Department of Industrial Engineering
University of Stellenbosch

Simulasie 442 : Simulation 442
2025

MEMORANDUM

Tutoriaal 6 *Tutorial 6*	Punt: 47 *Mark:*	Ingeedatum: **29-08-2025** (10:00) B3003 *Due date:*

Instruksies:	Formatteer alle syfers sinvol. Werk in groepe van twee. Toon beide lede se name op een dokument aan asb. Gebruik Matlab, R of Excel vir u berekenings. Die data vir hierdie tutoriaal is beskikbaar in die lêer Tut06_2025_RawData.xlsx. U mag nie oplossings met ander groepe uitruil nie.
Instructions:	*Format all numbers sensibly.* *Work in groups of two.* *Indicate both names on one submission please.* *Use Matlab, R or Excel for your calculations.* The data for this tutorial is available in the file Tut06_2025_RawData.xlsx. *You may not exchange solutions with other groups.*

Question 1 [8]

A sports analyst for the Maties netball team wants to investigate the relationship between players' training intensity and their match performance ratings. The following data was collected for the 10 players of the team.

Player	Hours - Avg Hours	Rating - Avg Rating
1	-3,8	-0,78
2	0,2	0,12
3	-5,8	-1,18
4	4,2	0,92
5	-1,8	-0,18
6	6,2	1,22
7	-7,8	-1,88
8	8,2	1,62
9	-2,8	-0,58
10	3,2	0,72

(a) Calculate and discuss the covariance of the two variables. [4]

(b) Calculate and discuss the correlation between the two variables. [4]

Player	Hours - Avg Hours(X)	Rating - Avg Rating(Y)	X*Y	X^2	Y^2
1	-3,8	-0,78	2,964	14,44	0,6084
2	0,2	0,12	0,024	0,04	0,0144
3	-5,8	-1,18	6,844	33,64	1,3924
4	4,2	0,92	3,864	17,64	0,8464
5	-1,8	-0,18	0,324	3,24	0,0324
6	6,2	1,22	7,564	38,44	1,4884
7	-7,8	-1,88	14,664	60,84	3,5344
8	8,2	1,62	13,284	67,24	2,6244
9	-2,8	-0,58	1,624	7,84	0,3364
10	3,2	0,72	2,304	10,24	0,5184
Total			**53,46**	**253,6**	**11,396**

(a) Covariance $= \dfrac{53,46}{10} = 5,346.$ ✓✓
Due to $C_{XY} > 0$, it suggests that the hours and rating of a player are positively correlated. A player who trains longer hours will have a higher performance rating.✓✓

(b) Correlation $= \dfrac{53,46}{\sqrt{253,6 \times 11,396}} = 0,994.$✓✓
The hours of training and performance rating are highly positively correlated.✓✓

Question 2 [12]

Consider the following values and calculate ρ_2 and ρ_4.

Xi	7,234	9,756	11,925	14,087	8,419	7,825	13,674

			Xi	**j=1**	**j=2**	**j=3**	**j=4**
			7,234	2,104	-4,800	-11,681	6,360
			9,756	-0,996	-2,425	1,320	1,713
X-bar	10,417		11,925	5,533	-3,013	-3,909	4,911
Var	6,804		14,087	-7,332	-9,514	11,952	
n	7		8,419	5,180	-6,507		
			7,825	-8,444			
			13,674				
			Sum	-3,955	-26,259	-2,318	12,984
			Cj	-0,659	**-5,252**	-0,580	**4,328**
			pj	-0,097	**-0,772**	-0,085	**0,636**

Refer to page 74 of the textbook.

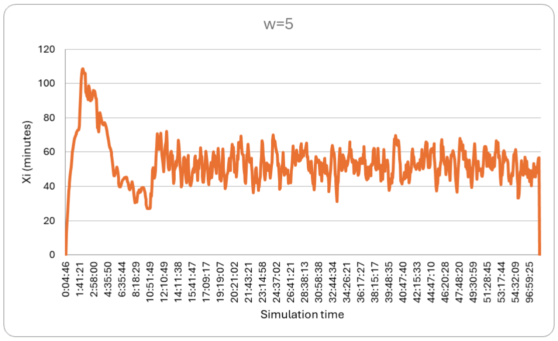
Question 3 [15]

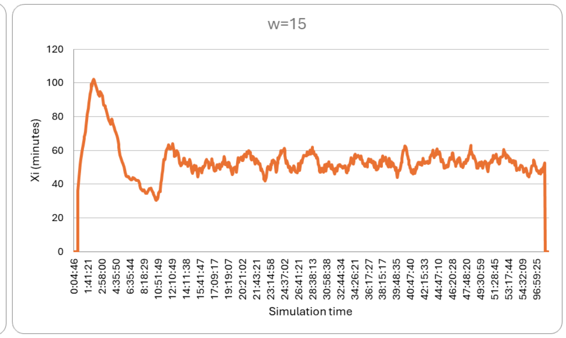
The provided data is from a preliminary simulation of a non-terminating system. In this context, "Time" refers to the simulation's runtime, and "Xi" represents the time (in minutes) that entity i spent in the system. The final objective is to determine the truncation points for $w = 5$ and $w = 15$. Please answer the questions that follow.

i	Time	Xi	w = 5	w = 15
1	0:04:46	5,59		
2	0:07:36	8,93		
3	0:15:28	8,81	12,865	
4	0:16:24	10,94	A	
5	0:28:24	30,06	24,798	
6	0:29:12	37,28	31,395	
7	0:29:45	36,91	37,559	
8	0:33:51	41,79	40,333	36,184
9	0:41:39	41,76	41,645	40,299
10	0:42:36	43,93	45,848	44,211
1477	96:54:17	76,61	44,950	50,438
1478	96:55:30	30,42	50,048	48,457
1479	96:59:25	30,78	48,575	47,917
1480	97:00:20	73,40	42,587	48,068
1481	97:01:33	31,66	47,584	47,600
1482	97:04:16	46,67	49,244	46,549
1483	97:06:50	55,41	40,407	47,897
1484	97:13:05	39,08	48,111	47,624
1485	97:14:10	29,22	46,991	46,120
1486	97:15:55	70,18	47,661	46,952
1487	97:18:23	41,07	45,453	48,687
1488	97:19:11	58,76	53,235	47,204
1489	97:20:45	28,04	46,184	47,911
1490	97:24:14	68,13	48,784	49,781
1491	97:25:18	34,93	45,611	49,829
1492	97:33:16	54,06	51,363	51,193
1493	97:38:27	42,90	47,970	52,630
1494	97:39:32	56,80	49,439	B
1495	97:46:22	51,16	53,567	
1496	97:47:30	42,27	56,216	
1497	97:47:49	74,71	56,764	
1498	97:50:43	56,14	C	
1499	97:56:07	59,54		
1500	98:23:21	50,76		

(a) Calculate the missing values indicated in pink. (A, B, C) [8]

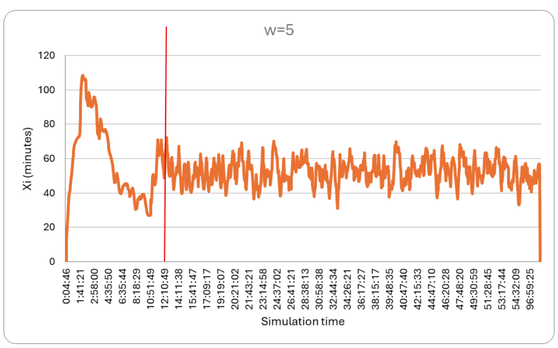
(b) Using the moving average window sizes of 5 and 15, determine the truncation point for future simulation runs. Indicate the point truncation point on the provided graphs. Explain how you arrived at the truncation point and its significance for the simulation. [7]

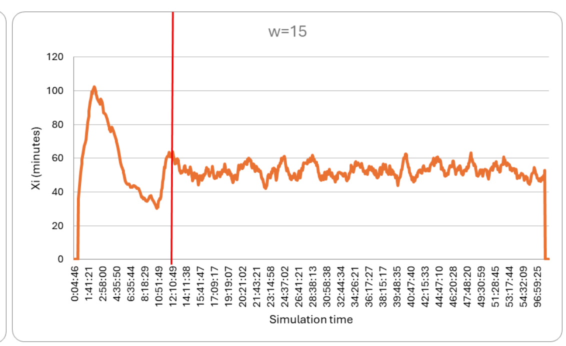




- (a) A=AVERAGE(second set of 5 Xi values)✓= 19.203 ✓✓
  B=0 or nothing ✓✓
  C= AVERAGE(last 5 Xi values)✓=56.685 ✓✓

- (b) The truncation point for future simulation runs is at time 12:10:49 for 5 ✓✓and 12:10:49 for 15✓✓
  This is where the moving averages stabilize✓,
  suggesting that additional simulation time beyond this point✓
  will not significantly alter the average performance metrics.✓





Question 4 [12]

Use the information given to determine the production run length for a batch-means approach in a stochastic non-terminating simulation model. The pilot run has provided the following data:

- Duration of pilot run: 7 890.75 simulation hours
- Observations made during pilot run: 2 050
- Warm-up period: 1 872.60 simulation hours
- Observations made during warm-up period: 620
- Number of preliminary batches formed: 11
- Assume that the j-value where the correlation estimators approach zero is at $j = 12$ for parameter X_i.
- Assume $\alpha = 0.05$ and $h^* = 0.1$.

Batched mean	1	31.22
Batched mean	2	30.85
Batched mean	3	31.09
Batched mean	4	30.76
Batched mean	5	31.33
Batched mean	6	30.91
Batched mean	7	31.18
Batched mean	8	31.07
Batched mean	9	31.25
Batched mean	10	30.96
Batched mean	11	31.15
Batched mean	12	30.88

Refer to page 74 of the textbook.

Even though the preliminary batches are given an 11, you must use n=12 as the given table has 12 batched means.

- Observations in total: 2050 - Observations in warm-up: 620
- Steady-state observations: 1430 ✓
- Total run time: 7890.75 - Warm-up time: 1872.60
- Steady-state time: 6018.15 ✓
- Time unit per observation: $\frac{6018.15}{1430} = 4.208$ ✓
- Observations per batch: $j \times 10 = 12 \times 10 = 120$ ✓
- Time units per batch: $120 \times 4.208 = 505.02$ ✓
- Estimated mean: 31.05 ✓
- Estimated variance: 0.032 ✓
- $t_{12-1,1-\frac{0.05}{2}} = 2.201$ ✓
- $h = t \times \sqrt{\frac{S^2}{n}} = 2.201 \times \sqrt{\frac{0.032}{12}} = 0.11$ ✓
- n* = 16 ✓
- Total simulation time for 16 batches:
  Time to warm-up + Time for 16 steady-state batches ✓
  $= 1\,872.60 + (505.02 \times 16)$
  $= 1\,872.60 + 8\,080.31$
  $= 9\,952.913$ time units ✓

Total: Cross-check: 47