GPSS
(Part I)

Discrete Event Simulation
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GPSS

- General Purpose Simulation System Language
- GPSS program consists of sequence of statements

a GPSS statement:

location (optional)	block type name (required)	fields (dpending on block type)	comment (optional)

Terminology

- block diagram
- *blocks* = actvities
- transactions (*Xacts*) = units of traffic moving along the blok diagram
  - air traffic control system: planes moving through a sequence of control zones
  - communication system: messages
  - hospital: patients, equipment, ...

Terminology

- Xacts have unique *id numbers* (positive integer)
- *no Xacts* when simulation begins
- Xacts are *created* and *introduced* into model
- Xacts leave model: *destroyed*
- current block
- next block attempted
  - many Xacts in system
  - only one Xact moves at a time

Terminology

- Xact tries to move from its current block into its next block attempted
- Xact stops moving
  - moves into block that *holds* Xact for a *simulated time*
  - next block attempted *refuses* Xact: blocks Xact
  - moves into block which *destroys* Xact
- when Xact stops, another Xact starts moving
- sources = birth blocks: *create* Xacts
- sinks = death blocks: *destroy* Xacts

Terminology

- simulated clock
  - positive real values
  - time cannot go back in GPSS
  - modeler chooses base time unit
- event scheduling

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Clock value	**Description of events**
clock= 0.0 simulation begins	Xacts created (NOT introduced into system)
clock= earlest time an Xact will come into model	Xact introduced into system Xact moves along its path until it stops
clock= earliest time one or more Xacts scheduled to move	done after no more Xacts can move in current simulated time

Example

- Simulation of a Repair Shop
  - faulty parts (fp) repaired
  - only 1 repairman
  - 8 hour shift

Order of events	Event	Time of occurrence	Simulated time of occurrence
1	shift begins	8:00am	0.0
2	1st fp arrives, repair begins	8:22:30am	22.5
3	2nd fp arrives, waits repair	8:36:12am	36.2
4	3rd fp arrives, waits repair	8:40:18am	40.3
5	repair of 1st fp ends, repair of 2nd fp begins	8:42:36am	42.6
...	...	...	...

Example

simulated clock time	**description of events**
0.0	Xact for fp1 created and scheduled to come into system at 22.5
22.5	fp1 introduced into system, Xact for fp2 cretaed and scheduld to come into system at 36.2, repair of fp1 begins (Xact moves into block which will hold it until 42.6 to simulate repair action)
36.2	fp2 introduced into system, Xact for fp3 cretaed and scheduld to come into system at 40.3, fp2 waits
40.3	fp3 introduced into system, Xact for fp4 cretaed and scheduld to come into system at 42.6, fp3 waits
42.6	fp1 frees repairman and leaves system; repair of fp2 begins
...	

GPSS Statements

- block statements
  - correspond to blocks in diagram
  - executed when Xact enters
  - block statements
    - has unique locations
      - provided by system
    - may have labels
      - given by modeler
    - operation keyword
    - may have operands
      - some may have defaults

GPSS Statements

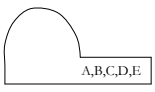
- control statements
  - do not correspond to blocks
    - not shown in diagram
  - some may have labels
    - for some labels not allowed
  - has operation keyword
  - may have operands
    - some have defaults

GPSS Statements

- comments statements
  - used for comments
- compiler directives
  - used as directives for compiler

Block Statements

- GENERATE A,B,C,D,E
  - create Xact for future entry into system
  - birth block
    - A: mean value of interarrival time
    - B: half-range of interarrival time
      - $B \leq A$
    - C: start delay time
    - D: creation limit
    - E: priority
- interarrival time uniformly distributed in $A \pm B$
- self-propagating



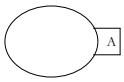
Block Statements

- GENERATE example

  GENERATE 15.0,4.5
  - interarrival times uniformly distributed in (10.5, 19.5), i.e. 15.0±4.5
  - at time 0.0 1st Xact created
  - interarrival time chosen randomly (e.g. 16.7)
  - Xact scheduled to move into system at 16.7 (0.0+16.7)
  - at time 16.7 1st Xact leaves block, 2nd Xact is created
  - interarrival time is chosen randonly (e.g. 14.3)
  - Xact scheduled to move into system at 31.0 (16.7+14.3)
  - at time 31.0 2nd Xact leaves block, 3rd Xact is created
  - ...

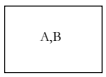
Block Statements

- TERMINATE A
  - destroys an Xact
  - block never denies entry
  - death block
  - A: termination count decrement
  - when an Xact moves into block, TC is decremented by value of A
  - may be more than one TERMINATE block
    - only one TC
  - when TC≤0, simulation stops



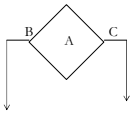
Block Statements

- ADVANCE A,B
  - delay movement
    - A: mean value for delay amount
    - B: half range for delay amount
  - delay amount uniformly distributed in A±B



Block Statements

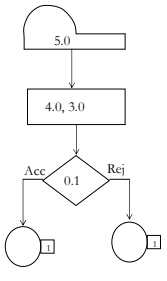
- TRANSFER A,B,C, D
  - jump to new location
  - A: probability or mode
    - determines which block to choose
    - probability shows transfer to location C
    - if empty: unconditional transfer to location B
    - Both: chooses empty block (B first if both empty)
  - B: block location
  - C: block location
  - D: increment for ALL mode



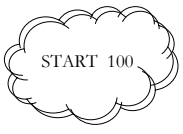
Example: Manufacturing Shop

A machine tool in a manufacturing shop is turning out parts at the rate of every 5 minutes. As they are finished, the parts are turned over to an inspector who takes 4±3 minutes to examine each one and rejects about 10% of the parts as faulty. Each part will be represented by an Xact and the base time unit for the system is chosen as 1 minute. Simulate for 100 parts to leave the system.

Example: Manufacturing Shop




```
        GENERATE  5
        ADVANCE   4,3
        TRANSFER  0.1,ACC,REJ
ACC     TERMINATE 1
REJ     TERMINATE 1
```



Example: Manufacturing Shop

What if asked to simulate system for 100 **faulty** parts to leave the system ?

```
        GENERATE   5
        ADVANCE    4,3
        TRANSFER   0.1,ACC,REJ
ACC     TERMINATE  0
REJ     TERMINATE  1
```