

Homework solution – HW1, due 2/2/04

Consider the following systems. Identify whether each is: stochastic or deterministic, static or dynamic, and discrete-time or continuous-time. Explain your answers:

- 1- Ideal pendulum with fixed length, fixed mass, fixed gravitational field, operating in a vacuum.
 - a. Deterministic – The behavior of the system for all future time can be predicted knowing its current state (position and velocity of pendulum weight) and the fixed parameters of the system (length, mass, and gravitational field).
 - b. Static – The parameters of the system are fixed for all time.
 - c. Continuous-time – The system state changes with no time or value jumps.
- 2- Internet traffic (packets per second) flowing in/out of Stevens Network.
 - a. Stochastic – The agents causing the behavior of the system (users and computers sending or receiving packets) are unpredictable or very complex to model.
 - b. Dynamic – The system parameters are variable with time, e.g., usage.
 - c. Discrete-time – Packet arrival/departures are events that happen at specific times. System behavior between the discrete packet transmission times can be considered to be irrelevant or nonexistent.
- 3- Velocity distribution of water flowing in water pipe at very low speed ($Re < 10$).
 - a. Deterministic – Low Reynolds number means that differential equations can be used to describe the system behavior (laminar flow).
 - b. Static – The system parameters (viscosity of the water, flow rate, pipe size, pressure) are fixed.
 - c. Continuous-time – The system state (e.g., volume of water moved) changes with no time or value jumps.
- 4- Velocity distribution of water flowing in pipe at very high speed ($Re > 100$).
 - a. Stochastic – High Reynolds number means that the flow is turbulent and cannot easily be modeled.
 - b. Static – The system parameters (viscosity of the water, flow rate, pipe size, pressure) are fixed.
 - c. Continuous-time – The system state (e.g., volume of water moved) changes with no time or value jumps.
- 5- Number of raindrops per second hitting a 12" horizontal metal plate during a hurricane.
 - a. Stochastic – The rain drops' arrival times are not predictable individually.
 - b. Dynamic – The system parameters (e.g., instantaneous average rainfall rate) changes with time.
 - c. Discrete-time – The system state (cumulative number of drops that have hit plate) only changes when a drop hits, which is a specific event.
- 6- Number of dots showing on the face of a pair of dice during a game of dice.
 - a. Stochastic – Which die face shows at any point of time in the game is not predictable.

- b. Static – The system parameters (probability of each face showing) does not change during the game.
- c. Discrete-time – System state (current die faces showing) only changes at the specific instant a die is rolled.