시뮬레이션 기초이론

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시뮬레이션의 정의

- Simulation is the ***process*** of designing a ***model*** of a ***real system*** and conducting ***experiments*** with this model for the purpose of understanding the ***behavior of the system*** or of ***evaluating various strategies*** for the operation of the system.

- ***Experimentation*** with ***dynamic models.***

- 문제 해결을 위한 도구(Tool), 모델을 바탕으로한 실험, 시스템의 이해,대안의 예측 또는 최적화를 목적으로 함.

컴퓨터 시뮬레이션의 수행이유

실제 실험 수행의 문제 :

- 위험성 (예 : war game)
- 시간 (예 : 생태환경)
- 비용 (예 : space shuttle)
- 부작용 (예 : hauthon effect)

컴퓨터 시뮬레이션만의 기능 :

- Back Track and Replay
- Freeze
- Malfunction
- Override

시뮬레이션의 대상

시스템의 정의 :

- 특정한 목적을 위해 서로 연관관계를 갖는 element들의 집합으로 주위 환경으로부터 구분되어지는 것

- A collection of interacting elements that function together for some purpose

- A collection of inputs whose pass through certain processing phases to produce outputs

시스템의 구성

요소 : Entity
Attributes
Activity

예 :

System	Entity	Attiribute	Activities
Aircraft	Autopilot Aerilons Airframe	Error Angle Heading	Signaling Forcing Turning
Factory	Workpieces Machines Markets	Number Capacity Size	Ordering Machining Scheduling
Business	Products Customers Markets	Price Demand Size	Manufacturing Selling Advertising
Political	Parties Issues Social groups	Size Acceptance Income	Fund raising Campaigning Migrating

시뮬레이션의 적용분야

- Computer System (network,circuit design)
- Flow process (oil,gas,water etc.)
- Game, Educational Modeling
- Health care system
- Manufacturing system
- Marketing and Sales modeling
- Military
- Traffic control
- Aircraft and Airport operation
- Financial modeling
- Governmental and urban planning
- Etc

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시뮬레이션의 종류

- Monte Carlo System Simulation
- Discrete System Simulation
- Continous System Simulation
- Combined Discrete-Continous Simulation

시뮬레이션 과정

- 시스템 분석과 문제의 정의
- 모델 구축
- 타당성 검증
- 실험 계획
- 실험 수행
- 결과 분석
- 문서화

문제의 정의와 시스템 분석

- Formulate of problem

  $Pt = | Dt - At |$

- System의 Boundary와 Environment의 구분

- Real System

  ||

  Abstraction ..... *Entity*

  Simplification ..... *Activity*

  Approximation ..... *Attributes*

  ⇓

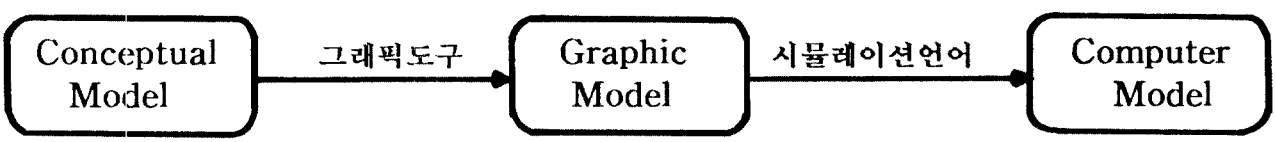
  Logical flow-diagram

  or

  Static Model

구축 단계

실시스템에
대한 이해



PERT
CP/M
Petri-Net
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GPSS
SIMSCRIPT
SLAM
SIMAN
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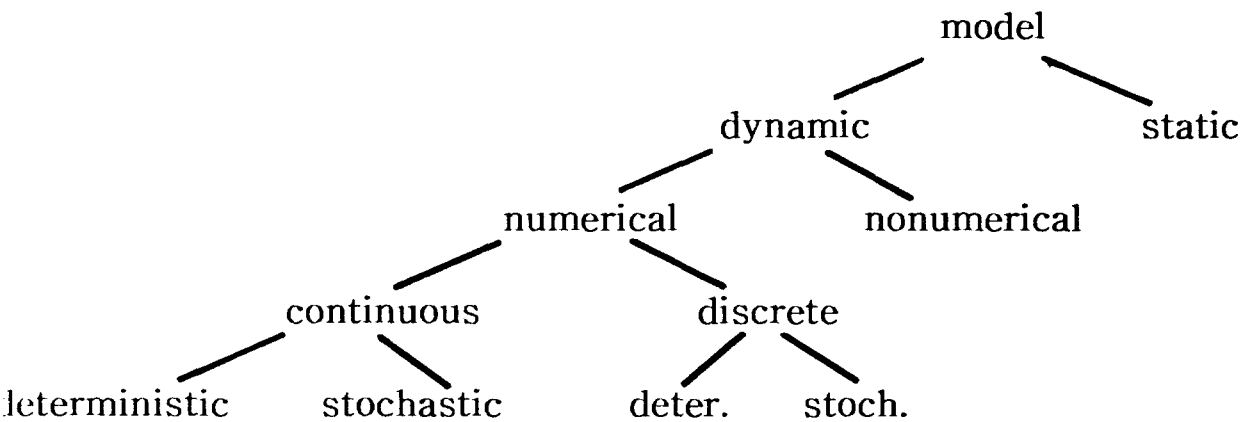
모 델

정의 :

- A model is a representation of an object, system or idea in some form other than that of the entity itself
- A simplified representation of a system

구분 :



타당성 검증

Verification

Validation

- Concept
- Methodology
- Results
- Inference
- Data

Problem Analysis

실험계획

원칙 - 최소 수행 횟수

목적 - 분석 , 관찰

방법 - parameter, 변수의 level들의
다양한 조합 수행
- 초기, 종료 조건
- sample size
- 결과의 차이 축소

실험 수행

Execution
Sensitivity Analysis

결과 분석과 문서화

시뮬레이션을 위한 기초 통계

개념 :

Continous Distribution
Discrete Distribution

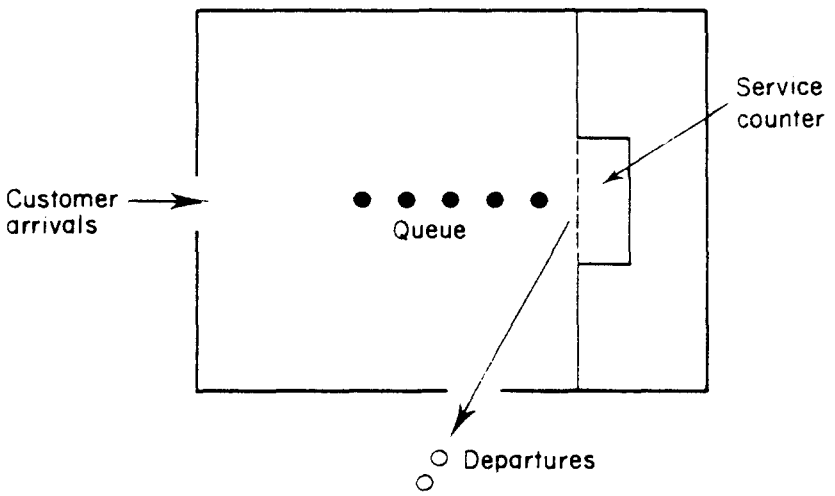
PDF(Probability Density Function)
CDF(Cumulative Distribution Function)

Random Number
Random Variate

Correlation
Covariate

Hypothesis Test
Confidential Interval

DISCRETE SYSTEM SIMULATION의 예



Post office system.

- single-server-single-queue system
- FIFO
- 목적(관찰 대상)
  - customer arrival rate
  - service rate
  - server utilization
  - average queue length
  - average number in the system
  - average waiting time
  - average time spent in the system

Observed Data for 2 hours

Customer i	Arrival time	Inter-arrival time	Time service begins	Time service ends	Service time, S_i	Waiting time in queue, W_i	Time spent in system, $(W_i + S_i)$
1	15	15	15	20	5	0	5
2	17	2	20	23	3	3	6
3	19	2	23	27	4	4	8
4	30	11	30	31	1	0	1
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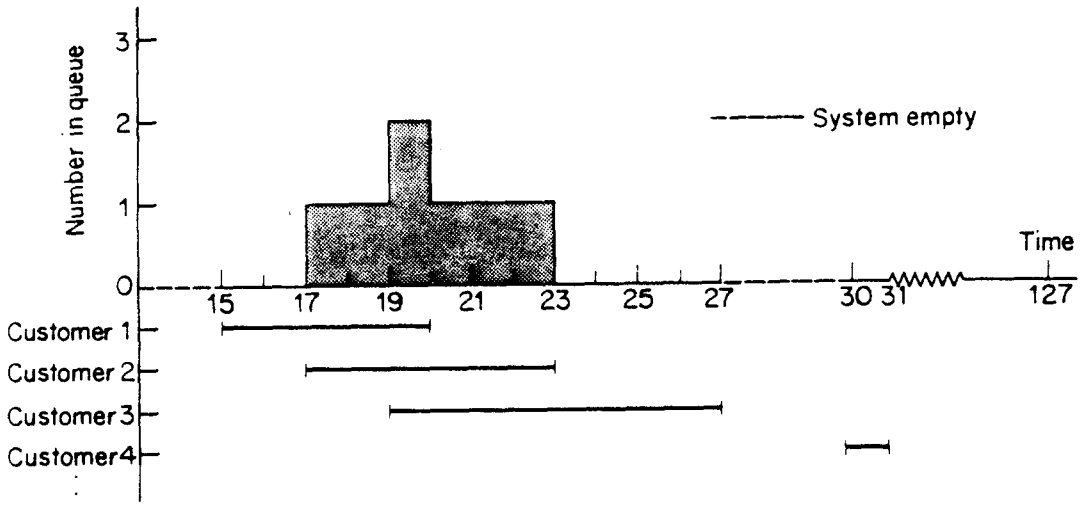
25	120	3	122	127	5	2	7
					$\Sigma S_i =$ 71	$\Sigma W_i =$ 100	$\Sigma (W_i + S_i)$ = 171

Observed data (time in minutes) for post office system.

- Total number of arrivals :N = 25
- Arrival time of the last customer :T' = 120
- Departure time of the last customer: T = 127



Observed number of customers in the queue.

i	No. of customers in queue, m_i	No. of customers in system, n_i	Cumulative time, t_i
1	0	0	56
2	0	1	21
3	1	2	15
4	2	3	20
5	3	4	15
			$\Sigma t_i = T = 127$

Observed cumulative times for customers in queue and in system.

		Approximate Method	Theoretical Method
Average arrival rate	λ	$\frac{N}{T'}$	λ
Average service rate	μ	$\frac{N}{\Sigma S_i}$	μ
Utilization of server	$\frac{\lambda}{\mu}$	$\frac{\lambda}{\mu}$	$\frac{\lambda}{\mu} = \rho$
Average waiting time in queue	W_q	$\frac{\Sigma W_i}{N}$	$\frac{\rho}{(1-\rho)\mu}$
Average time spent in system	W	$\frac{\Sigma(S_i + W_i)}{N}$	$\frac{1}{\mu - \lambda}$
Average number of customers in queue	L_q	$\frac{\Sigma(m_i t_i)}{T}$	$\frac{\rho^2}{1-\rho}$
Average number of customer in system	L	$\frac{\Sigma(n_i t_i)}{T}$	$\frac{\rho}{1-\rho}$

	Approximate method	Theoretical method	Simulation method
Average no. of customers in system, L	1.35	1.43	1.353
Average no. of customers in queue, L_q	0.79	0.84	0.793
Average time spent in system, W	6.84	6.94	6.72
Average time spent in queue, W_q	4.0	4.08	3.94
Utilization of postmaster ρ	0.59	0.59	0.56

Comparison of results (post office) by different methods.