

Modul OMSI-2 ***im SoSe 2010***

Objektorientierte Simulation ***mit ODEMx***

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5. GPSS

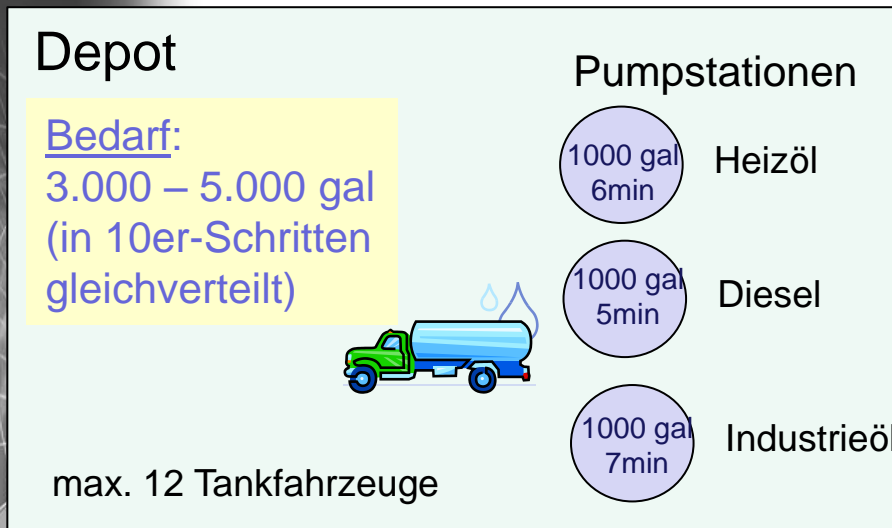
1. Grundphilosophie
2. Aktivatoren und Ereignisverwaltung
3. Einfaches GPSS-Beispiel
4. Block/Stations-Übersicht
5. Komplexeres Beispiel?

Beispiel: Treibstofflager

vertreibt 3 Treibstoffarten:

- Heizöl (privater Wohnbereich)
- Dieselkraftstoff (Kraftfahrzeuge)
- Industrieöl

1 Gallone [gal] = 3,78541178 Liter [l]



Pumpzeit ~

- Pumprate der Station
- angeforderte Menge
- Anzahl der Tankfahrzeuge im Depot
(30 s zusätzlich je Fahrzeug)
- Vorbereitungszeit (2 min)

Ankunftszeit ~

- Mittel 18 min

Schwankung (+/-)

Häufigkeit ($0 \leq p < 1$)	.20	.40	.25	.15
Abweichung vom Mittel [min]	.45	.60	1.5	2.0

Untersuchungsziel:

1. Simulation des Betriebes für 5 Tage
2. Bestimmung der Verteilungsfunktion der Fahrzeugverweildauer im Depot
3. Gesamtmenge an verkauften Kraftstoff pro Tag

```

; GPSS World Sample File - OILDEPOT.GPS, by Gerard F. Cummings
*****
*      Oil Storage and Distribution Depot      *
*      Time Unit Is One Minute                *
*****
RMULT      5631, 39941
Arr        FUNCTION  RN2,C5          ;Arrivals frequency
0,0/0.2, .45/.6,1/.85,1.5/1.0,2
Pumprate   FUNCTION  P$type,L3      ;Mins to pump 1000 gals
1,6/2,5/3,7
Gals       VARIABLE  (RN1@201+300)#10
Type       VARIABLE  RN1@3+1
Pump       VARIABLE  (FN$Pumprate#P$Gals)/1000+S$Depot/2+2
Depot      STORAGE   12              ;Room for 12 trucks max
Transit    TABLE    M1,10,10,20     ;Time of truck in depot
Qty        TABLE    X$Gals,20000,20000,9 ;Qty of oil sold per day
*****
GENERATE    18, FN$Arr          ;Truck arrivals;
ASSIGN      Gals,V$Gals        ;P$Gals=Number of gals
ASSIGN      Type,V$type        ;P$type=Type of oil
ENTER       Depot              ;Truck enters depot
QUEUE       P$type             ;Queue for type of oil
SEIZE       P$type             ;Get a pump
DEPART     P$type              ;Depart the queue
ADVANCE     V$Pump              ;Service time pumping
RELEASE     P$type              ;Release the pump
LEAVE       Depot              ;Truck leaves the depot
SAVEVALUE   Gals+,P$Gals        ;Tally no. of gals sold
TABULATE    Transit            ;Table of transit times
TERMINATE   ;Truck departs
*****
GENERATE    480                 ;One transaction per day
TABULATE    Qty                 ;Record no. of gals sold
SAVEVALUE   Sold+,X$Gals        ;Record total oil sold
SAVEVALUE   Gals,0              ;Savevalue set to 0
TERMINATE   1                   ;One day has passed
*****

```

Struktur des GPSS-Simulationsmodells

4 Teile (getrennt durch Kommentarzeile)

1. Kommentarkopf

Problem, Autor

2. Deklarationen/
Initialisierungen

3. Transaktionslebenslauf
(Tankfahrzeuge)

4. Transaktionslebenslauf
(Tagesablauf)



Tool-bedingte Kommandos zur
Steuerung von
Simulationsläufen

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TABULATE  Transit              ;Table of transit times
TERMINATE
```

```
*****
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```
*****
```

Kommentar: Modellbeschreibung

Zufallszahlenstartwerte (optional):
RN1: 5631, RN2: 39941

Deklaration von

- Funktionen: Arr, Pumprate
- Ausdrücken: Gals, Type, Pump
- Speichern: Depot
- Histogrammen: Transit, Qty

Implizite Deklaration von

- Transaktionsparametern:
 - Gals,
 - Type {1, 2, 3}
- Einrichtungen {1,2, 3}
- Wartschlangenstatistiken {1, 2, 3}

-globalen (Gleitkomma-)Variablen (0-initilisiert)

- Gals
- Sold

Indirekte Adressierung

Lebenslauf von Fahrzeug-Transaktionen

- (Kraftstoffmenge, Kraftstoffart)
- Benutzung einer Kraftstoffart-spezif. Einrichtung (Tanksäule)
- Bedienungsdauer (~ benötigte Menge)

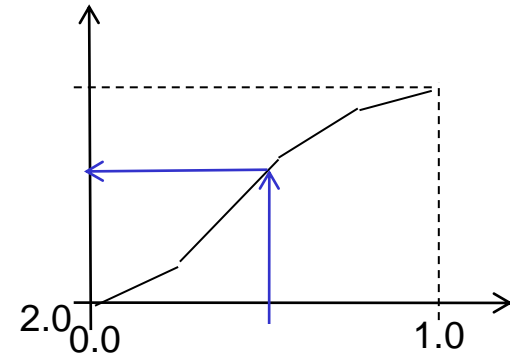
Lebenslauf einer 8h-Schicht-Transaktion
(1 Schicht pro Tag)

```

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SEIZE     P$type                      ;Get a pump
DEPART    P$type                      ;Depart the queue
ADVANCE   V$pump                      ;Service time pumping
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```

Deklaration von
- Funktion: **Arr**



Inverse empirische Verteilungsfunktion

Name: **Arr**

Basis-(0,1)-Generator: **RN2**

Typ der stochastischen Variable: **C** (stetig)

Anzahl der Stützstellen: **5**

Angabe der Wertepaare: ...

Deklaration von

- Funktion: **Pumprate**

Liste

Name: **Pumprate** (x min für 1000 gal)

Anzahl der Einträge: **3**

Definitionsbereich: Parameter **Type**
von **LKW-Transaktion**

Rate der Station **1**: **6** min

2: **5** min

3: **7** min

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Transit    TABLE    M1,10,10,20      ;Time of truck in depot
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```

Deklaration von Ausdrücken

- RN1: liefert Wert aus [0, 999]
- @: ganzzahliger Divisionsrest : RN1@201 [0, 200]
- +: Summe: RN1@201 + 300 [300, 500]
- #: Produkt: (RN1@201 + 300)*10 [3000, 5000]

RN1: liefert Wert aus [0, 999]

- @: ganzzahliger Divisionsrest : RN1@3 [0, 2]
- +: Summe: RN1@201 + 1 [1, 3]

FN –Funktionsaufruf von Pumprate

- Transaktions-Parameter Type liefert Index i {1,2,3} der Liste
- #: Produkt: ... # Transaktions-Parameter liefert Pumpzeit für zu pumpende Menge
- / Division: 1000 (Normierung)
- + (Summe): (halbe Minute je Fahrzeug im Depot) ... +S\$Depot/2
- + (Summe): 2 Minuten zusätzlich

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```

Deklaration des Speichers Depot
- Kapazität 12 Transaktionen (hier: LKWs)

Deklaration von Histogrammen

Transit

Wert: bisherige Transaktions-Lebensdauer

M1

untere Schranke: 10

Schrittweite: 10

Klassenanzahl: 20

Qty

Wert: globale Variable

Gals

untere Schranke: 20000

Schrittweite: 20000

Klassenanzahl: 9


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```

GENERATE (Operand A & B)

1. Fall – Operand B ist kein Funktionsaufruf:

Zwischenankunftszeit ermittelt sich zufällig entsprechend einer stetigen Gleichverteilung im Intervall [A-B,A+B]

2. Fall – Operand B ist ein Funktionsaufruf:

Zwischenankunftszeit ermittelt sich als Produkt aus A und dem Funktionswert als Rückgabe der Funktion (hier z.B. 18*1.5)

GENERATE (nur Operand A)

Operand A:

Zwischenankunftszeit
fester Wert:
480
(8h = 480 min)

Reduktion des Startzählers
um 1

```

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```

Parameter-Wertzuweisung

Gals (Parameter der aktuellen Transaktion)

erhält Wert als Ergebnis des Ausdrucks (Variable) **Gals**

als Tankvolumen

Parameter-Wertzuweisung

Type (Parameter der aktuellen Transaktion)

erhält Wert als Ergebnis des Ausdrucks (Variable) **Type**

als Kraftstoffart

Befahren des **Depots** (evtl. Blockierung in impliziter DelayQ) – Warten vor **Depot**

Verlassen des **Depots** (evtl. De-Blockierung wartender LKWs vor **Depot**)

Akkumulation der Tankmenge

Histogramm-Aktualisierung (Zeit im Depot, mit Blockierung)

```

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```

Erfassen in Warteschlangenstatistik der *Zapfsäule i*

Betreten der Einrichtung *Zapfsäule i*

Aktualisierung der Warteschlangenstatistik der *Zapfsäule i*

Verzögerung in der Einrichtung *Zapfsäule i* (Tanken)

Freigabe der Einrichtung *Zapfsäule i*

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```

Simulationslauf mit Standard-Report

Command / Create Simulation
Command / START 5

Startzähler: 5

GENERATE 1440

wäre überzeugender

Report-1

GPSS World Simulation Report - Oildepot-1.5.1

Monday, May 03, 2010 11:05:41

START TIME	END TIME	BLOCKS	FACILITIES	STORAGES
0.000	480.000	18	3	1

NAME	VALUE
ARR	10000.000
DEPOT	10005.000
GALS	10002.000
PUMP	10004.000
PUMPRATE	10001.000
QTY	10007.000
SOLD	10008.000
TRANSIT	10006.000
TYPE	10003.000

plus 9 implizite Blocknummern

Report-2: Block-Nutzung

LABEL	LOC	BLOCK TYPE	ENTRY COUNT	CURRENT COUNT	RETRY
	1	GENERATE	91	0	0
	2	ASSIGN	91	0	0
	3	ASSIGN	91	37	0
	4	ENTER	54	0	0
	5	QUEUE	54	9	0
	6	SEIZE	45	0	0
	7	DEPART	45	0	0
	8	ADVANCE	45	3	0
	9	RELEASE	42	0	0
	10	LEAVE	42	0	0
	11	SAVEVALUE	42	0	0
	12	TABULATE	42	0	0
	13	TERMINATE	42	0	0
	14	GENERATE	1	0	0
	15	TABULATE	1	0	0
	16	SAVEVALUE	1	0	0
	17	SAVEVALUE	1	0	0
	18	TERMINATE	1	0	0

vor dem Depot

12
im Depot

12
im Depot

Report-3: Einrichtungen, Speicher, Warteschlangenstatistik

Bei drei besetzten Tanksäulen können nur noch 9 Fahrzeuge auf die drei Warteschlangen verteilt sein

Transaktionsnummer

momentan blockierte Transaktionen

FACILITY	ENTRIES	UTIL.	AVE. TIME	AVAIL.	OWNER	PEND	INTER	RETRY	DELAY
1	15	0.979	31.328	1	41	0	0	0	5
2	17	0.965	27.251	1	51	0	0	0	1
3	13	0.924	34.114	1	45	0	0	0	3

QUEUE	MAX	CONT.	ENTRY	ENTRY (0)	AVE. CONT.	AVE. TIME	AVE. (-0)	RETRY
1	6	5	20	1	4.077	97.841	102.991	0
2	4	1	18	2	1.833	48.874	54.983	0
3	4	3	16	1	2.156	64.683	68.995	0

STORAGE DEPOT	CAP.	REM.	MIN.	MAX.	ENTRIES	AVL.	AVE.C.	UTIL.	RETRY	DELAY
	12	0	0	12	54	1	10.934	0.911	0	37

initiale Anzahl verfügbarer Plätze

momentane Anzahl verfügbarer Plätze

Generelle (modifizierbare) Verfügbarkeit {0, 1} der/des Einrichtung/Speichers

momentan blockierte Transaktionen

Report-4: Histogramme, globale Variablen

TABLE	MEAN	STD.DEV.	RANGE	RETRY	FREQUENCY	CUM.%
TRANSIT	141.387	68.206		0		
		20.000	-	30.000	2	4.76
		30.000	-	40.000	2	9.52
		40.000	-	50.000	0	9.52
		50.000	-	60.000	3	16.67
		60.000	-	70.000	1	19.05
		70.000	-	80.000	1	21.43
		80.000	-	90.000	2	26.19
		90.000	-	100.000	1	28.57
		100.000	-	110.000	3	35.71
		110.000	-	120.000	1	38.10
		120.000	-	130.000	2	42.86
		130.000	-	140.000	2	47.62
		140.000	-	150.000	4	57.14
		150.000	-	160.000	0	57.14
		160.000	-	170.000	2	61.90
		170.000	-	180.000	3	69.05
		180.000	-	190.000	1	71.43
		190.000	-		12	100.00
QTY	170310.000	0.000	-	0		
		160000.000	-		1	100.00
SAVEVALUE		RETRY	VALUE			
GALS		0	0			
SOLD		0	170310.000			

Report-5: Future Event Chain

Transaktionsnummer
Priorität
Ereigniszeit
Gruppenidentifikation
(hier: gleich Transaktionsnummer)
aktuell erfasst
in Block ...
Folgeblock
Transaktions-
Parameter

FEC_XN	PRI	BDT	ASSEM	CURRENT	NEXT	PARAMETER	VALUE
93	0	480.144	93	0	1		
51	0	481.787	51	8	9	GALS TYPE	4270.000 2.000
41	0	494.845	41	8	9	GALS TYPE	4110.000 1.000
45	0	509.392	45	8	9	GALS TYPE	4720.000 3.000
94	0	960.000	94	0	14		

ADVANCE

CEC ist dann immer leer.

Spezielle Fenster-1

Loc	Block Ty...	Current ...	Entry ...	Retry ...	Line Nu...	Includ...
1 GEN	GENERA...	0	91	0	18	0
2 ASN	ASSIGN	0	91	0	19	0
3 ASN	ASSIGN	37	91	0	20	0
4 ENT	ENTER	0	54	0	21	0
5 QUE	QUEUE	9	54	0	22	0
6 SEI	SEIZE	0	45	0	23	0
7 DEP	DEPART	0	45	0	24	0
8 ADV	ADVANCE	3	45	0	25	0
9 REL	RELEASE	0	42	0	26	0
10 L...	LEAVE	0	42	0	27	0
11 S...	SAVEVA...	0	42	0	28	0
12 T...	TABULATE	0	42	0	29	0
13 T...	TERMIN...	0	42	0	30	0
14 G...	GENERA...	0	1	0	32	0
15 T...	TABULATE	0	1	0	33	0
16 S...	SAVEVA...	0	1	0	34	0
17 S...	SAVEVA...	0	1	0	35	0
18 T...	TERMIN...	0	1	0	36	0

Storage	Utilizati...	Delay Chain	Capacity	Storage In U...	Min In Use	Max In U...	Entry Count	Availa...	Retry Chain
DEPOT	0.911	37	12	12	0	12	54	+	0

Facility	Utilization	Delay Chain	Acquisitions	Available	Ave. Time	Owner XN	Retry Chain	Pending Chain	Interrupt Chain
F. 1	0.979	5	15	+	31.328	41	0	0	0
F. 2	0.965	1	17	+	27.251	51	0	0	0
F. 3	0.924	3	13	+	34.114	45	0	0	0

Queue Entity	Current Content	Entry Count	Zero Entry Count	Maximum Content	Average Content	Average Time (+0)	Average Time (-0)	Retry Chain
1	5	20	1	6	4.077	97.841	102.991	0
2	1	18	2	4	1.833	48.874	54.983	0
3	3	16	1	4	2.156	64.683	68.995	0

Savevalue	Value	Retry Chain
GALS	0.000	0
SOLD	170310.000	0

Spezielle Fenster-2

TRANSIT

Mean: 141.387

S.D.: 68.206

