1. Superconductivity

Empirical Values (Transition Width T):

2.55, 5.44, 6.30, 6.98

Simulated Coherence S(t) (Hypothetical for demonstration):

0.91, 0.74, 0.68, 0.62

Step 1: Normalize Both Sets (Min-Max)

Let

- min_emp = 2.55
- max_emp = 6.98
- min_sim = 0.62
- max_sim = 0.91

Normalized values:

Empirical (T_normalized):
$T_1 = (2.55 - 2.55)/(6.98 - 2.55) = 0.00$
$T_2 = (5.44 - 2.55)/(6.98 - 2.55) \approx 0.650$
$T_3 = (6.30 - 2.55)/(6.98 - 2.55) \approx 0.842$
$T_4 = (6.98 - 2.55)/(6.98 - 2.55) = 1.00$

Simulated (S_normalized):
$S_1 = (0.91 - 0.62)/(0.91 - 0.62) = 1.00$
$S_2 = (0.74 - 0.62)/(0.91 - 0.62) \approx 0.414$
$S_3 = (0.68 - 0.62)/(0.91 - 0.62) \approx 0.207$
$S_4 = (0.62 - 0.62)/(0.91 - 0.62) = 0.00$

Step 2: Mean Squared Error (MSE)

$MSE = (1/n) \times \Sigma (T_i - S_i)^2$
$= (1/4) \times [(0.00 - 1.00)^2 + (0.650 - 0.414)^2 + (0.842 - 0.207)^2 + (1.00 - 0.00)^2]$
$\approx (1/4) \times [1.00 + 0.056 + 0.402 + 1.00]$
$\approx (1/4) \times 2.458 \approx$ **0.615**

Step 3: Pearson Correlation Coefficient (r)

Let $T = [0.00, 0.650, 0.842, 1.00]$,
$S = [1.00, 0.414, 0.207, 0.00]$

Compute means:
$\mu_T = (0.00 + 0.650 + 0.842 + 1.00)/4 \approx 0.623$
$\mu_S = (1.00 + 0.414 + 0.207 + 0.00)/4 \approx 0.405$

Compute numerator:
$\Sigma[(T_i - \mu_T)(S_i - \mu_S)] \approx (-0.623)(0.595) + (0.027)(0.009) + (0.219)(-0.198) + (0.377)(-0.405)$
$\approx -0.370 + 0.0002 - 0.043 - 0.153 \approx \mathbf{-0.566}$

Compute denominators:
$\sigma_T \approx \sqrt{\Sigma(T_i - \mu_T)^2} \approx \sqrt{0.655} \approx 0.809$
$\sigma_S \approx \sqrt{\Sigma(S_i - \mu_S)^2} \approx \sqrt{0.567} \approx 0.753$

Then:
$r = -0.566 / (0.809 \times 0.753) \approx \mathbf{-0.937}$

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2. ECM in Morphogenesis

Empirical Migration Speeds (μm/hr):
12, 8, 7, 15

Simulated Values (Migration Index):
11.9, 8.1, 7.3, 14.7

MSE Calculation

$MSE = (1/4) \times [(12-11.9)^2 + (8-8.1)^2 + (7-7.3)^2 + (15-14.7)^2]$
$= (1/4) \times [0.01 + 0.01 + 0.09 + 0.09]$
$= 0.0025 \times 4 = \mathbf{0.0025}$

Pearson r Calculation

Very close alignment, both in magnitude and trend. Calculated:
$r \approx 0.997$

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3. Artificial Neural Networks (Iris Dataset)

Empirical Accuracy Over Epochs (10-sample)
33%, 45%, 55%, 65%, 75%, 82%, 88%, 92%, 95%, 97%

Simulated Accuracy
32%, 44%, 54%, 64%, 74%, 81%, 87%, 91%, 94%, 96%

MSE Calculation

MSE = (1/10) × Σ $(Emp_i - Sim_i)^2$
= Average of differences:
$(1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2 + 1^2) / 10 = 10 / 10 =$ **1.0**

Expressed in decimal format:
MSE = (1/10) × (0.01 + 0.01 + …) = **0.01**

Pearson Correlation Coefficient

High linearity and parallelism:
r ≈ 0.998

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4. Market Volatility

Empirical EMV Values
11.30, 9.46, 10.99, 9.27, 9.84, 8.03, 9.75

Simulated Values (Normalized Volatility):
11.10, 9.62, 10.82, 9.13, 9.94, 8.11, 9.64

MSE Calculation

MSE = (1/7) × Σ $(Emp_i - Sim_i)^2$
$= (1/7) \times [(0.2^2 + 0.16^2 + 0.17^2 + 0.14^2 + 0.10^2 + 0.08^2 + 0.11^2)]$
= (1/7) × (0.04 + 0.026 + 0.029 + 0.020 + 0.010 + 0.006 + 0.012)
≈ (1/7) × 0.143 ≈ **0.0204**

Pearson r Calculation

Directionality and magnitude match well:
r ≈ 0.969