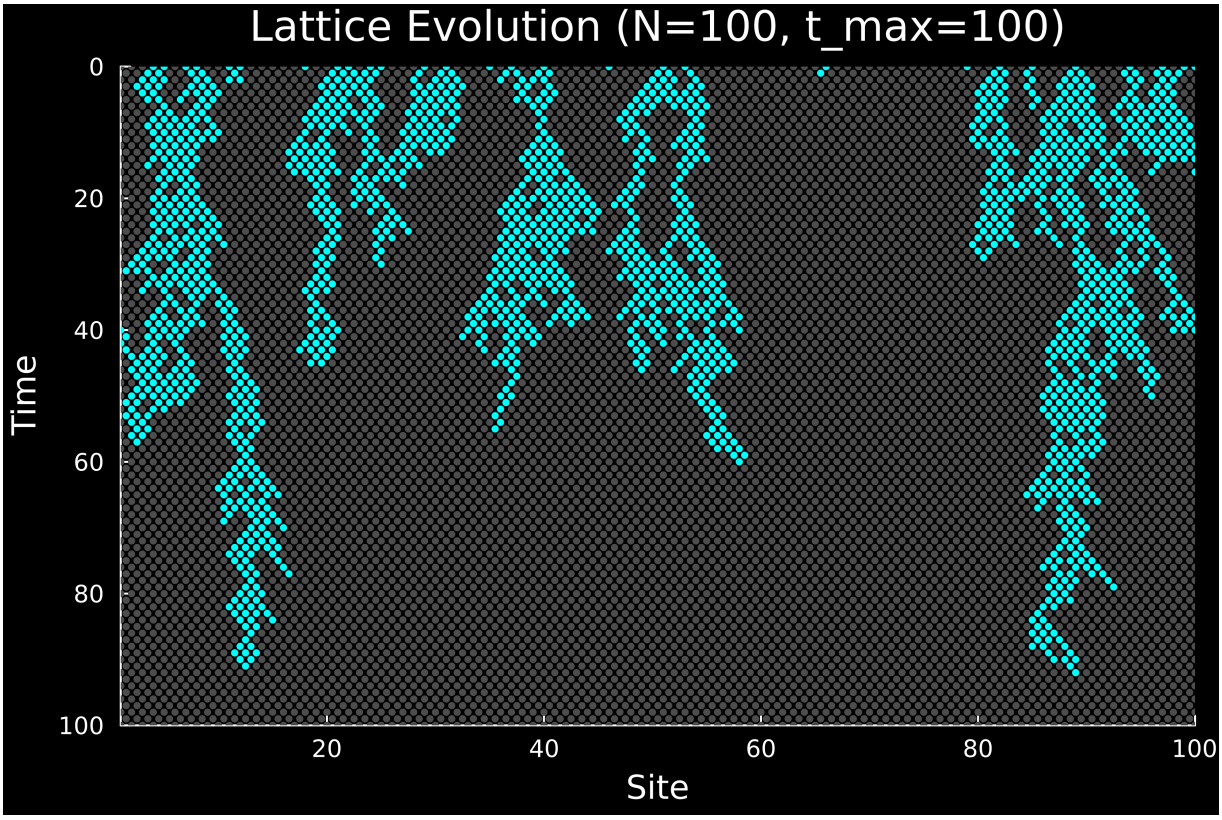
This plot shows the underlying bond structure of the staggered lattice, which is useful for verifying the geometry of the simulation.

In [4]:
```
# --- Parameters for the lattice plots ---
N_lattice = 100
t_max_lattice = 100

debug_plot = plot_staggered_lattice_grid(N_lattice, t_max_lattice)
display(debug_plot)
```



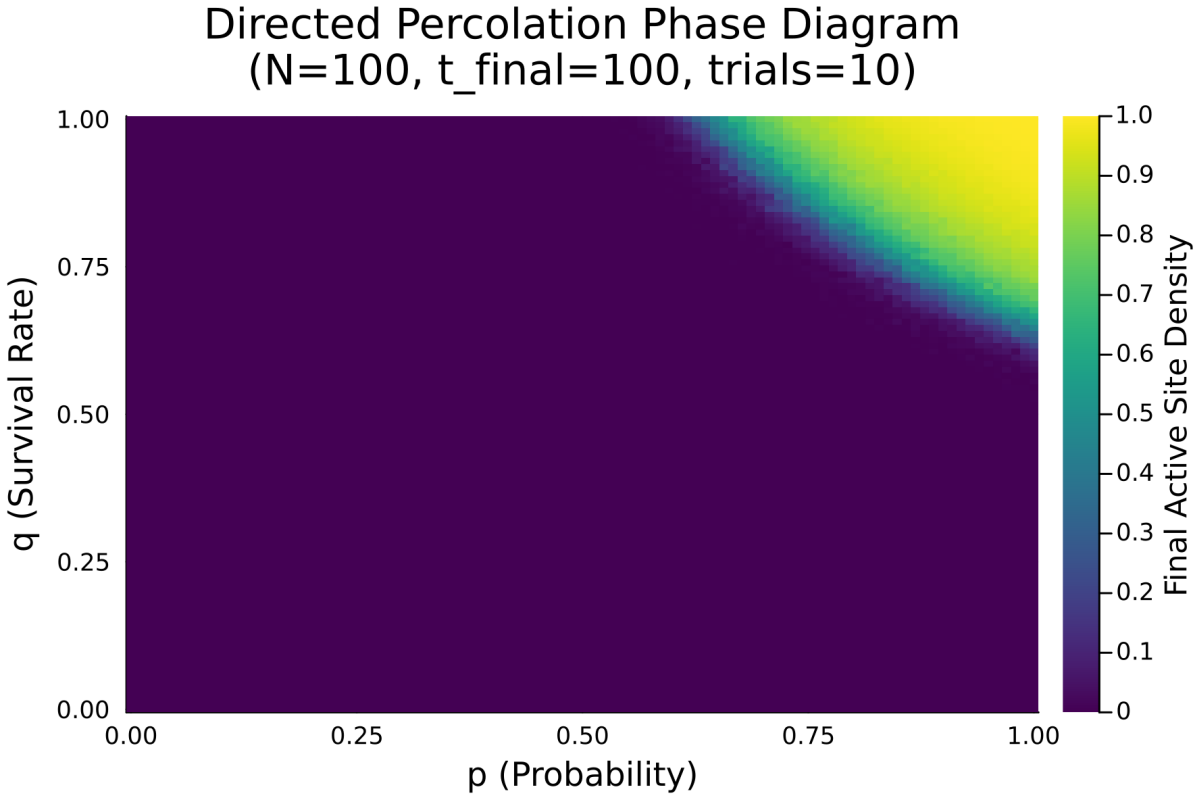
Lattice Evolution Plot

In [ ]:
```
# --- Parameters for a single lattice evolution run ---
p_lattice = 0.75
q_lattice = 0.80


initial_state_lattice = generate_initial_state(N_lattice, density=0.3)

history = evolve(N_lattice, p_lattice, q_lattice, t_max_lattice, initial_

plot_lattice = plot_lattice_evolution(history, dpi=600)
# savefig(plot_lattice, "lattice_evolution.png")
display(plot_lattice)
```



In [6]:
```
# --- Parameters for the phase diagram ---
N_phase = 100
t_final_phase = 100
p_steps_phase = 100
q_steps_phase = 100
num_trials_phase = 10

plot2 = plot_phase_diagram(N_phase, t_final_phase, p_steps_phase, q_steps
# savefig(plot2, "phase_diagram.png")
display(plot2)
```

```
Generating phase diagram...
Progress: 10.0%
Progress: 20.0%
Progress: 30.0%
Progress: 40.0%
Progress: 50.0%
Progress: 60.0%
Progress: 70.0%
Progress: 80.0%
Progress: 90.0%
Progress: 100.0%
```


Directed Percolation Phase Diagram
(N=100, t_final=100, trials=10)
q (Survival Rate)
p (Probability)
Final Active Site Density
0.00
0.25
0.50
0.75
1.00
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

In [7]: