

Optimizing a Business Process Model by Using Simulation

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Outline

- Introduction and problem definition
- A Model for estimating performance of a Process
- Type of processes
- Suggested optimization algorithms
- Conclusions and future work

What is Performance of an Organization?

- There is no universal approach.
- The ultimate measure of performance is to what degree the desired effects are achieved.
- Performance improvement is a holistic and long-term approach.



Possible Improvements Methods

- Employing qualified personnel
- Improving capabilities of personnel with education and training
- Optimizing the Work process and the structure of the organization
- Assigning tasks to employees best qualified for performing them



Simplifying Factors

- Resources are generally qualified (in some degree) for all activities in the process
- Non-time-critical tasks
- Budget is not a constraint

Problem Definition

- tasks $\mathbb{T} = \{t_1, \dots, t_n\}$
- agents $\mathbb{A} = \{a_1, \dots, a_m\}$
- a gain model $v : \{\mathbb{T} \times \mathbb{A}\} \rightarrow \mathbb{R}$
- a Business Process Model *BPM*
- constraint: each agent performs only one task
- Find: the optimal assignment of tasks to agents

Performance of a Process

- $v : \{\mathbb{T} \times \mathbb{A}\} \rightarrow \mathbb{R}$ defines the Matrix $\mathbb{V} = [v_{ij}]_{m \times n}$
- Number of times each Task is performed (x_j)
- The impact of each Task on the Process (q_j)
- The Assignment Matrix $\mathbb{Z} = [z_{ij}]_{m \times n}$ if Task j is assigned to Agent i then $z_{ij} = 1$ and 0 otherwise.
- $u = \sum_{j=1}^n x_j q_j \sum_{i=1}^m v_{ij} z_{ij}$.

Different Types of Processes

- Deterministic Processes
- Markovian Processes
- Non-Markovian Processes
- Assignment Depended Processes

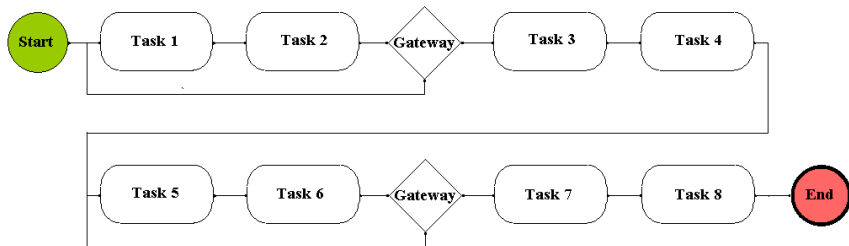
Types of Processes: Optimization Methods

- Deterministic Processes: Hungarian Algorithm
- Markovian Processes: Analytical Solution & Hungarian Algorithm
- Non-Markovian Processes: Simulation & Hungarian Algorithm
- Assignment Depended Processes: Repeated Simulation & Hungarian Algorithm

Assignment Depended Processes

- Critical Tasks / Non-Critical Tasks
- Finding optimal solution for non-critical Tasks using simulation and Hungarian algorithm
- Finding a near-optimal solution for critical Tasks using simulation and Hill-Climbing

BPMN Model in Arena



Test Model with 16 tasks for Non-Markovian processes.

Optimizer Application

Hungarian Algorithm

of replications: Replicationbias: Polaritybias:

Permutations:

	Task_01	Task_02	Task_03	Task_04	Task_05	Task_06	Task_07	Task_08
		8				1		
		8				2		
		8				3		
		8				4		
		8				5		
		8				6		
		8				7		
		8				8		
**								

Mapping

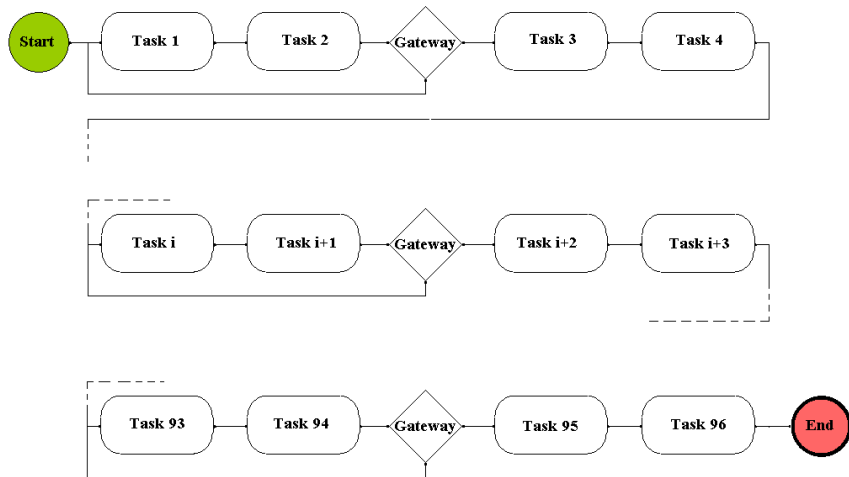
	Task_01	Task_02	Task_03	Task_04	Task_05	Task_06	Task_07	Task_08
▶ Agent 1	15.5942	06.7257	05.1250	03.6875	13.2896	10.1401	08.5000	06.0000
Agent 2	04.2970	06.5389	05.5625	05.9375	02.3814	03.4568	04.0000	03.7500
Agent 3	04.7640	09.5281	04.7500	05.5625	04.3787	05.9150	03.5000	05.7500
Agent 4	14.6658	19.9903	10.8125	12.0000	12.7519	14.5187	10.5000	12.7500
Agent 5	18.2154	03.5497	10.2500	08.0625	11.1387	07.1441	13.5000	03.7500
Agent 6	14.5724	16.0670	03.5625	04.8125	15.5942	15.5174	09.0000	11.5000
Agent 7	15.1328	05.6048	10.5000	08.3750	09.6792	06.9137	10.0000	04.5000
Agent 8	16.2538	20.9244	07.8750	09.5000	15.9783	17.2074	11.0000	14.0000

Log:

The best solution is [Agent 1, Agent 8, Agent 2, Agent 3, Agent 6, Agent 7, Agent 5, Agent 4] with gain: 96.0335
 Running permutation [1, 8 (locked), 1, 1, 1, 7 (locked), 1, 1]
 The best solution is [Agent 7, Agent 8, Agent 2, Agent 3, Agent 1, Agent 6, Agent 5, Agent 4] with gain: 102.2392
 Running permutation [1, 8 (locked), 1, 1, 1, 6 (locked), 1, 1]
 The best solution is [Agent 1, Agent 8, Agent 2, Agent 3, Agent 6, Agent 5, Agent 7, Agent 4] with gain: 92.7639
 Running permutation [1, 8 (locked), 1, 1, 1, 5 (locked), 1, 1]
 The best solution is [Agent 1, Agent 8, Agent 7, Agent 2, Agent 6, Agent 4, Agent 5, Agent 3] with gain: 101.951
 Running permutation [1, 8 (locked), 1, 1, 1, 4 (locked), 1, 1]

Run

BPMN Model in Arena

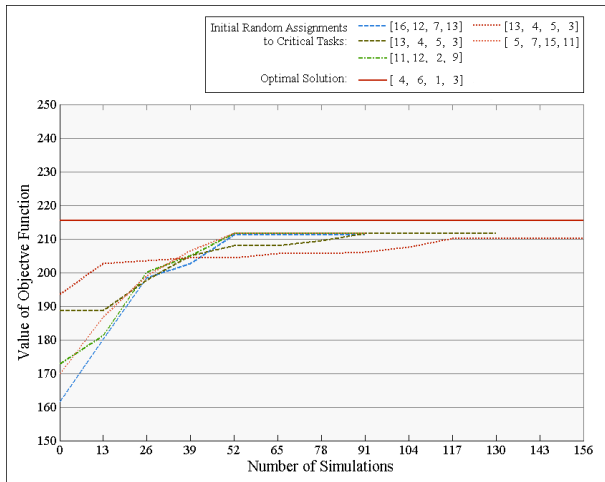


Results for Algorithm 2

Size	Min Gain	Max Gain	Nr. of Combinations
8	46.80	103.71	4.03×10^4
16	93.70	213.53	2.09×10^{13}
24	124.34	323.13	6.20×10^{23}
32	162.25	435.38	2.63×10^{35}
40	203.30	554.92	8.16×10^{47}
48	249.52	655.53	1.24×10^{61}
56	298.37	775.47	7.11×10^{74}
64	327.25	882.18	1.27×10^{89}
72	393.78	1016.79	6.12×10^{103}
80	451.29	1137.24	7.16×10^{118}
88	506.57	1256.00	1.85×10^{134}
96	556.60	1385.57	9.92×10^{149}

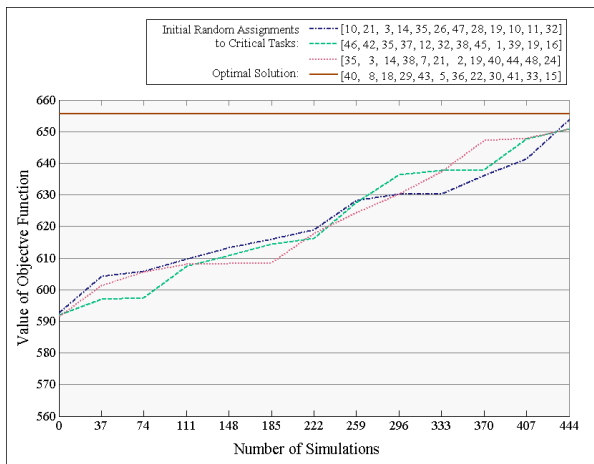


Results of Algorithm 4



Results of Algorithm 4 for 16 tasks

Results of Algorithm 4



Results of Algorithm 4 for 48 tasks

Conclusion and Future Work

- Given a model for performance of an agent we suggested a method for estimating the performance of a Business Process by aggregating performances of Tasks and considering uncertainty of the flow of the Business Process
- The most general case is non-Markovian, assignment dependent process
- a method based on partitioning the process into critical and non-critical Tasks yields a near-optimal solution in reasonable time
- Future Work: Modeling and including team working in estimating the performance of Agents



Thank You!

