Benchmark for real-practice distributed scheduling in heterogeneous, flexible job shop

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Abstract: We designed a benchmark for distributed scheduling in heterogeneous, flexible job shop environment. Our benchmark contains 20 toy instances (2, 4, 6, and 8 tasks) and 150 realistic instances (100, 200, 300, 400, and 500 tasks), reflecting normal and extreme scenarios in scheduling of medical tests in a clinical laboratory. Key characteristics to be considered were empirical hardness and exhaustiveness, which helped to result in a more discriminating benchmark. We utilized this benchmark in [1]. To our knowledge, this is the first benchmark for scheduling related to clinical laboratory and for distributed scheduling in heterogeneous, flexible job shop.

Keywords: benchmark, distributed scheduling, heterogeneous, flexible job shop, health care, clinical laboratory.

1. Introduction

There are 6 separate "*.txt*" files. Table 1 provides information about each file. For toy instances, the ratio of biochemical tests to immunologic tests is one to one. For each test size (2, 4, 6, 8), five instances are generated, generating a total of 20 toy instances. To generate realistic instances, ratios of biochemical tests to immunologic tests are 1:4, 1:1, and 4:1, respectively. For each combination of test size (100, 200, 300, 400, 500) and each test ratio, ten instances are generated, for a total of 150 instances. Instances are publicly available at [2].

Table 1

Summary of benchmark

File name	Number of specimens	Ratio of biochemical tests to immunologic tests	Number of instances per combination	Total instances
Benchmark_Toys.txt	{2, 4, 6, 8}	{1:1}	5	20
Benchmark_100 Tasks.txt	100	{1:4, 1:1, 4:1}	10	30
Benchmark_200 Tasks.txt	200	{1:4, 1:1, 4:1}	10	30
Benchmark_300 Tasks.txt	300	{1:4, 1:1, 4:1}	10	30
Benchmark_400 Tasks.txt	400	{1:4, 1:1, 4:1}	10	30
Benchmark_500 Tasks.txt	500	{1:4, 1:1, 4:1}	10	30

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2. Contents in files

Within each file, each instance is named as the term "*INSTANCE_BT_IT_Idx*", which denotes *BT* specimens for biochemical tests, *IT* specimens for immunologic tests, and *Idx* as the index number for each combination of *BT* and *IT*. Data structure for *INSTANCE_BT_IT_Idx* is explained in Table 2. The *number of parallel instruments or staffs* and *maximum capacity* are from Table 3. The *operation's processing time* is sampled within the lower and upper bounds of processing time in Table 3. Note: In our articles, we have used "*INSTANCE*" and "*INST*." interchangeably. However, in our Benchmark, we exclusively use "*INSTANCE*".

Table 2

Data structure for *INSTANCE_BT_IT_Idx*

Record type	Line number below *INSTANCE_BT_IT_Idx*	Data meanings
Task size	1	Number of specimens for biochemical tests
	2	Number of specimens for immunologic tests
Number of parallel instruments or staffs	3	Number of centrifuges in Region 1
	4	Number of decappers in Region 1
	5	Number of biochemistry analyzers in Region 1
	6	Number of immunoassay analyzers in Region 1
	7	Number of staffs for result validation & reporting in Region 1
	8	Number of centrifuges in Region 2
	9	Number of staffs for decapping in Region 2
	10	Number of biochemistry analyzers in Region 2
	11	Number of immunoassay analyzers in Region 2
	12	Number of staffs for result validation & reporting in Region 2
Maximum capacity	13	Maximum capacity of centrifuges in Region 1
	14	Maximum capacity of decappers in Region 1
	15	Maximum capacity of biochemistry analyzers in Region 1
	16	Maximum capacity of immunoassay analyzers in Region 1
	17	Maximum capacity of staffs for result validation & reporting in Region 1
	18	Maximum capacity of centrifuges in Region 2
	19	Maximum capacity of staffs for decapping in Region 2
	20	Maximum capacity of biochemistry analyzers in Region 2
	21	Maximum capacity of immunoassay analyzers in Region 2
	22	Maximum capacity of staffs for result validation & reporting in Region 2
Operation's processing time	23 to (23+*BT*-1)	Processing time for centrifugation of biochemical-testing specimen in Region 1
	(23+*BT*) to (23+2*BT*-1)	Processing time for decapping biochemical-testing specimen in Region 1
	(23+2*BT*) to (23+3*BT*-1)	Processing time for specimen's biochemical test in Region 1
	(23+3*BT*) to (23+4*BT*-1)	Processing time for result validation & reporting of biochemical-testing specimen in Region 1

	(23+4*BT*) to (23+5*BT*-1)	Processing time for centrifugation of biochemical-testing specimen in Region 2
	(23+5*BT*) to (23+6*BT*-1)	Processing time for decapping biochemical-testing specimen in Region 2
	(23+6*BT*) to (23+7*BT*-1)	Processing time for specimen's biochemical test in Region 2
	(23+7*BT*) to (23+8*BT*-1)	Processing time for result validation & reporting of biochemical-testing specimen in Region 2
	(23+8*BT*) to (23+8*BT*+*IT*-1)	Processing time for centrifugation of immunologic-testing specimen in Region 1
	(23+8*BT*+*IT*) to (23+8*BT*+2*IT*-1)	Processing time for decapping immunologic-testing specimen in Region 1
	(23+8*BT*+2*IT*) to (23+8*BT*+3*IT*-1)	Processing time for specimen's immunologic test in Region 1
	(23+8*BT*+3*IT*) to (23+8*BT*+4*IT*-1)	Processing time for result validation & reporting of immunologic-testing specimen in Region 1
	(23+8*BT*+4*IT*) to (23+8*BT*+5*IT*-1)	Processing time for centrifugation of immunologic-testing specimen in Region 2
	(23+8*BT*+5*IT*) to (23+8*BT*+6*IT*-1)	Processing time for decapping immunologic-testing specimen in Region 2
	(23+8*BT*+6*IT*) to (23+8*BT*+7*IT*-1)	Processing time for specimen's immunologic test in Region 2
	(23+8*BT*+7*IT*) to (23+8*BT*+8*IT*-1)	Processing time for result validation & reporting of immunologic-testing specimen in Region 2

Table 3

Operations, processing time, capacity and quantity of instruments/physicians in a real-practice clinical laboratory

Region	Instrument / Staff	Operation	Processing time (second)	Maximum Capacity	Number of parallel instruments
1	Centrifuge	Centrifugation	[480, 600]	84	2
	Decapper	Decapping	2	1	1
	Biochemistry Analyzer	Biochemical test	[480, 600]	84	2
	Immunoassay Analyzer	Immunologic test	[1080, 1800]	84	2
	Staff	Result validation & reporting	[4, 6]	1	1
2	Centrifuge	Centrifugation	[300, 360]	32	4
	Staff	Decapping	[4, 6]	1	1
	Biochemistry Analyzer	Biochemical test	[300, 720]	60	2
	Immunoassay Analyzer	Immunologic test	[900, 2700]	48	2
	Staff	Result validation & reporting	[4, 6]	1	1

Note: Maximum capacity refers to the upper limit of the instruments' capability to process tubes simultaneously.

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