Session (E) - Solving the BIG Research Questions: Then and Now

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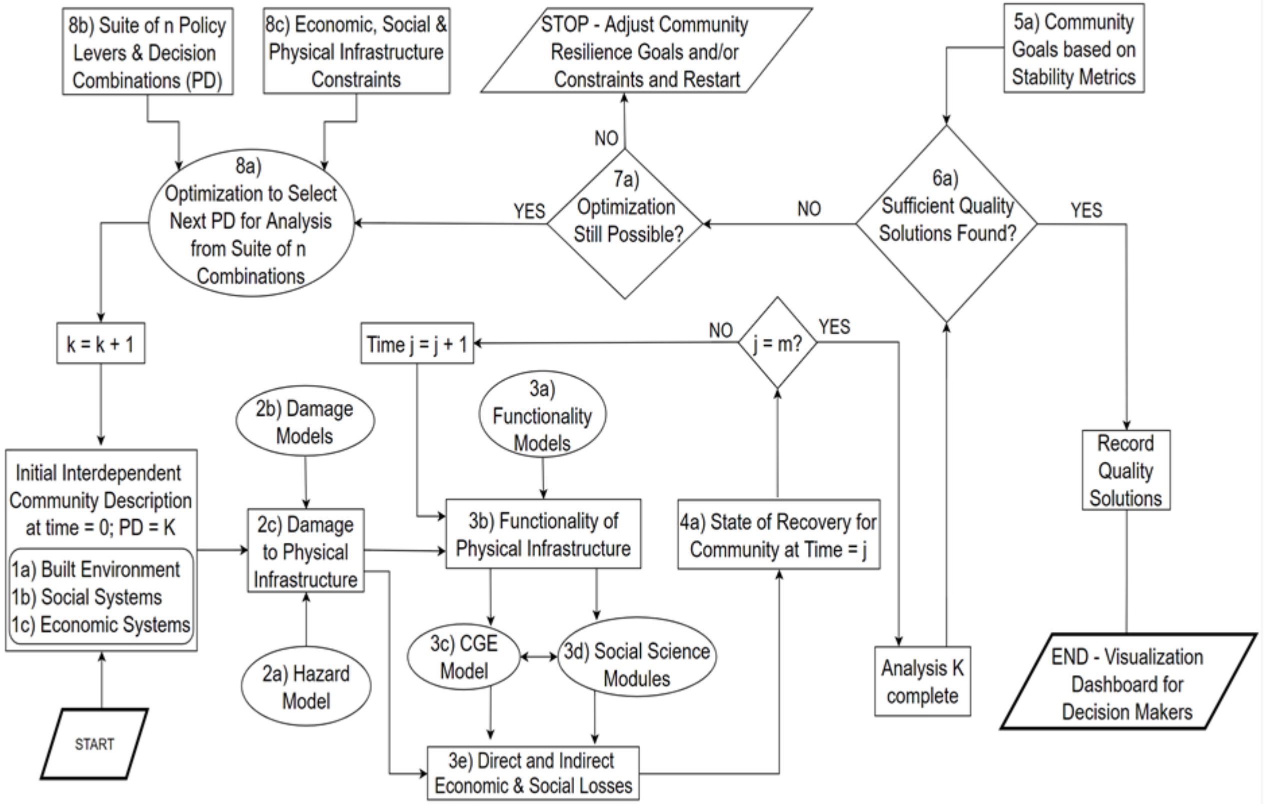
November 8, 2024

Then and Now

Then and Now


8b) Suite of n Policy Levers & Decision Combinations (PD)
8c) Economic, Social & Physical Infrastructure Constraints
STOP - Adjust Community Resilience Goals and/or Constraints and Restart
5a) Community Goals based on Stability Metrics
NO
7a) Optimization Still Possible?
YES
8a) Optimization to Select Next PD for Analysis from Suite of n Combinations
NO
6a) Sufficient Quality Solutions Found?
YES
k = k + 1
Time j = j + 1
NO
j = m?
YES
2b) Damage Models
3a) Functionality Models
Record Quality Solutions
Initial Interdependent Community Description at time = 0; PD = K
1a) Built Environment
1b) Social Systems
1c) Economic Systems
2c) Damage to Physical Infrastructure
3b) Functionality of Physical Infrastructure
4a) State of Recovery for Community at Time = j
3c) CGE Model
3d) Social Science Modules
Analysis K complete
END - Visualization Dashboard for Decision Makers
2a) Hazard Model
START
3e) Direct and Indirect Economic & Social Losses

Responsible Uncertainty Quantification

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Heuristics in Numerical Simulation

UQ Zoo

Fig. 8 presents an example result of the Monte Carlo sampling analysis for a scenario of magnitude 7 on the closest point of any of the three faults. The analysis comprises 200,000 samples. Fig. 8(a) plots the mean

numerical value of the proposed resilience framework in this paper the Monte Carlo Simulation method [44] is used. Since the accuracy of the answers in stochastic Monte Carlo Simulation highly depends on the number of the simulations [45], in this paper, 10000 random scenarios are considered. First, the static computations are done and random scenarios are gene

E7600 @ 3.07 GHz) and the large number of simulations required by SA (for example, more than 10^6 Monte Carlo simulations are required in SA approaches that use a distribution-based SA indicator [18]).

considering uncertainties in the damage, restoration, and performance of infrastructure components. For this purpose, 10,000 simulations are performed for each return period for seismic hazard only, tsunami hazard only, and joint seismic and tsunami hazards. For every simulation, at a given return period, the damage state of all the

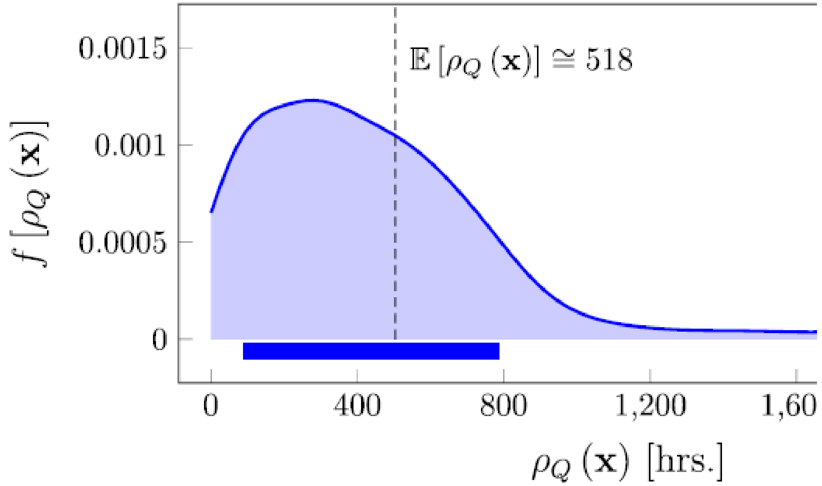
ility

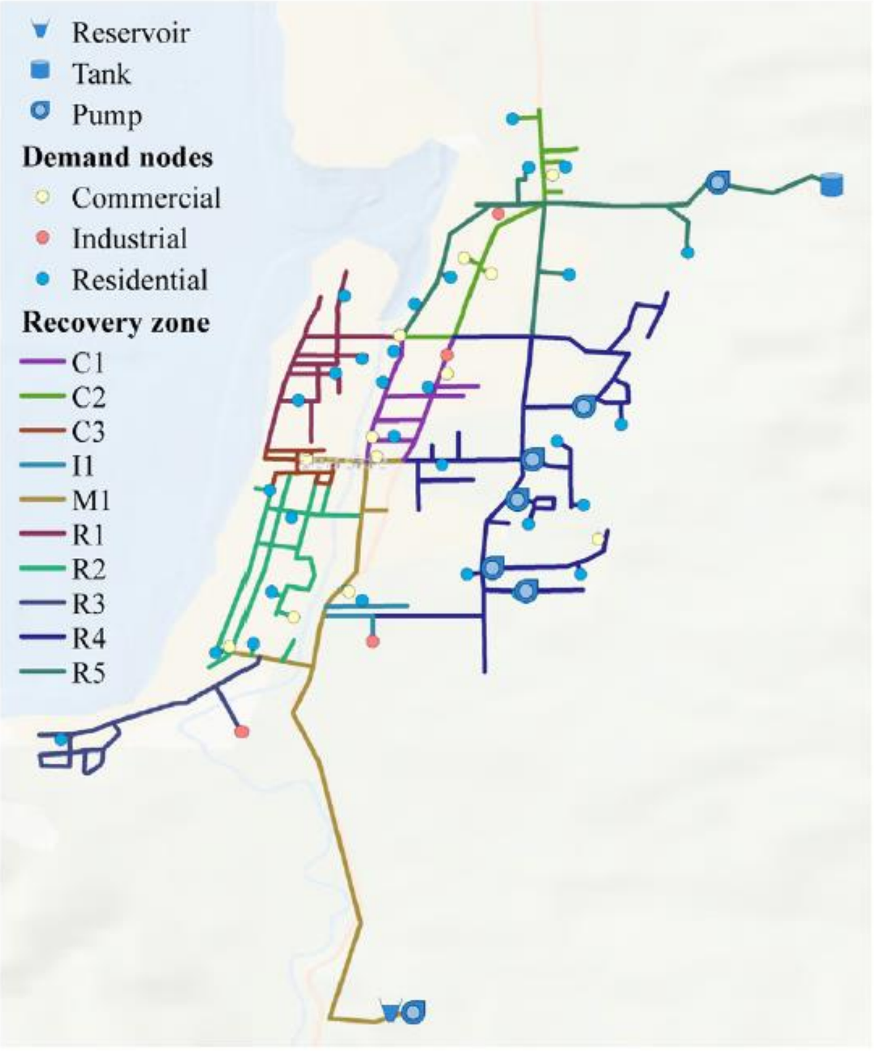
the relationship between ζ and η for the residential and commercial customers in Micropolis. For these simulations, a hurricane occurred only 3257 of 50,000 simulated project-years (6.51%) in Scenario 1, 3242 of 50,000 in Scenario 2 (6.48%), and 3277 of 50,000 in Scenario

One of the drawbacks of such methods is that they are based on sampling techniques such as Monte Carlo that fails to handle long-tail scenarios when the probability of occurrence is very small (e.g., one in one billion) and would require a large number of trials to make the analysis statis-

Establish Acceptable Uncertainty

Cap coefficient of variation c.o.v.

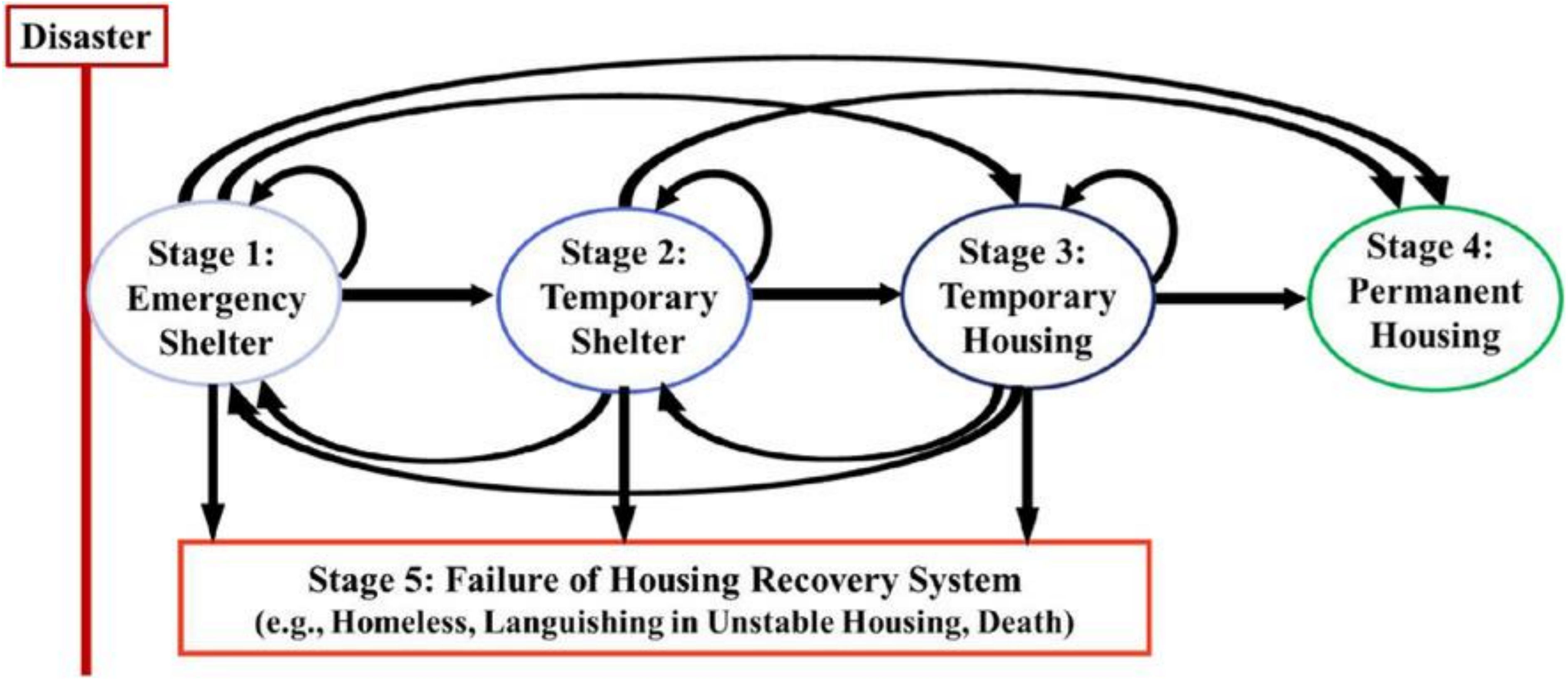




The total number of high-fidelity evaluations for the sensitivity analysis is $(64)(2M)$. The obtained results from the stochastic simulations indicate that with $M = 1,500$ we can satisfy the convergence criterion $\left\| \left[\mathrm{CoV}\left(\hat{\gamma}^{t}_{\mathbf{x}_u,y}\right)\right]_{u\in\mathcal{F}} \right\|_{\infty} \leq 0.05$, where $\mathcal{F}$ is the collection of index sets identifying the groups in Table 3. Fig. 8 shows the predicted

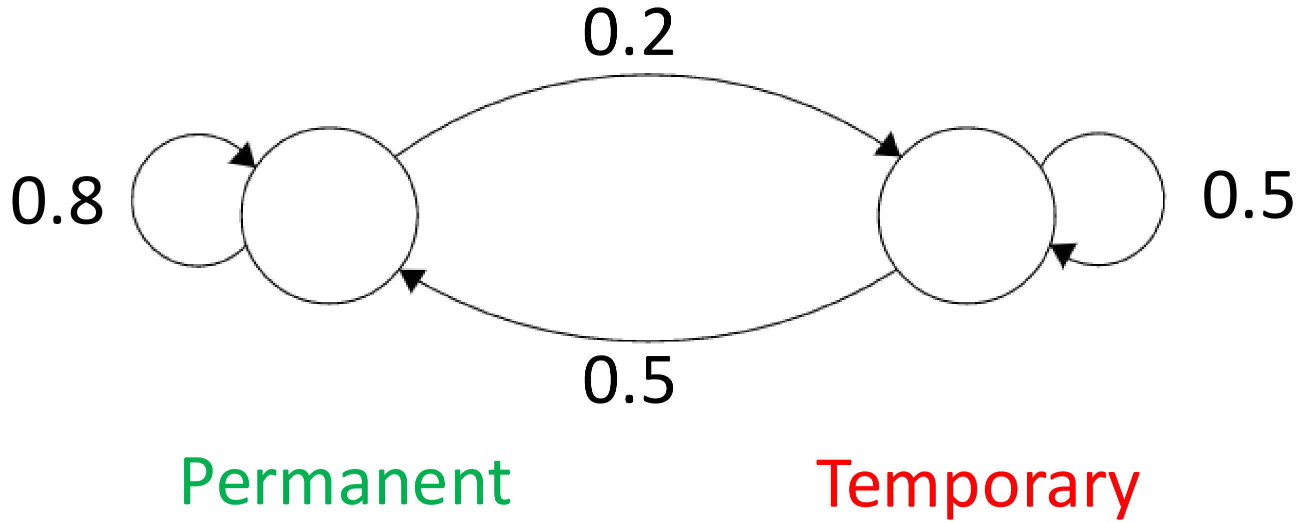
Perform Sensitivity Analyses

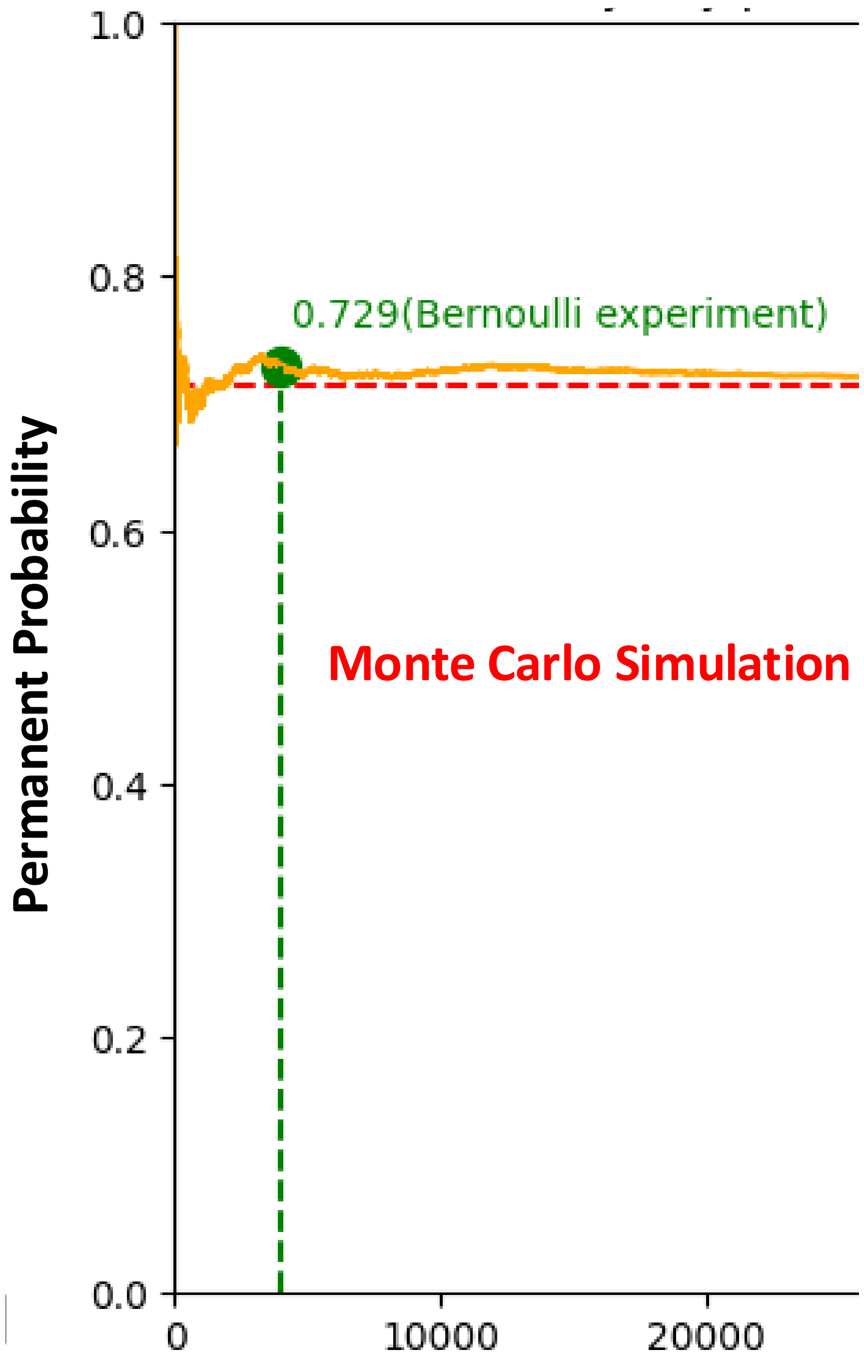
Housing States



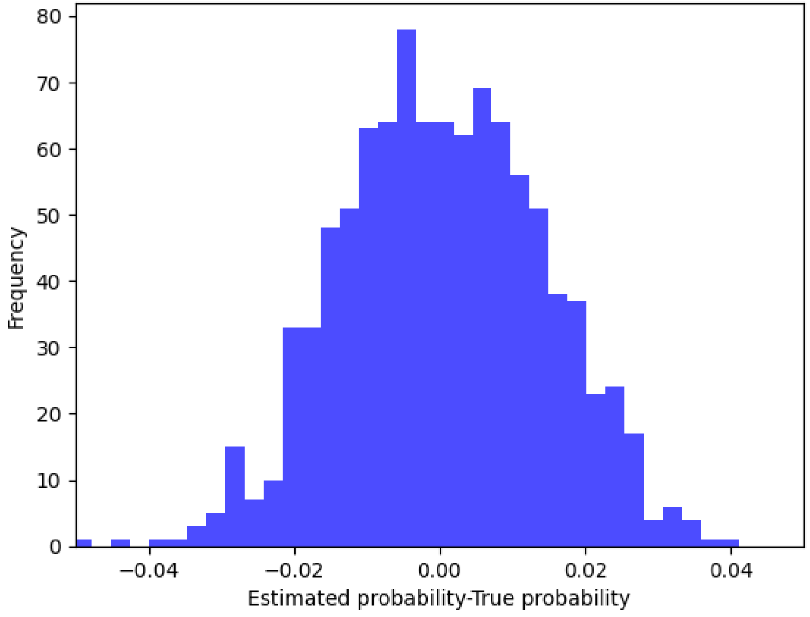
Establish Stopping Rules for Stable Results

Housing
States
Simplified



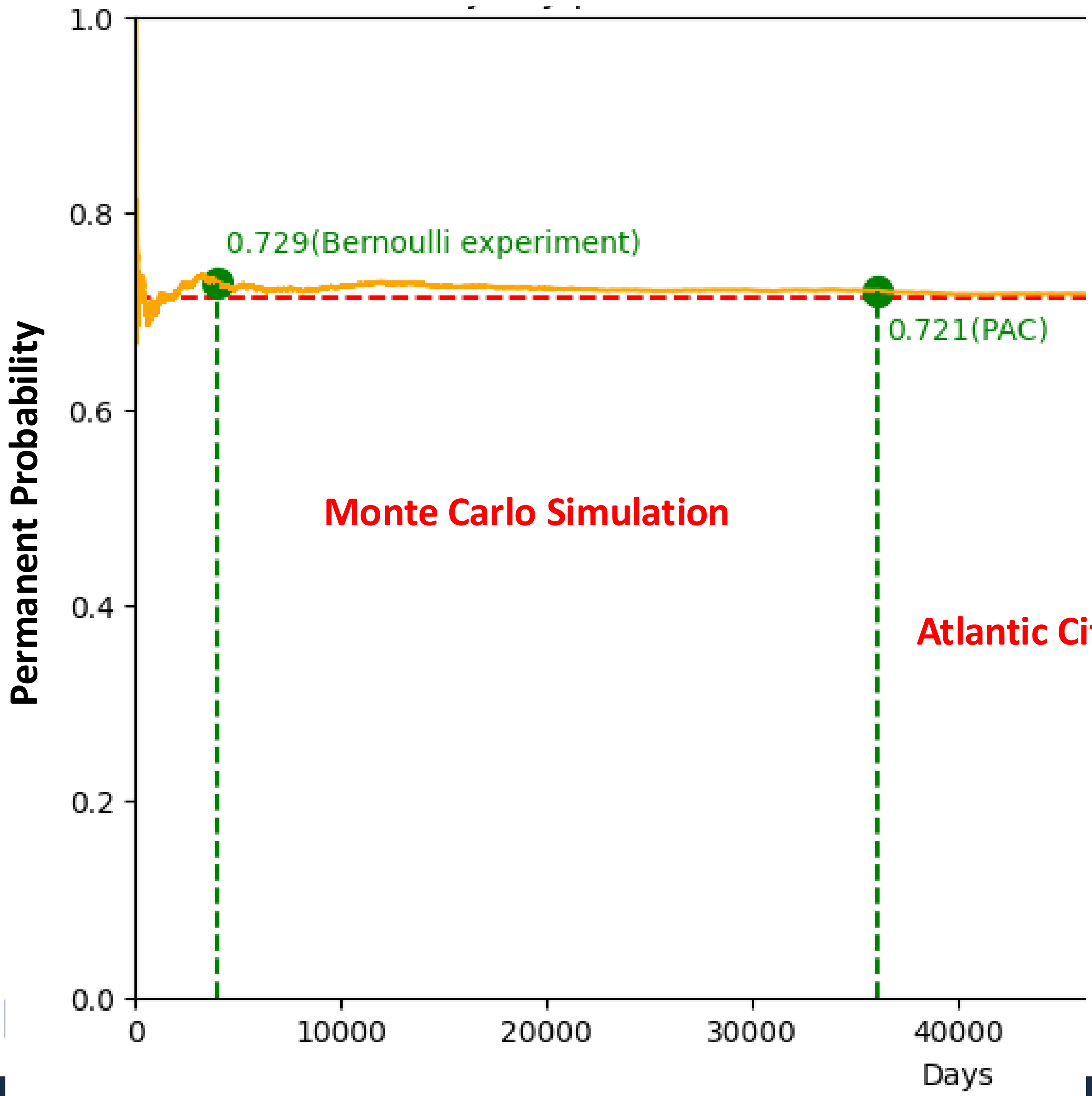


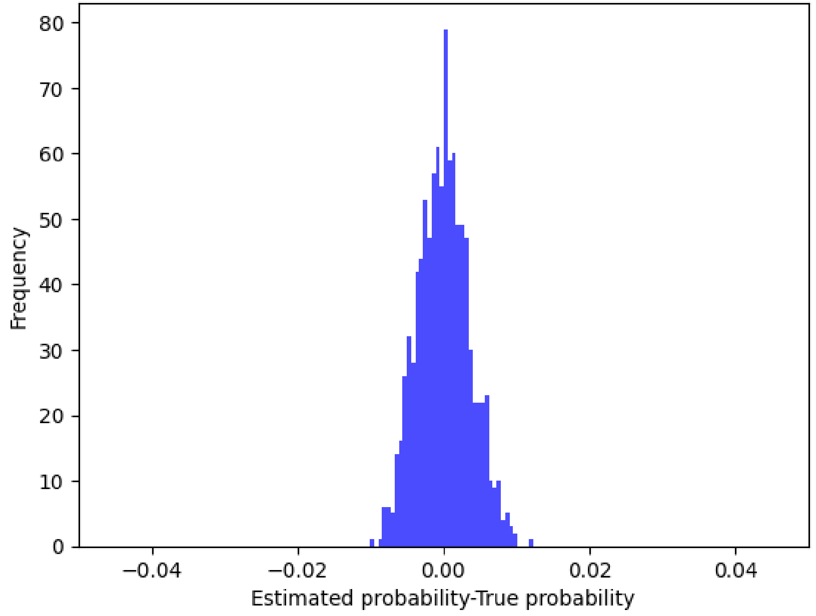
Permanent Probability
0.729(Bernoulli experiment)
Monte Carlo Simulation
1.0
0.8
0.6
0.4
0.2
0.0
0
10000
20000



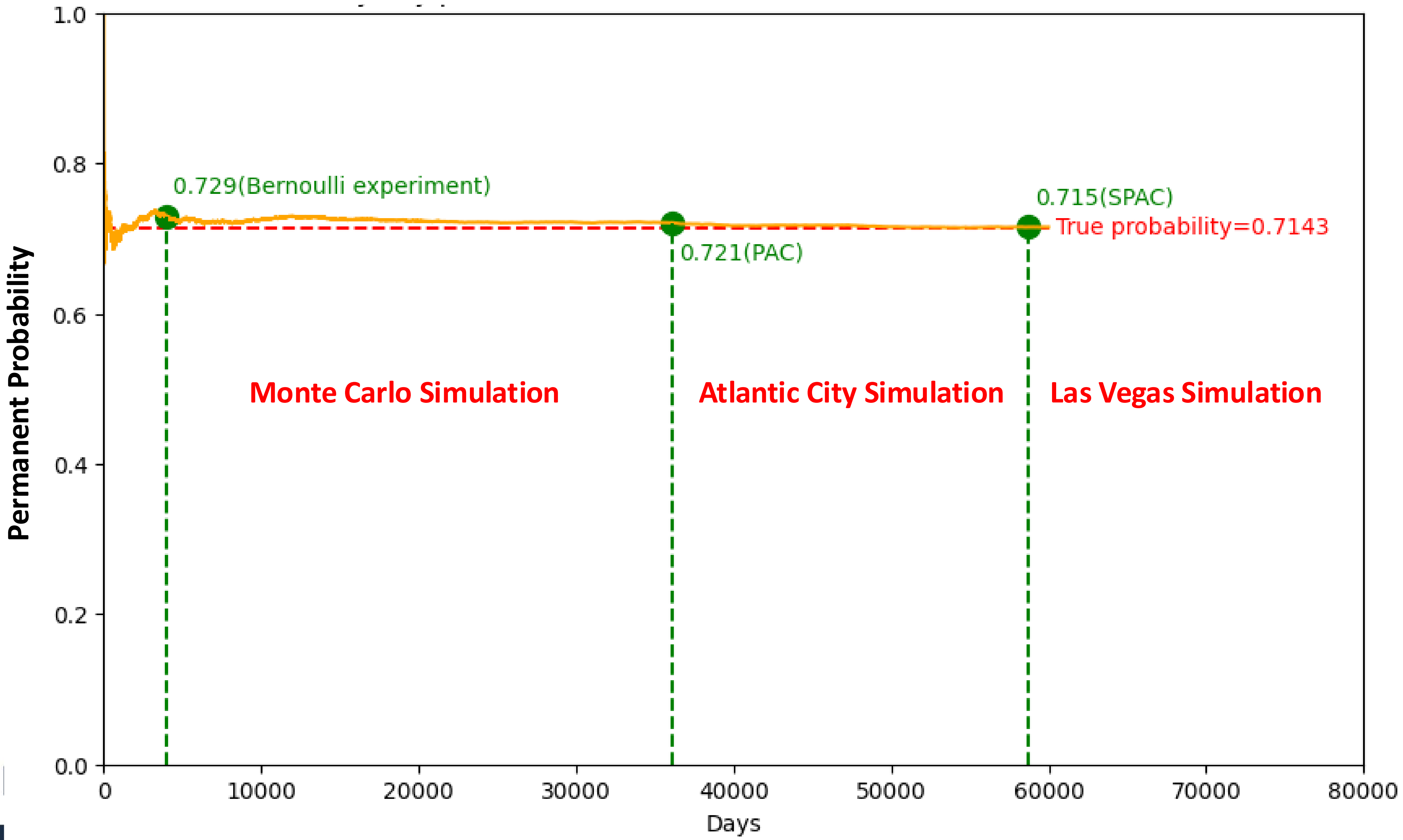
Frequency
Estimated probability-True probability
80
70
60
50
40
30
20
10
0
−0.04
−0.02
0.00
0.02
0.04

Resilience

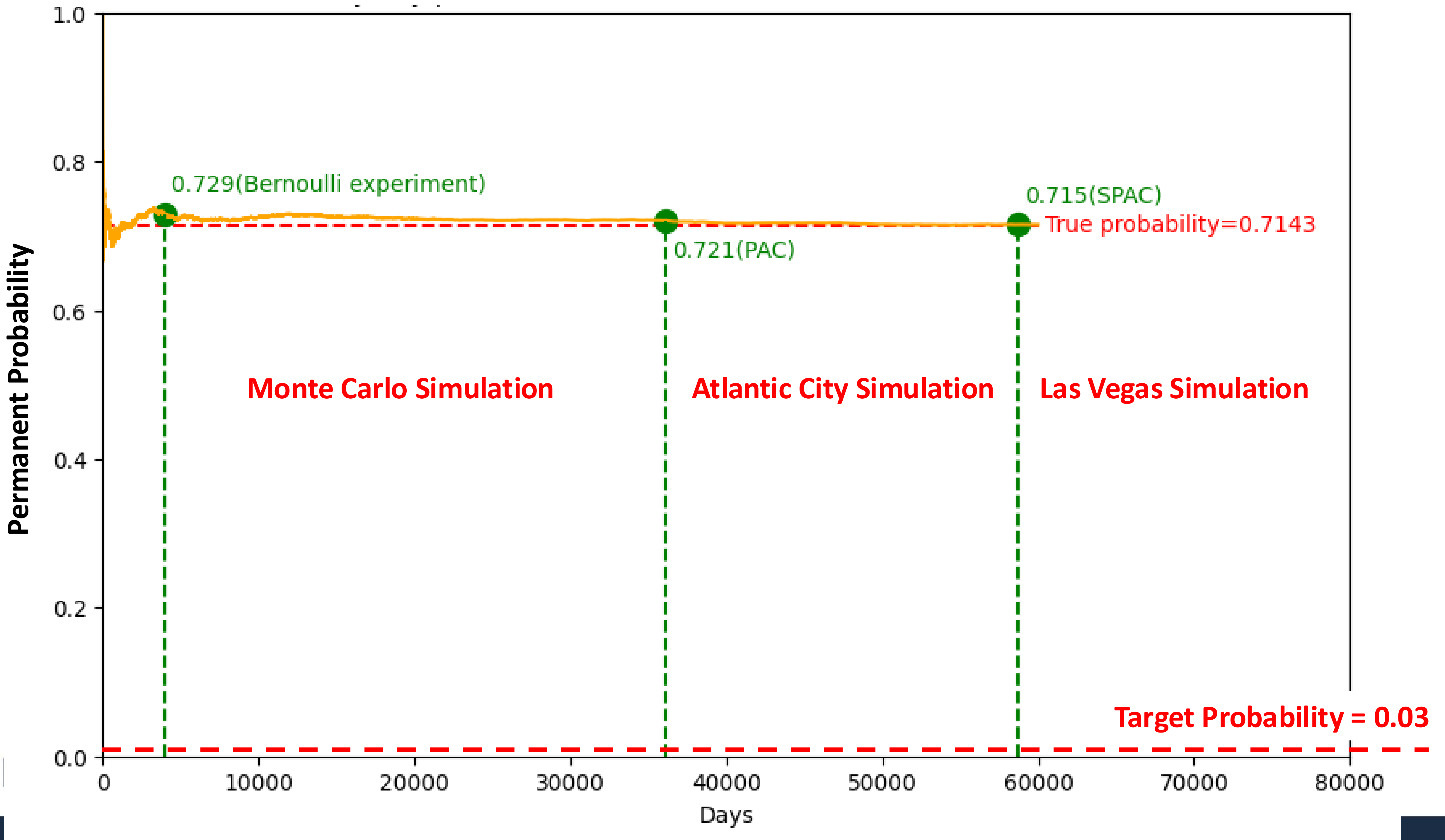




Atlantic City Simulation



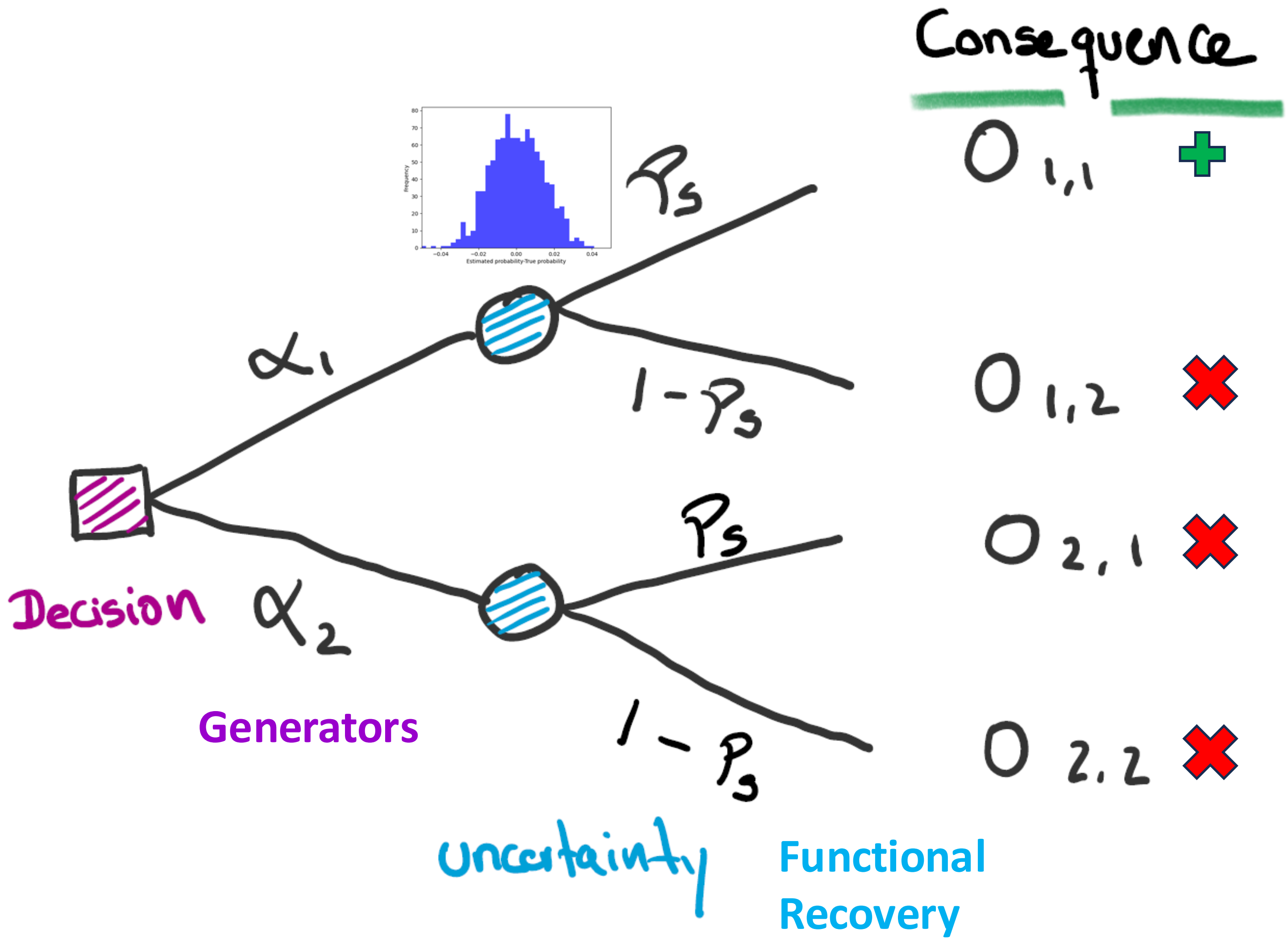
1.0
0.8
0.6
0.4
0.2
0.0
Permanent Probability
0.729(Bernoulli experiment)
0.715(SPAC)
True probability=0.7143
0.721(PAC)
Monte Carlo Simulation
Atlantic City Simulation
Las Vegas Simulation
0
10000
20000
30000
40000
50000
60000
70000
80000
Days



1.0
0.8
0.6
0.4
0.2
0.0
Permanent Probability
0.729(Bernoulli experiment)
0.721(PAC)
0.715(SPAC)
True probability=0.7143
Monte Carlo Simulation
Atlantic City Simulation
Las Vegas Simulation
Target Probability = 0.03
0
10000
20000
30000
40000
50000
60000
70000
80000
Days

Decision Support

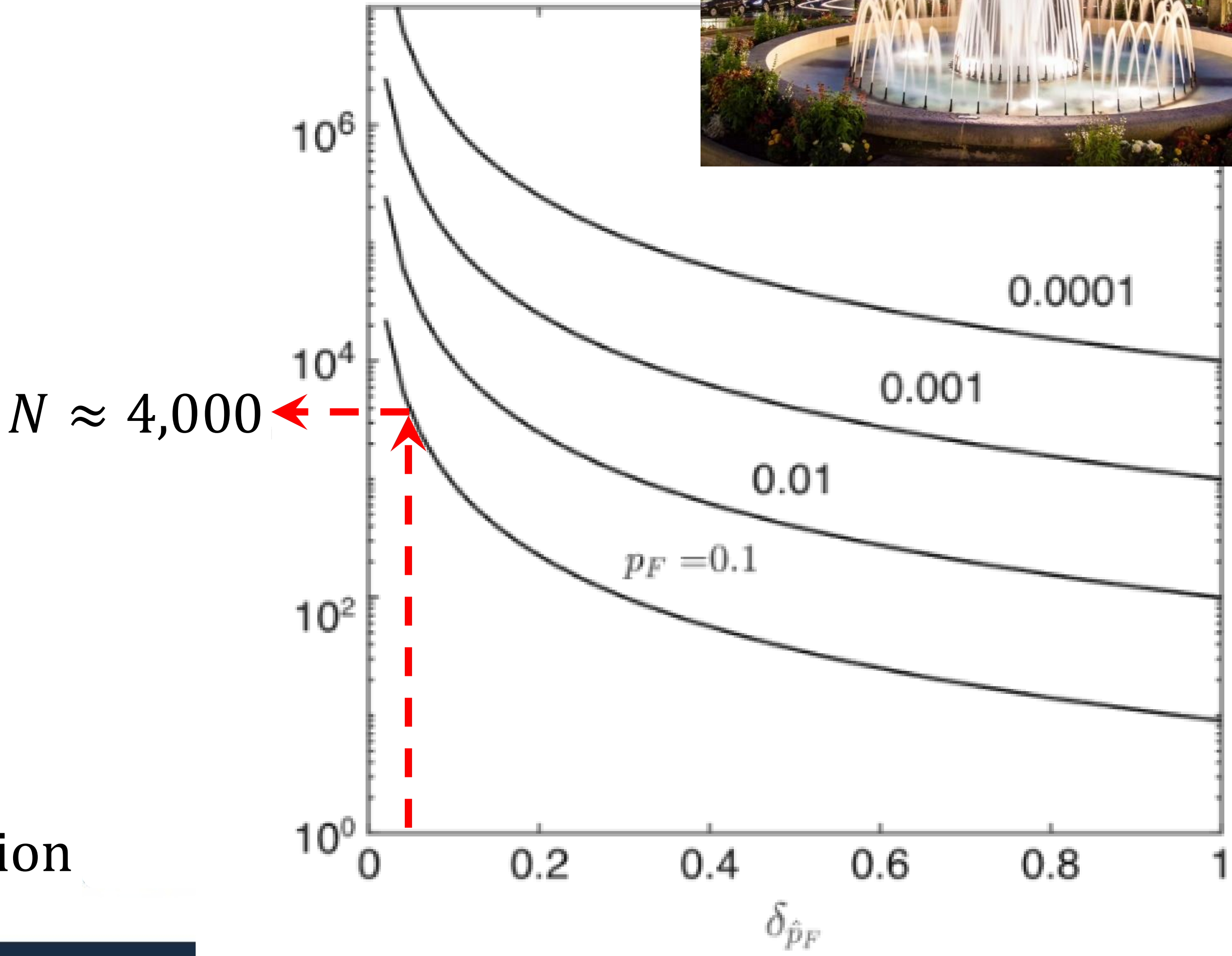
Role of Risk Attitudes and Uncertainty on Outcomes



Prescriptive Stopping Rules

Risk Attitude in External Uncertainty

$$N = \frac{1 - p_f}{p_f \cdot \delta^2_{\hat{p}_f}}$$



N := Sample size

p_f := Prof. of failure

$\delta_{\hat{p}_f}$:= Coeff. of variation