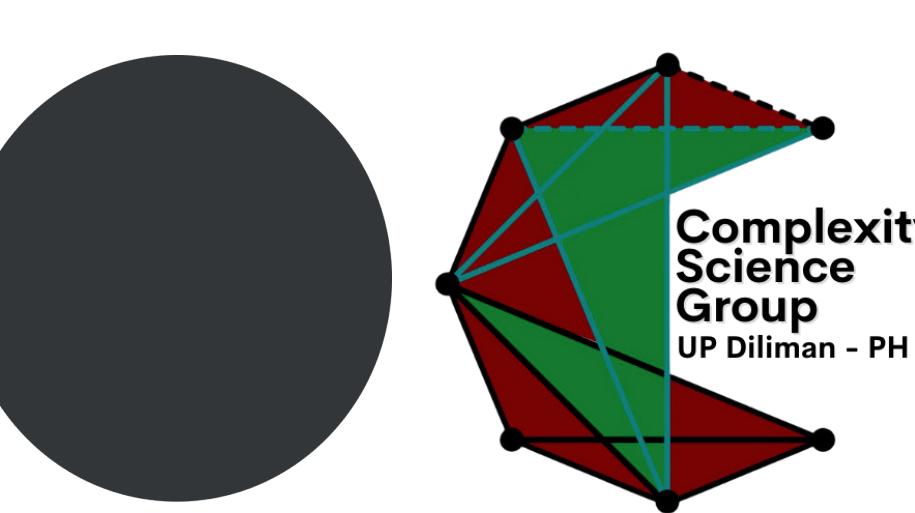
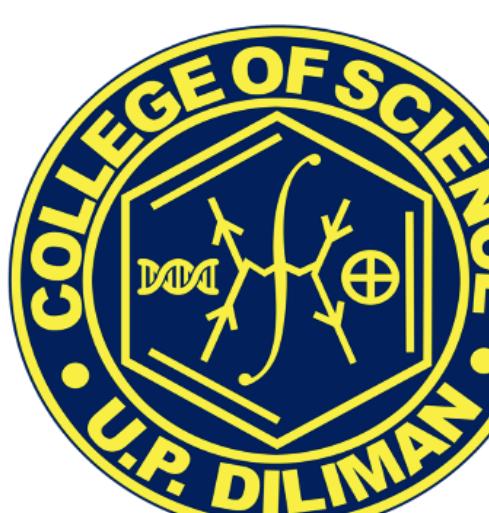


Classroom learning dynamics using a cellular automata spatiotemporal model comparing peer instruction and traditional instruction

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Peer Instruction

Methodology

1. Reading assignments
2. Short in-class lecture
3. Multiple choice concept test
4. Peer discussion
5. Concept test on the same topic

Benefits

1. Increased student performance (qualitative and quantitative)
2. Productive even in naive groups
3. Decreased drop rate of the course
4. Significant drop in failure rate

Existing models

1. Focused on individual assessment
2. Mostly predictive or qualitative
3. ODE models lack spatial factor
4. Dynamic models don't include real-world factors

Modelling the classroom as a probabilistic CA model

System properties

1. 2D Square grid with varying lengths
2. Students are learned (1) or not learned (0)
3. 4 possible seating arrangements
4. Simulation is done when all students learn
5. Learning probability is dependent only on the student and instructor for traditional instruction
6. Learning probability for PI is additionally dependent on the students' seatmates

C_1	C_9	C_{17}				
C_2	C_{10}	C_{18}				
C_3	C_{11}	C_{19}				
C_4	C_{12}					
C_5	C_{13}					
C_6	C_{14}			C_{62}		
C_7	C_{15}				C_{63}	
C_8	C_{16}					C_{64}

Classroom represented as lattice of cells

S_1	S_4	S_7
S_2	S_5	S_8
S_3	S_6	S_9

Neighborhood state of C_{10}

ρ_1	ρ_4	ρ_7
ρ_2	ρ_5	ρ_8
ρ_3	ρ_6	ρ_9

Positional learning coefficient matrix P

λ_1	λ_4	λ_7
λ_2	λ_5	λ_8
λ_3	λ_6	λ_9

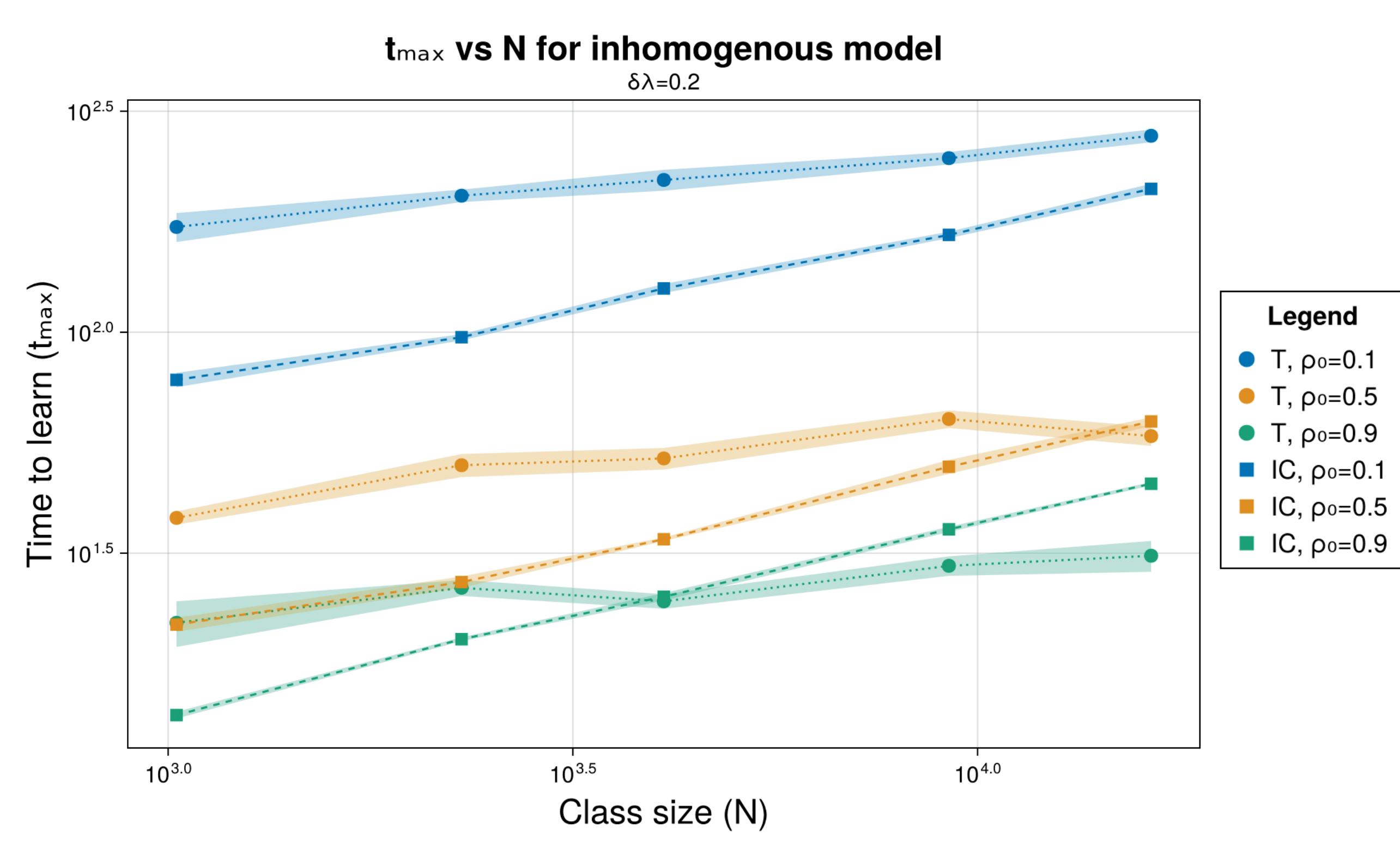
Learning rate matrix Λ

Learning probability:

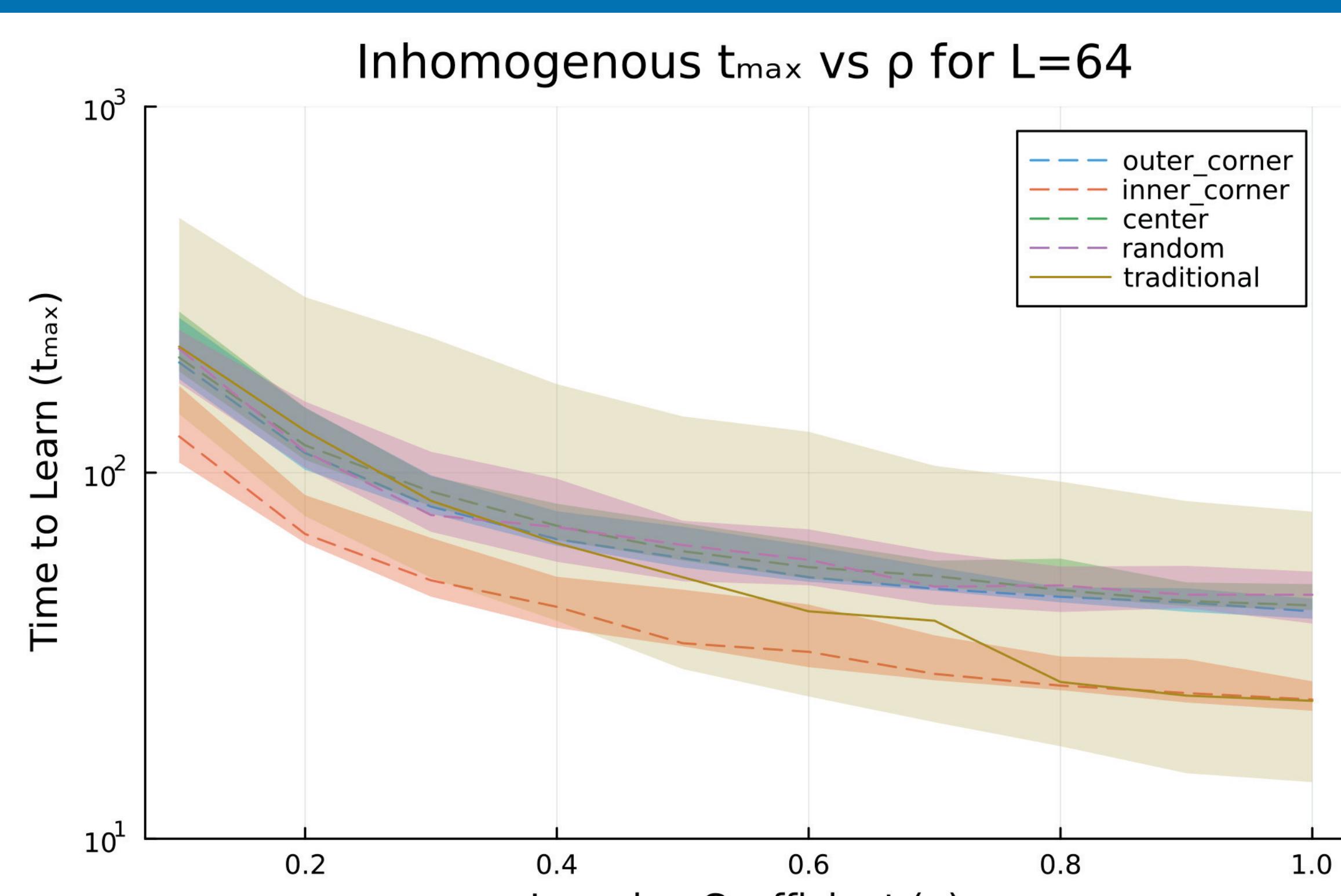
$$P_{ij} = 1 - \prod_{\forall \delta i, \delta j} [1 - (\lambda_{ij})(\rho_{i+\delta i, j+\delta j})(s_{i+\delta i, j+\delta j})]$$

Key results

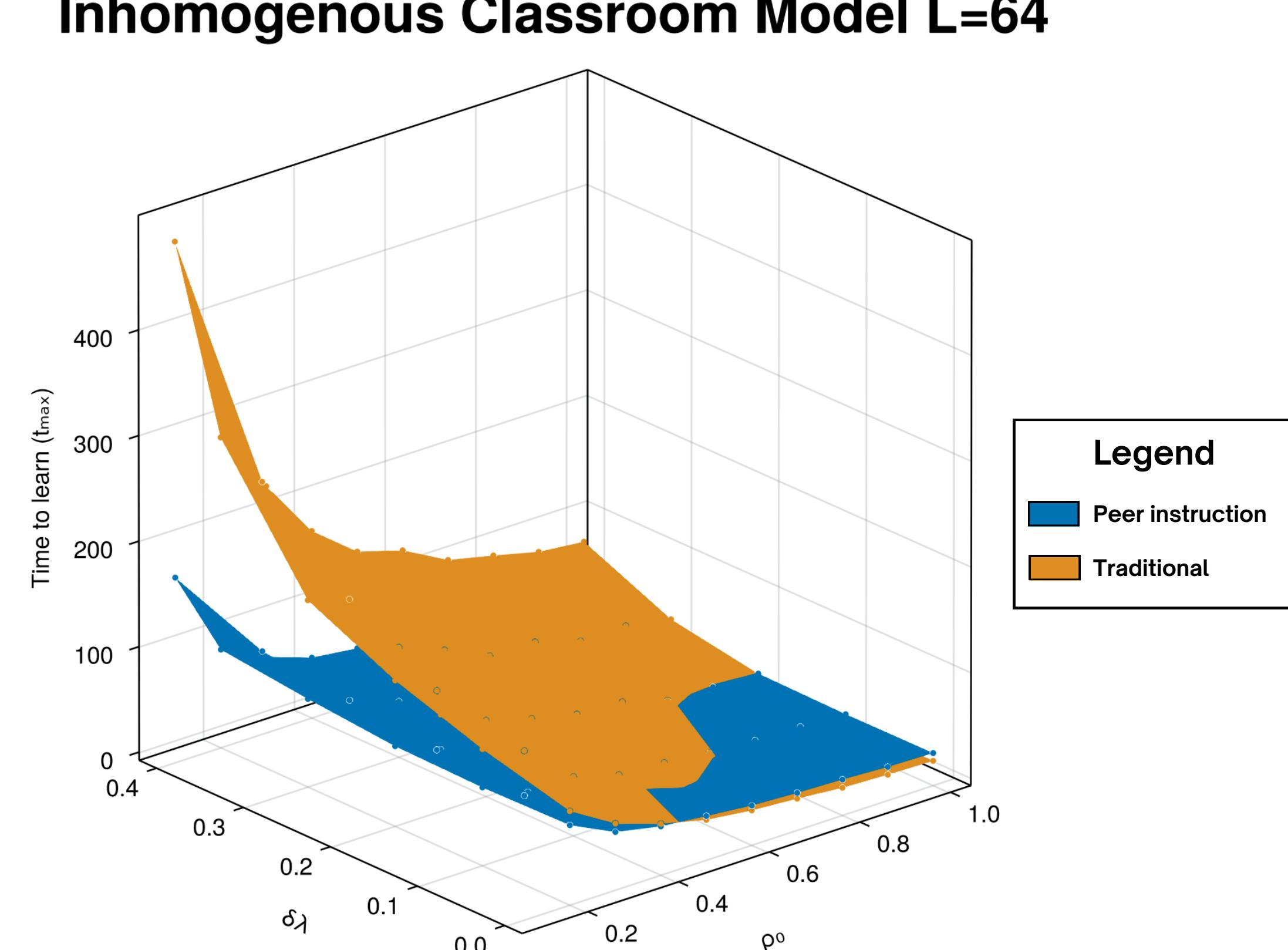
1



2



3



Traditional instruction

- Less dependent on class size than PI 1
- More sensitive to student heterogeneity 2
- Time to learn is heavily dependent on slow learners
- More students learn earlier compared to PI

Peer instruction

- Dependent on classroom geometry and initial conditions
- Less affected by student heterogeneity 2
- Generally lower time to learn 3
- Lower initial class learning rate

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