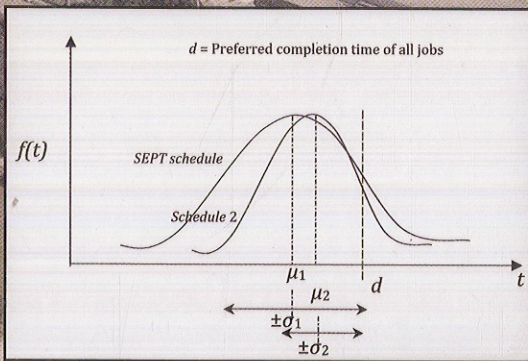


STOCHASTIC SCHEDULING

Expectation-Variance Analysis of a Schedule



SUBHASH C. SARIN
BALAJI NAGARAJAN
LINGRUI LIAO

CAMBRIDGE

Contents

<i>Foreword</i>	<i>page ix</i>
<i>Salah E. Elmaghraby</i>	
<i>Preface</i>	xi
1 Introduction	1
1.1 Uncertainty	1
1.2 Uncertainty in Scheduling	1
1.3 Modeling Uncertainty in Scheduling	2
1.4 Significance of Variance in Scheduling	3
1.5 Multiobjective or Multicriteria Stochastic Scheduling	5
1.6 Variance of the Performance Measure: Other Production Systems	6
1.6.1 CONWIP Systems	6
1.6.2 Production Lines	7
1.7 Processing Time Variance in Scheduling	8
1.8 Analytic Evaluation of Expectation and Variance of a Performance Measure	9
1.9 Organization of the Book	10
2 Robust Scheduling Approaches to Hedge against Processing Time Uncertainty	12
2.1 Introduction	12
2.2 Modeling Processing Time Uncertainty	12
2.3 Robust Scheduling for Single-Machine Systems	13
2.3.1 Properties of Robust Schedules	15
2.3.2 Solution Approaches for ADRSP	16
2.4 β -Robust Scheduling for Single-Machine Systems	22
2.4.1 Dominance Properties of β -Robust Schedules	23
2.4.2 Solution Approaches for β -RSP	23

2.4.3	Extensions of the β -RSP	25
2.4.4	Solution Approaches for β -RSPVR	26
2.5	Robust Scheduling for Two-Machine Flow Shops	26
2.5.1	Properties of Two-Machine Flow-Shop Robust Schedules	27
2.5.2	Solution Approaches for the TM-ADRSP	28
2.6	Concluding Remarks	30
3	Expectation-Variance Analysis in Stochastic Multiobjective Scheduling	32
3.1	Introduction	32
3.2	Expectation-Variance-Efficient Sequences/Nondominated Schedules	33
3.3	Identification of Expectation-Variance-Efficient Sequences	34
3.3.1	Approaches for Identifying EV-Efficient Sequences	34
3.4	Identification of Extreme EV-Efficient Sequences	36
3.4.1	Linear-Assignment-Problem Approach (XEV-LAP)	36
3.5	Preferred Schedule for Bicriteria Single-Machine Scheduling	36
3.5.1	Upperward 100α Percentile Minimum Schedule	37
3.5.2	Combined Nondominated Schedules	38
3.5.3	Combined Upperward 100α Percentile Minimum Schedules	38
3.5.4	Algorithmic Procedure for Preferred Schedule Selection	38
3.6	Preferred Schedule for Bicriteria Parallel-Machine Scheduling	39
3.6.1	Fixed-Job-Assignment Case	39
3.6.2	General Parallel-Machine Case	41
3.6.3	Algorithmic Procedure for Preferred Schedule Selection	41
3.7	Concluding Remarks	42
4	Single-Machine Models	43
4.1	Introduction	43
4.2	Completion-Time-Based Objectives	44
4.2.1	Total Completion Time	44
4.2.2	Total Weighted Completion Time	46
4.2.3	Total Weighted Discounted Completion Time	47
4.3	Due-Date-Based Objectives	52
4.3.1	Total Tardiness	52
4.3.2	Total Weighted Tardiness	58
4.3.3	Total Number of Tardy Jobs	58
4.3.4	Total Weighted Number of Tardy Jobs	60
4.3.5	Mean Lateness	61
4.3.6	Maximum Lateness	62
4.4	Concluding Remarks	65

5	Flow-Shop Models	66
5.1	Introduction	66
5.2	Permutation Flow Shops with Unlimited Intermediate Storage	67
5.2.1	Expectation and Variance of Makespan	67
5.3	Concluding Remarks	72
6	Job-Shop Models	73
6.1	Introduction	73
6.2	Job Shops with Unlimited Intermediate Storage and No Recirculation	74
6.2.1	Expectation and Variance of Makespan	74
6.3	Job Shops with Unlimited Intermediate Storage and with Recirculation	84
6.4	Concluding Remarks	86
7	Parallel-Machine Models	87
7.1	Introduction	87
7.2	Parallel Machines with No Preemptions	87
7.2.1	Makespan with No Preemptions	87
7.2.2	Total Completion Time with No Preemptions	90
7.3	Parallel Machines with Preemptions	92
7.4	Concluding Remarks	93
8	The Case of General Processing Time Distribution	94
8.1	Introduction	94
8.1.1	Finite-Mixture Models	94
8.1.2	Maximum-Likelihood Fitting of Mixture Models	97
8.1.3	Related Issues in Model Fitting	103
8.2	Application of Mixture Models for Estimating the Moments of Various Performance Measures of a Schedule	109
8.2.1	Estimating Expectation and Variance of Tardiness	111
8.2.2	Estimating Expectation and Variance of a Unit Penalty Function	114
8.2.3	Single-Machine Problems	116
8.2.4	Job-Shop Problems	128
8.2.5	Flow-Shop and Parallel-Machine Problems	134
8.2.6	Mixture Reduction	137
8.2.7	Application to Stochastic Activity Network	143
9	Concluding Remarks	153
9.1	Significance of This Work	155

Appendix	157
A.1 Analysis for a Single-Machine Total Tardiness Problem	157
A.2 Analysis for a Single-Machine Total Number of Tardy Jobs Problem	161
A.3 Analysis for a Single-Machine Maximum Lateness Problem	163
A.4 Software XVA-Sched	164
A.4.1 Starting the Software	165
A.4.2 Single Machine	166
A.4.3 Parallel Machine	170
A.4.4 Flow Shop	173
A.4.5 Job Shop	176
A.4.6 Specifying Distributions	180
 <i>Bibliography</i>	 183
<i>Index</i>	187