CQSIM

Low-Level Design Document

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1. INTRODUCTION

1.1 Goals

- **An event driven job schedule**
  - Simulator scans the event sequence and do the operation related to every event in time order.
  - Event can be job submit/job finish, monitor event or other event added by the user.
  - An overall method invokes and initializes all the modules and the handles of the modules will be transported into the simulator.
  - The simulator should be able to support other modules and their subclasses.
- **A user command line interface**
  - User can pass all the parameters by command line
  - Advantage user interface can be used to call the command line entry automatically.
  - A system parameter config file can be used to initialize the command line parameter
  - A file name config file can be used to initialize all the temp, debug and output path, name and extension name.
  - The data read from the config file are on low level, so the parameter given in the command line will replace the same data read in config file.
- **Extendable module design**
  - These modules should have the standard interface.
  - All modules are supposed to know all the data formats. Hence, they can get correct data from the dictionary type of parameter. And any modification in data format should be specified clearly in the design document.
  - The modules can be extended in 2 ways: subclass and new method.
  - Also, new function can be added to the existed method. But this kind of modification should be static, which is used in all extension.
- **Running time interface**
  - Keep receiving running time information and show them in the user friendly way.
- **Result analysis and show**
  - Read job trace result file and do the statistics as request.
  - Show the analysis result in graph.
  - New graph method can be added to it easily.

- **Input and output files**
  - Input raw files: Job trace and Node structure files
  - Formatted files: Job trace, Node structure, Job and Node config files
  - Output Result files: Job simulator result, Event log and Debug log.

2. STRUCTURE

2.1 Function Map

The program contains 5 parts:

User Interface & Overall Method		
	cqsim	• Basic user command line interface. • All parameters should be transferred by command line. • Additional profile is allowed, but corresponding explain program should be designed.
	filter	• Job and node filter command line interface. • Call the filter process to read raw files and output the data into the formatted file. • Also provide a port to output the formatted data list.
	cqsim_ad	• Advanced user interface, to simplify the user input. • Parameters are stored in a profile. • Can be designed as a command line interface that user need to only provide the profile file name, or a graphic user interface. • Call the basic command line interface **cqsim** with the data.
	cqsim_main	• Define all modules and transfer these modules to the simulator . • Different modules can be chosen here. • Call the simulator **Cqsim_sim**, transfer the modules(in a dictionary data) and parameters into the simulator. • Start the simulation process. • Import the path file Cqsim_path.py.
	cqsim_path	• Contain all path value • Be invoked if the file need to access other file in some other place
	factory_import	• Import all versions of modules

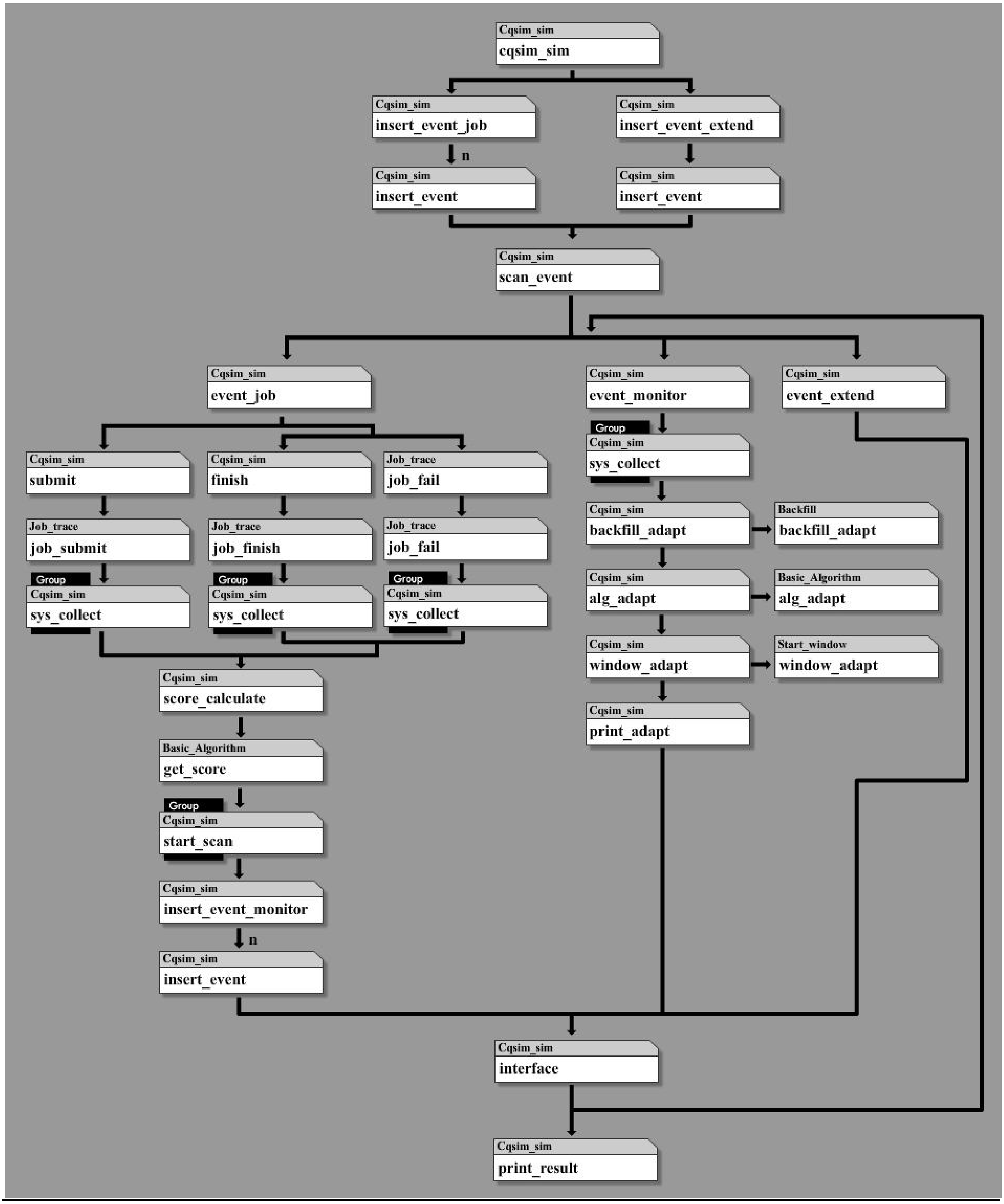
		• Build a module group dictionary data. This data will be invoked by the factory object to select module group.
	factory	• Factory class which "produce" modules • Read the module group data, receive the module name and select the corresponding modules • Pass the income parameter to selected module and return the module to caller
	Result_analysis	• Call the result analysis program to deal with the result.
Modules		
	• All the modules should contain: __init__(), reset() method to initialize and reset the basic setting. • At least one interface for other module to call it with the input running time parameters.	
	Filter_job	• Receive job trace file name and other parameters. • Read the file and extract the necessary information. • Format the data according to the parameters and store them into a list. • Store the data into a temp file according to the parameters. • Store the overall job trace information into a config file. • Provide output port to transfer the formatted data.
	Filter_node	• Receive node structure file name and other parameters. • Read the file and extract the necessary information. • Format the data according to the parameters and design and store them into a list. • Store the data into a temp file according to the parameters. • Store the overall node tructure information into a config file. • Provide output port to transfer the formatted data.
	Job_trace	• Receive formatted job trace file name or the formatted job trace data. • Read the temp file and store the data into a list. • Provide all the job trace operations, and keep tracing the information of every job.
	Node_struc	• Receive formatted node structure file name or the formatted node structure data. • Read the temp file and store the data into a list. • Provide all the node structure operations, and keep tracing

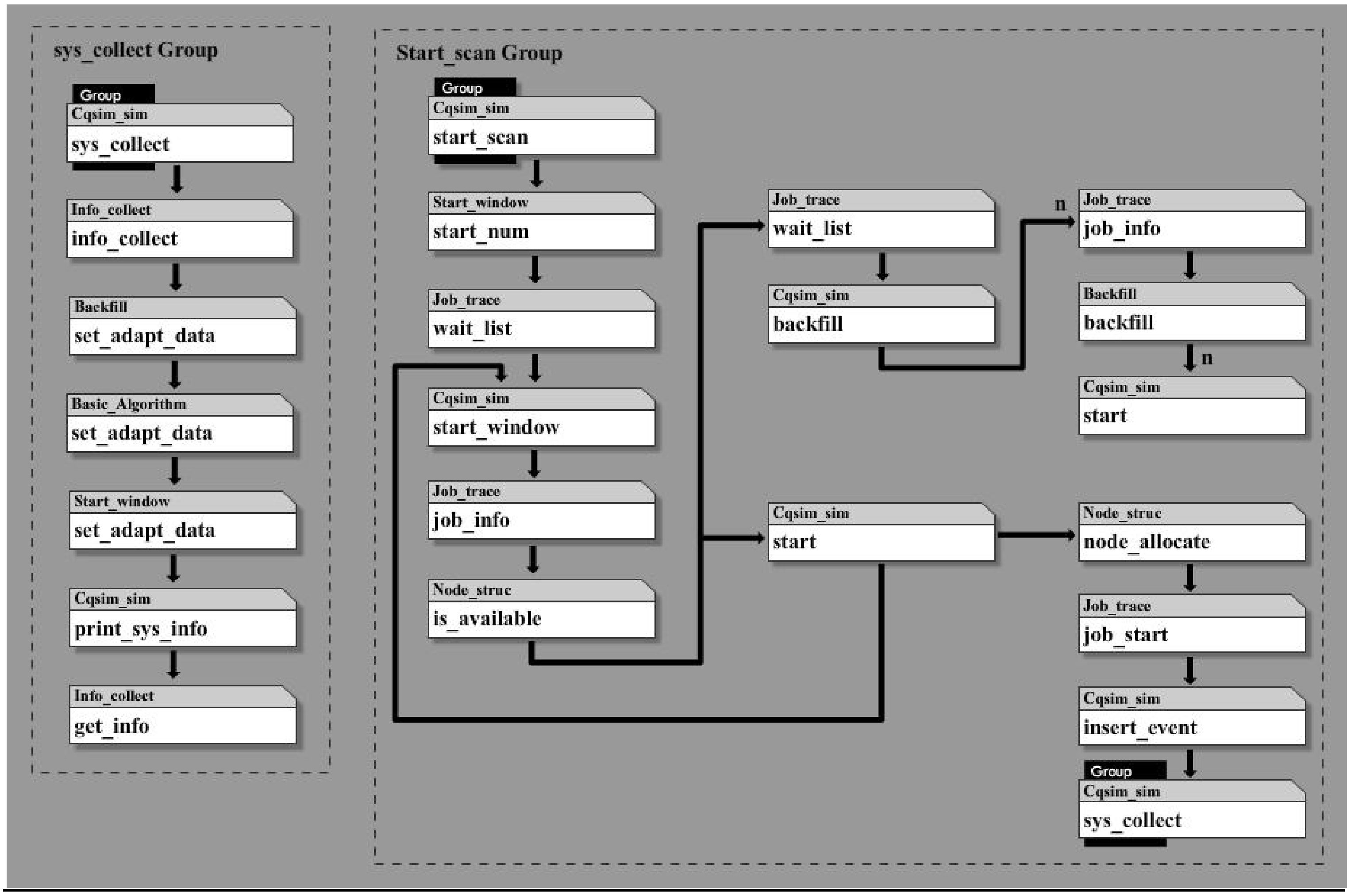
		the information of every node. • Provide the prediction of the state of the node structure. • Provide the function to check the prediction data.
	Backfill	• Receive parameters when it is initialized. • Provide backfill operation: receive the current state of the waiting list, make some prediction by calling the **node structure object**, return the index list of the jobs which can be backfilled now. • Different backfill mode can be added by designing a new backfill method and build the relationship between mode number and backfill function in **main()** method • Adapt function can be called by the simulator, to modify the parameters in running time depend on the changing of system state. ▪ Adapt config file name is transmitted into the module in adapt parameter list. ▪ All the adapt parameters and the requested average utilization interval list are get from the config file. ▪ Provide a method to analysis and set the adapt value in the **info_collect** module ▪ Check the most new system information in **info_collect** module to see whether it reach the adapt request. Call the adapt method if so. • Extend: User can also design a subclass of it if the current backfill structure can not reach the request. If you do so, import the right subclass in **cqsim_main()** method, and modify the input running-time parameters in **backfill()** method in **Cqsim_sim** class. Also, you may want to modify the initial parameters in **cqsim_main()** method and re-design the command line in both **Cqsim()** method and **Cqsim_ad()** method. So does the corresponding config files.
	Start_window	• Receive parameters when it is initialized. • Provide window operation when look for the next job to start: Receive ***x*** job indexes with related system information which need to be scanned in waiting list, Change the order of the waiting jobs according to the window function. Then return the new order. The simulator will call the window operation again when ***y*** job has started after the last window operation in one event

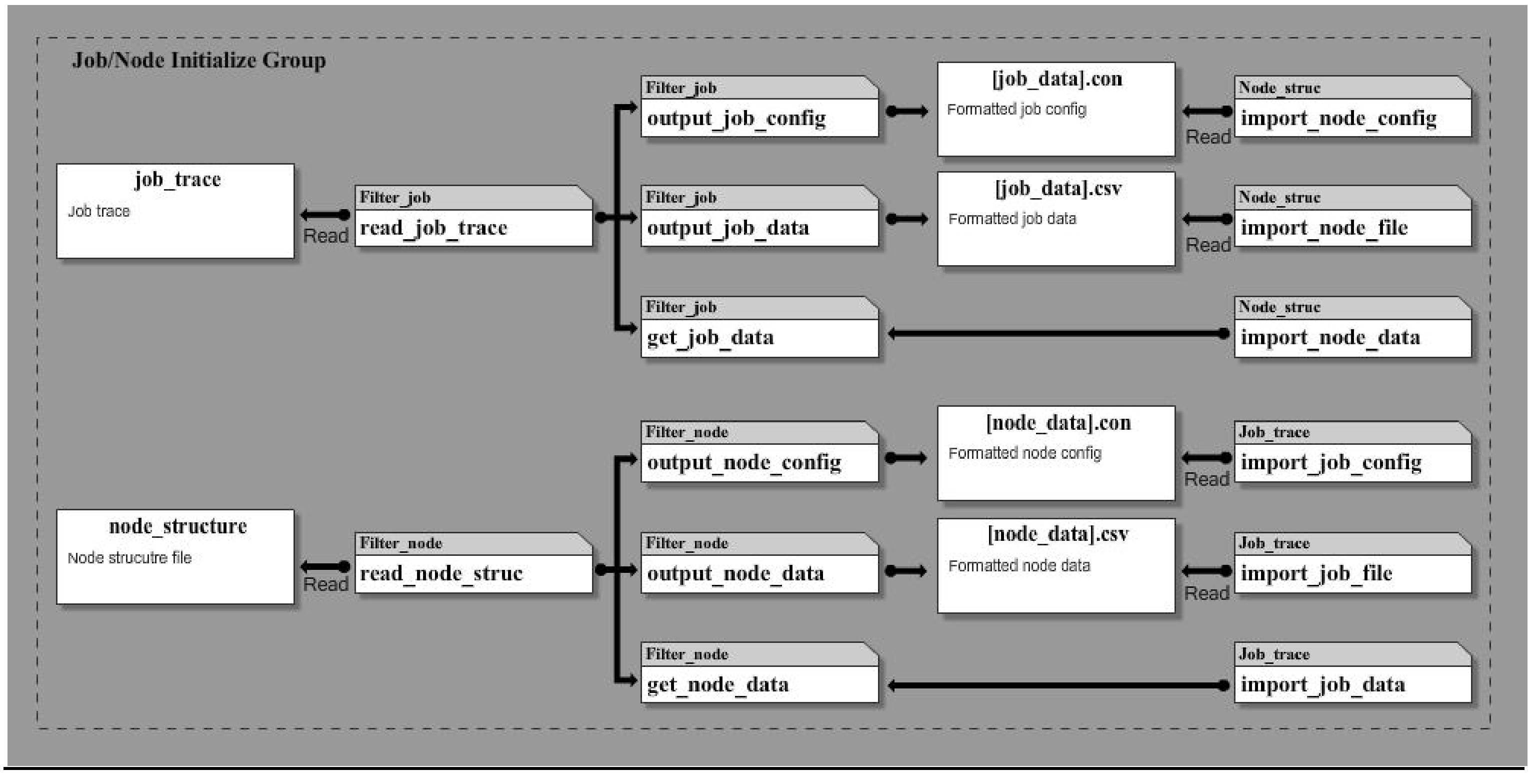
		iteration. Provide port to output ***x*** and ***y*** • This module will reorder the waiting list before any job starts in this iteration. • Different window mode: Similar to **Backfill** module • Adapt function: Similar to **Backfill** module • Extend: Similar to **Backfill** module
	Bacis_Algorithm	• Receive parameters when it is initialized. • Receive algorithm list and assemble the elements into an algorithm string. • Receive the information of a job and return the job score. Also can receive a list of job information and then return the corresponding list of scores in the same order. • Adapt function: Similar to **Backfill** module • Extend: Similar to **Backfill** module
	Info_collect	• Collect all the system information for record and analysis. • Provide collect and read operations. Hence other methods can check and store the information.
	Log_print	• Provide all the output file operation for the simulator. • Result, running time information and debug log can be done by invoking this module. • Provide the basic operation on files: open, write and close. • Changing style of log can be done by design a different subclass of it. • Every **Log_print** object can only manage a file in one time.
	Debug_log	• Receive the debug level: 0: No debug 1-3: Three debug level, 3 is the highest. 4: Print the debug information on the screen. 5,6: Print the method and module name. • User should provide the debug log content with the level number. • The debug module will print the given content depending on the input level number.
	Output_log	• Provide 3 output log print method: System information log Job result log Adapt information log .

		• System information log and Adapt information log method are invoked in every iteration. • Job result log is printed when all jobs are done.
Simulator		
	• Receive parameters and module handles. • Contain an inside event sequence, every event information includes virtual time, event type, event priority and event parameter list. • The simulator can add, delete or modify the event sequence in running time. • There are 3 kinds of event: job event(Job submit/finish), monitor event and extend event which is specially designed for new requirement. • Job submit events added to the sequence before all the process. Monitor events (from time A to B) added to the sequence when a job starts at A and finish at B. If there exist same monitor event at one time point, no new monitor event will be added. Job finish event added when the job start. User designed event added depending on the design. • In running time, simulator move its virtual time from one event to the next, and stop when all events are done and no more new event comes. • Simple flow of the 3 kinds of event: ◆ Job event - job start scan - system information collect ◆ Monitor event - adapt function ◆ Extend event - user designed function • Call the run-time interface to show the running time state after every event • Print system information log at every event. Output job result file when all jobs are done.	
Run-time Interface		
	•	
Result Analysis		
	•	

2.2 Flow Diagram


Cqsim_sim
cqsim_sim
Cqsim_sim
insert_event_job
Cqsim_sim
insert_event_extend
n
Cqsim_sim
insert_event
Cqsim_sim
insert_event
Cqsim_sim
scan_event
Cqsim_sim
event_job
Cqsim_sim
event_monitor
Cqsim_sim
event_extend
Group
Cqsim_sim
sys_collect
Cqsim_sim
submit
Cqsim_sim
finish
Job_trace
job_fail
Cqsim_sim
backfill_adapt
Backfill
backfill_adapt
Job_trace
job_submit
Job_trace
job_finish
Job_trace
job_fail
Cqsim_sim
alg_adapt
Basic_Algorithm
alg_adapt
Group
Cqsim_sim
sys_collect
Group
Cqsim_sim
sys_collect
Group
Cqsim_sim
sys_collect
Cqsim_sim
window_adapt
Start_window
window_adapt
Cqsim_sim
score_calculate
Cqsim_sim
print_adapt
Basic_Algorithm
get_score
Group
Cqsim_sim
start_scan
Cqsim_sim
insert_event_monitor
n
Cqsim_sim
insert_event
Cqsim_sim
interface
Cqsim_sim
print_result


sys_collect Group
Group
Cqsim_sim
sys_collect
Info_collect
info_collect
Backfill
set_adapt_data
Basic_Algorithm
set_adapt_data
Start_window
set_adapt_data
Cqsim_sim
print_sys_info
Info_collect
get_info
Start_scan Group
Group
Cqsim_sim
start_scan
Start_window
start_num
Job_trace
wait_list
Cqsim_sim
start_window
Job_trace
job_info
Node_struc
is_available
Job_trace
wait_list
Cqsim_sim
backfill
n
Job_trace
job_info
Backfill
backfill
n
Cqsim_sim
start
Cqsim_sim
start
Node_struc
node_allocate
Job_trace
job_start
Cqsim_sim
insert_event
Group
Cqsim_sim
sys_collect


Job/Node Initialize Group
job_trace
Job trace
Read
Filter_job
read_job_trace
Filter_job
output_job_config
Filter_job
output_job_data
Filter_job
get_job_data
[job_data].con
Formatted job config
[job_data].csv
Formatted job data
Read
Node_struc
import_node_config
Read
Node_struc
import_node_file
Node_struc
import_node_data
node_structure
Node strucutre file
Read
Filter_node
read_node_struc
Filter_node
output_node_config
Filter_node
output_node_data
Filter_node
get_node_data
[node_data].con
Formatted node config
[node_data].csv
Formatted node data
Read
Job_trace
import_job_config
Read
Job_trace
import_job_file
Job_trace
import_job_data

3. Module

3.1 Overall

This is a sample.

Name	*Method name*			
Input	*Parameter Name*	*(type)*	*Initial value*	*Comment* *The parameter is necessary if it has no initial value*
Output	*Return value type*	*(type)*		*Comment*
Process	• *Detail of the duty of the method*			

3.2 Filter_job

Name	__init__			
Input	trace	(string)	-	Path and name of the job trace file.
	save	(string)	None	Path and name of the format job trace file which the formatted job trace data will be stored in.
	config	(string)	None	Path and name of the format job trace config file
	sdate	(date)	None	The date and time of the first selected job. If it is None, no modification will be made.
	start	(float)	-1	Virtual submit time of the first selected job._j
	density	(float)	1.0	The scale of the submit time of the job trace. The virtual submit time will be: **[**(Original submit time - first job submit time + **start**) * **density]**
	anchor	(int)	0	The index of the first job will be read in the job trace file.
	rnum	(int)	0	The number of jobs will be read.
	max_node	(int)	dictionary	max number of node structure, this is used to check whether the node request is more than max
	debug	(handle)	None	Debug module handle
Output	None	-		-
Process	Initialize the parameters.			

Name	reset			
Input	trace	(string)	None	-
	save	(string)	None	-
	config	(string)	None	-
	sdate	(date)	None	-

	start	(float)	None	-
	density	(float)	None	-
	anchor	(int)	None	-
	rnum	(int)	None	-
	max_node	(int)	None	-
	debug	(handle)	None	-
Output	None	-		-
Process	Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	Show module information in debug file.			

Name	reset_config_data			
Input	None	-	-	-
Output	None	-		-
Process	Reset config data			

Name	read_job_trace			
Input	None	-	-	-
Output	None	-		-
Process	Open the job trace file with path string **[trace]** Read the job trace file and store **[rnum]** jobs starting at **[anchor]** position. Modify the start date of the selected job trace to **[start]** if it is not None. Modify the submit time of the jobs: **[**(Original submit time - first job submit time + **start**) * **density]** Formatted all the selected job data and store them into a local list. Also get some config data from the original file.			

Name	input_check			
Input	jobInfo	(dictionary)	-	Input job data
Output	(int)	(int)		1 for correct, <0 for error
Process	Check the input job data. Correct some error if the it can be corrected simply. Return negative number if any error found.			

Name	config_set			
Input	None	-	-	-
Output	None	-		-
Process	This method provide the addition change on config file.			

Name	get_job_data

Input	None	-	-	-
Output	(list)	(list)		Return the formatted job trace data
Process	Return the formatted job trace data without other additional information			

Name	get_job_num			
Input	None	-	-	-
Output	(int)	(int)		Return the length of the formatted job list
Process	Return the length of the formatted job list.			

Name	output_job_data			
Input	None	-	-	-
Output	None	-		-
Process	Open the formatted job data file with path **[save]** Store the list and other information in the designed format.			

Name	output_job_config			
Input	None	-	-	-
Output	None	-		-
Process	Open the formatted job config file with path **[config]** Store the overall job config data			

3.3 Filter_node

Name	__init__			
Input	struc	(string)	-	Path and name of the node structure file
	save	(string)	None	Path and name of the temp node structure file which the formatted node structure data will be stored in.
	config	(string)	None	Path and name of the format node structure config file
	debug	(handle)	None	Debug module handle
Output	None	-		-
Process	• Initialize the parameters.			

Name	reset			
Input	struc	(string)	None	-
	save	(string)	None	-
	config	(string)	None	-
	debug	(handle)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-

Output	None	-		-
Process	• Show module information in debug file.			

Name	reset_config_data			
Input	None	-	-	-
Output	None	-		-
Process	• Reset config data			

Name	read_node_struc			
Input	None	-	-	-
Output	None	-		-
Process	• Open the node structure file with path string **[struc]** • Formatted the node structure and store them into a local list.			

Name	input_check			
Input	nodeInfo	(dictionary)	-	Input node data
Output	(int)	(int)		1 for correct, <0 for error
Process	• Check the input node data. • Return negative number if any error found.			

Name	get_node_num			
Input	None	-	-	-
Output	(int)	(int)		Return the length of the formatted node list
Process	• Return the length of the formatted node list.			

Name	get_node_data			
Input	None	-	-	-
Output	(list)	(list)		Return the formatted node structure data.
Process	• Return the formatted node structure data without other additional information			

Name	output_node_data			
Input	None	-	-	-
Output	None	-		-
Process	• Open the formatted node structure file with path **[save]** • Store the list and other information in the designed format.			

Name	output_node_config			
Input	None	-	-	-
Output	None	-		-
Process	• Open the formatted node config file with path **[config]** • Store the overall node config data			

3.4 Job_trace

Name	__init__			
Input	start	(float)	-1	Virtual submit time of the first selected job._j
	num	(int)	0	The number of jobs will be read.
	anchor	(int)	0	The index of the first job will be read in the job trace file.
	density	(float)	1.0	The scale of the submit time of the job trace. The virtual submit time will be: **[**(Original submit time - first job submit time + **start**) * **density]**
	debug	(handle)	None	Debug module handle
Output	None	-		-
Process	• Initialize the parameters.			

Name	reset			
Input	start	(float)	None	-
	num	(int)	None	-
	anchor	(int)	None	-
	density	(float)	None	-
	debug	(handle)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	import_job_file			
Input	job_file	(string)	-	Path and name of the formatted temp job data file.
Output	None	-		-
Process	• Open the temp job data file with path string **[job_file]** • Store the information into the local buffers.			

Name	import_job_config			
Input	config_file	(string)	-	Path and name of the formatted job config file.
Output	None	-		-
Process	• Open the job config file with path string **[config_file]** • Store the config information into the local buffers.			

Name	import_job_data			
Input	job_data	(list)	-	Formatted job trace data list.
Output	None	-		-
Process	• Store the income job data into the local list.			

Name	submit_list			
Input	None	-	-	-
Output	(list)	(list)		Return the job list which have not been submitted.
Process	• Return the job list which have not been submitted.			

Name	wait_list			
Input	None	-	-	-
Output	(list)	(list)		Return the current waiting list.
Process	• Return the current waiting list.			

Name	run_list			
Input	None	-	-	-
Output	(list)	(list)		Return the current running list.
Process	• Return the current running list.			

Name	done_list			
Input	None	-	-	-
Output	(list)	(list)		Return the job list which are done.
Process	• Return the job list which are done.			

Name	wait_size			
Input	None	-	-	-
Output	(int)	(int)		Return the total size of the waiting job
Process	• Return the total size of the waiting job.			

Name	get_start_date			
Input	None	-	-	-
Output	(date)	(date)		Return the start date
Process	• Return the start date .			

Name	get_virtual_start_time			
Input	None	-	-	-
Output	(float)	(float)		Return the virtual start time
Process	• Return the virtual start time			

Name	refresh_score			
Input	score	(float)	-	The new score or score list (if **[job_index]** is None)
	job_index	(int)	None	The index of the selected job.
Output	None	None		-
Process	• Refresh the score of the selected job if index is given • Refresh the scores of all jobs in the old order if no index is given. • Reorder the wait list in the order of score (from high to low-)			

Name	scoreCmp			
Input	jobIndex_c1	(int)	-	-
	jobIndex_c2	(int)	-	-
Output	<cmp>	<cmp>		-
Process	• Method used to order.			

Name	job_info			
Input	job_index	(int)	-1	The index of the selected job.
Output	(dictionary)	(dictionary)		Return the detail of the job indicated by the input index #.
Process	• Return the detail of the job. • If job_index is -1, return the whole job trace information			

Name	job_submit			
Input	job_index	(int)	-	The index of the selected job.
	job_score	(int)	0	The score of the selected job.
	job_est_start	(int)	-1	The estimated tart time of the selected job.
Output	(int)	(int)		1: Success 0: Fail
Process	• Submit the selected job • Move the submit pointer to the next job and add the index of the job to waiting list. • Modify the state of the job form "not-submit" to "waiting". • Fill other information of the job. (e.g. scores of the job) • Return 0 if any error ocurr. Otherwise return 1.			

Name	job_start			
Input	job_index	(int)	-	The index of the selected job.
	time	(float)	-	Start time
Output	(int)	(int)		1: Success 0: Fail
Process	• Start the selected job • Delete the index of the job from waiting list and add the index of the job to running list. • Modify the state of the job form " waiting " to "running". • Fill other information of the job. (e.g. start time) • Return 0 if any error ocurr. Otherwise return 1.			

Name	job_finish			
Input	job_index	(int)	-	The index of the selected job.
	time	(float)	None	Finish time
Output	(int)	(int)		1: Success 0: Fail
Process	• Finish the selected job • Delete the index of the job from running list and add the index of the job to done list. • Modify the state of the job form "running " to "done". • Fill other information of the job. • Return 0 if any error ocurr. Otherwise return 1.			

Name	job_fail			
Input	job_index	(int)	-	The index of the selected job.
	time	(float)	None	Finish time
Output	(int)	(int)		1: Success 0: Fail
Process	• Mark the selected job failed • Delete the index of the job from running list and add the index of the job to fail list. • Modify the state of the job form "running " to "fail". • Fill other information of the job. • Return 0 if any error ocurr. Otherwise return 1.			

Name	job_set_score			
Input	job_index	(int)	-	The index of the selected job.
	score	(float)	-	The score of the selected job
Output	(int)	(int)		1: Success 0: Fail
Process	• Modify the score of the job • Fill other information of the job. • Return 0 if any error ocurr. Otherwise return 1.			

3.5 Node_struc

Name	__init__			
Input	debug	(handle)	None	Debug module handle
Output	None	-		-
Process	• Initialize the parameters.			

Name	reset			
Input	debug	(handle)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	read_list			
Input	source_str	(string)	None	The string need to be analysis into a list
Output	(list)	(list)		The list get from the string
Process	• Translate a string into a list of int • The string must be like [a,b,…,z]			

Name	import_node_file

Input	node_file	(string)	-	Path and name of the formatted temp node data file.
Output	None	-		-
Process	• Open the temp node data file with path string **[node_file]** • Store the information into the local buffers.			

Name	import_node_config			
Input	config_file	(string)	-	Path and name of the formatted node config file.
Output	None	-		-
Process	• Open the node config file with path string **[config_file]** • Store the config information into the local buffers.			

Name	import_node_data			
Input	node_data	(list)	-	Formatted node structure data list.
Output	None	-		-
Process	• Store the income node data into the local list.			

Name	is_available			
Input	node_req	(dictionary)	-	Request node/core/process..
Output	(int)	(int)		1: Yes 0: No
Process	• Check whether the request processe is available. • Return 1 for available, 0 for not available.			

Name	get_tot			
Input	None	-	-	-
Output	(int)	(int)		Return total processe number.
Process	• Return total processe number.			

Name	get_idle			
Input	None	-	-	-
Output	(int)	(int)		Return current idle processe number.
Process	• Return current idle processe number.			

Name	get_avail			
Input	None	-	-	-
Output	(int)	(int)		Return current max available idle processe number.
Process	• Return current max available idle processe number.			

Name	node_allocate			
Input	node_req	(dictionary)	-	Request node/core/process..
	start	(float)	-	Current virtual time
	end	(float)	-	Job expect end time.
	job_index	(int)	-	The index of the job which requests the processe.
Output	(int)	(int)		1: Success 0: Fail

Process	• Find the available processe and mark them with the **[job_index]**. • Modify other information. • Return 1 if every thing is OK, otherwise return 0.			

Name	node_release			
Input	job_index	(int)	-	The index of the job which release the processe.
	end	(float)	-	Job end time.
Output	(int)	(int)		1: Success 0: Fail
Process	• Release all the processe which marked as **[job_index]**. • This method need at least 1 input parameter and the parameter should be identically named. • Mark the released processe with "idle" • Modify other related information • Return 1 if every thing is OK, otherwise return 0.			

Name	pre_avail			
Input	node_req	(dictionary)	-	Request node/core/process..
	start	(float)	-	Current virtual time
	end	(float)	None	Job expect end time.
Output	(int)	(int)		1: Yes 0: No
Process	• Check whether the job can run from **[start]** to **[end]** with all the prediction. • If **[end]** is None, then set it to **[start]** • Return 1 for available, 0 for not available.			

Name	reserve			
Input	node_req	(dictionary)	-	Request node/core/process..
	job_index	(int)	-	The index of the job which requests the processe.
	time	(float)	-	Job expect run time.
	start	(float)	None	Current virtual time
	index	(int)	-1	The index of the prediction list start to scan
Output	(int)	(int)		1: Yes 0: No
Process	• Reserve the job can from **[start]** to **[end]** in the prediction data. • If **[start]** is None, just find a space to reserve it • If **[index]** is -1, scan the prediction list from 0, otherwise scan from **[index]** • Return 1 for available, 0 for not available.			

Name	pre_delete			
Input	node_req	(dictionary)	-	Request node/core/process..
	job_index	(int)	-	The index of the job which requests the processe.
Output	(int)	(int)		1: Yes 0: No
Process	• Delete **[node_num]** number of processes from the reserved job whose index is **[job_index]** • Return 1 for available, 0 for not available.			

Name	pre_modify

Input	node_req	(dictionary)	-	Request node/core/process..
	start	(float)	-	Current virtual time
	end	(float)	-	Job expect end time.
	job_index	(int)	-	The index of the job which requests the processe.
Output	(int)	(int)		1: Yes 0: No
Process	• Modify the reserve data of the selected job. • Return 1 for available, 0 for not available.			

Name	pre_get_last			
Input	None	-	-	-
Output	(dictionary)	(dictionary)		The dictionary contain the last value of all kind of information
Process	• Scan the prediction job list and return the last value of start and end time			

Name	pre_reset			
Input	time	(int)	-	Current virtual time
Output	(int)	(int)		1: Success 0: No
Process	• Reset the prediction list • Clean the prediction list, then scan the node state and build the initial prediction list.			

Name	find_res_place			
Input	node_req	(dictionary)	-	Request node/core/process..
	index	(int)	-	The index of prediction list start to scan
	time	(int)	-	Current virtual time
Output	(int)	(int)		-1: Can reserve the job starting at **[index]** >=0: The index not available for the reservation
Process	• Scan the prediction list from **[index]**, return the index of the position in prediction list where the is not available for the reservation. Otherwise, return -1			

Name	find_ place			
Input	node_req	(dictionary)	-	Request node/core/process..
Output	(list)	(list)		List of the allocated job index
Process	• Find the request node, return the list of node index			

Name	recover_place			
Input	node_list	(list)	-	The node index lit need to release
Output	None	-		-
Process	• Release the node whose index are in the input list.			

3.6 Backfill

Name	__init__			
Input	mode	(int)	0	Backfill mode, no difference will be made if only one mode

				designed.
	ad_mode	(int)	0	Adapt backfill mode
	node_module	(handle)	None	Node structure module handle
	info_module	(handle)	None	System information module handle
	debug	(handle)	None	Debug module handle
	para_list	(list)	None	Additional parameter.
	ad_para_list	(list)	None	Adapt parameter.
Output	None	-		-
Process	• Initialize the parameters. • Initialize the adapt parameters.			

Name	reset			
Input	mode	(int)	None	-
	ad_mode	(int)	None	-
	node_module	(handle)	None	-
	info_module	(handle)	None	-
	debug	(handle)	None	-
	para_list	(list)	None	-
	ad_para_list	(list)	None	-
Output	None	-		-
Process	• Reset the parameters. • Reset the adapt parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	backfill			
Input	wait_job	(list)	-	The list of the related waiting job with the details. Each job information is a dictionary.
	para_in	(dictionary)	None	Running time parameters in the dictionary type.
Output	(list)	(list)		List of the backfill jobs. None for no job can be backfill.
Process	• This is the entry of the backfill module. • Receive the running time information and store them into the local buffers, then invoke **main** method to deal with the request. • Get the first backfill job index(in wait list) from the **main** method and return it to the invoker.			

Name	main			
Input	None	-	-	All the parameters should be stored in the local buffer.
Output	(list)	(list)		List of the backfill jobs. None for no job can be backfill.
Process	• Provide the backfill function. • Return the List of index of the backfill jobs .			

	• It select different backfill mode by the input parameter **[mode]**, and invoke corresponding backfill method.

Name	backfill_EASY			
Input	None	-	-	All the parameters should be stored in the local buffer.
Output	(list)	(list)		List of the backfill jobs. None for no job can be backfill.
Process	• EASY backfill • Return the List of index of the backfill jobs .			

Name	backfill_cons			
Input	None	-	-	All the parameters should be stored in the local buffer.
Output	(list)	(list)		List of the backfill jobs. None for no job can be backfill.
Process	• Conservative backfill • Return the List of index of the backfill jobs .			

Name	adapt_reset			
Input	None	-	-	-
Output	None	-		-
Process	• Read the adapt config file and reset the adapt parameter • Add average utilization interval time into **Info_collect** module.			

Name	set_adapt_data			
Input	None	-	-	-
Output	None	-		-
Process	• Analysis the information in the **Info_collect** module and add the new adapt data in the most new item in **Info_collect** module.			

Name	get_adapt_info_name			
Input	None	-	-	-
Output	(string)	(string)		The name of the adapt data name in **Info_collect** module
Process	• Return the name of the adapt data name in **Info_collect** module			

Name	adapt_read_config			
Input	fileName	(string)	-	Config file name
Output	(int)	(int)		1. success 0. not
Process	• Read the adapt config file • Return 1 if success.			

Name	backfill_adapt			
Input	para_in	(list)	-	Current running time parameters
Output	(int)	(int)		1. success 0. not
Process	• Call the selected adapt method depending on the adapt mode • Return 1 if success.			

Name	adapt_1			
Input	None	-	-	-
Output	(int)	(int)		1. success 0. not
Process	• Adapt method • Return 1 if success.			

Name	get_list			
Input	inputstring	(string)	-	Input string which need to be analysis into a list
	regex	(string)	r”([^,]+)”	Regular expression string
Output	(list)	(list)		The result list
Process	• Analysis the income string and use the income regular expression sample to analysis it. • Return the result list of string.			

Name	get_adapt_list			
Input	None	-	-	-
Output	(list)	(list)		The list of parameters which may be modified when adapt
Process	• Return the list of parameters which may be modified when adapt			

3.7 Start_window

Name	__init__			
Input	mode	(int)	0	Window mode, no difference will be made if only one mode designed.
	ad_mode	(int)	0	Adapt window mode
	node_module	(handle)	None	Node structure module handle
	info_module	(handle)	None	System information module handle
	debug	(handle)	None	Debug module handle
	para_list	(list)	[5,0,0]	Additional parameter list.
	para_list_ad	(list)	None	Additional parameter list for adapt function.
Output	None	-		-
Process	• Initialize the parameters. • **[win_size]** = **[para_list[0]]** • **[check_size_in]** =**[para_list[1]]**, **[check_size_in]** = **[win_size]** if **[para_list[1]]** is -1 • **[start_max_size]** =**[para_list[2]]**, **[start_max_size]** = **[win_size]** if **[para_list[1]]** is -1			

Name	reset			
Input	mode	(int)	None	-
	ad_mode	(int)	None	-
	node_module	(handle)	None	-
	info_module	(handle)	None	-
	debug	(handle)	None	-

	para_list	(list)	None	-
	para_list_ad	(list)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	start_window			
Input	wait_job	(list)	-	The list of the related waiting job with the details. Each job information is a dictionary.
	para_in	(dictionary)	None	Running time parameters in the dictionary type.
Output	(list)	(list)		The reordered sequence of the input job list.
Process	• This is the entry of the adapt module. • Receive the running time information and store them into the local buffers, then invoke **main** method to deal with the request. • Get the reordered job sequence from the **main** method and return it to the invoker.			

Name	main			
Input	None	-	-	All the parameters should be stored in the local buffer.
Output	(list)	(list)		The reordered sequence of the input job list.
Process	• Provide the adapt function. • Return the reordered job sequence . • It select different window mode by the input parameter **[mode]**, and invoke corresponding window method.			

Name	window_size			
Input	None	-	-	-
Output	(int)	(int)		Return the window size
Process	• As the window function only change the order of the first x waiting jobs, it is not necessary for the simulator to pass the whole waiting list into the adapt module. • Return the window size. If waiting job list is longer than that, the window module do not care about the rest part.			

Name	check_size			
Input	None	-	-	-
Output	(int)	(int)		Return the check size
Process	• Return the check size.			

Name	start_num			
Input	None	-	-	-

Output	(int)	(int)		The number of the jobs which are started before next window.
Process	• Return the number of the jobs which are started before next window			

Name	reset_list			
Input	None	-	-	-
Output	None	-		-
Process	• Reset the buffers and rebuild the sequence list by calling the recursion method **build_seq_list()**.			

Name	build_seq_list			
Input	seq_len	(int)	-	Sequence list length
	ele_pool	(list)	-	Element pool in order
	temp_index	(int)	-	The position of the number set in this iteration.
Output	None	-		-
Process	• This is a recursion method. It keep calling itself until no more element in **[ele]**. • In every iteration, the method takes an element out from the element pool. • When no more element in the pool, it stop recursion and record all the elements in order, hence a new sequence is produced and be added to the sequence list. • This design is to make the sequence list be able to fit different check size in running time: if check size is 3, take first 1*2*3=6 sequences in the list if check size is 4, take first 1*2*3*4=24 sequences in the list, and so on.			

Name	window_check			
Input	None	-	-	-
Output	(list)	(list)		The reordered sequence of the input job list.
Process	• Do the window check and return the reordered sequence of the input job list.			

Name	adapt_reset			
Input	None	-	-	-
Output	None	-		-
Process	• Read the adapt config file and reset the adapt parameter • Add average utilization interval time into **Info_collect** module.			

Name	set_adapt_data			
Input	None	-	-	-
Output	None	-		-
Process	• Analysis the information in the **Info_collect** module and add the new adapt data in the most new item in **Info_collect** module.			

Name	get_adapt_info_name			
Input	None	-	-	-
Output	(string)	(string)		The name of the adapt data name in **Info_collect** module
Process	• Return the name of the adapt data name in **Info_collect** module			

Name	adapt_read_config			
Input	fileName	(string)	-	Config file name
Output	(int)	(int)		1. success 0. not
Process	• Read the adapt config file • Return 1 if success.			

Name	window_adapt			
Input	para_in	(list)	-	Current running time parameters
Output	(int)	(int)		1. success 0. not
Process	• Call the selected adapt method depending on the adapt mode • Return 1 if success.			

Name	adapt_1			
Input	None	-	-	-
Output	(int)	(int)		1. success 0. not
Process	• Adapt method • Return 1 if success.			

Name	get_list			
Input	inputstring	(string)	-	Input string which need to be analysis into a list
	regex	(string)	r"([^,]+)"	Regular expression string
Output	(list)	(list)		The result list
Process	• Analysis the income string and use the income regular expression sample to analysis it. • Return the result list of string.			

Name	get_adapt_list			
Input	None	-	-	-
Output	(list)	(list)		The list of parameters which may be modified when adapt
Process	• Return the list of parameters which may be modified when adapt			

3.8 Basic_Algorithm

Name	__init__			
Input	ad_mode	(int)	0	Adapt mode, no difference will be made if only one mode designed.
	element	(list)	None	Element list of the algorithm.
	info_module	(handle)	None	System information module handle
	debug	(handle)	None	Debug module handle
	ad_para_list	(dictionary)	None	Adapt parameter.
Output	None	-		-
Process	• Initialize the parameters. • Assemble the element list into the algorithm string			

Name	reset			
Input	ad_mode	(int)	None	-
	element	(list)	None	-
	info_module	(handle)	None	-
	debug	(handle)	None	-
	ad_para_list	(dictionary)	None	-
Output	None	-		-
Process	• Reset the parameters. • Assemble the element list into the algorithm string			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	build_alg_str			
Input	None	-	-	-
Output	None	-		-
Process	• Group the algorithm elements and form the algorithm string.			

Name	get_score			
Input	wait_job	(list)	-	The list of all waiting job with the details. Each job information is a dictionary.
	currentTime	(float)	-	Current virtual time
	para_list	(dictionary)	None	Related system current information.
Output	(list)	(list)		The score list of the wait job. Return None if any error ocurr.
Process	• Receive the job information and system information. • Calculate the job score depending on the input information. • Return the score list.			

Name	adapt_reset			
Input	None	-	-	-
Output	None	-		-
Process	• Read the adapt config file and reset the adapt parameter • Add average utilization interval time into **Info_collect** module.			

Name	set_adapt_data			
Input	None	-	-	-
Output	None	-		-
Process	• Analysis the information in the **Info_collect** module and add the new adapt data in the most new item in **Info_collect** module.			

Name	get_adapt_info_name			
Input	None	-	-	-
Output	(string)	(string)		The name of the adapt data name in **Info_collect** module
Process	• Return the name of the adapt data name in **Info_collect** module			

Name	adapt_read_config			
Input	fileName	(string)	-	Config file name
Output	(int)	(int)		1. success 0. not
Process	• Read the adapt config file • Return 1 if success.			

Name	alg_adapt			
Input	para_in	(list)	-	Current running time parameters
Output	(int)	(int)		1. success 0. not
Process	• Call the selected adapt method depending on the adapt mode • Return 1 if success.			

Name	adapt_1			
Input	None	-	-	-
Output	(int)	(int)		1. success 0. not
Process	• Adapt method • Return 1 if success.			

Name	get_list			
Input	inputstring	(string)	-	Input string which need to be analysis into a list
	regex	(string)	r"([^,]+)"	Regular expression string
Output	(list)	(list)		The result list
Process	• Analysis the income string and use the income regular expression sample to analysis it. • Return the result list of string.			

Name	get_adapt_list			
Input	None	-	-	-
Output	(list)	(list)		The list of parameters which may be modified when adapt
Process	• Return the list of parameters which may be modified when adapt			

3.9 Info_collect

Name	__init__			
Input	ave_uti	(list)	None	Average utilization interval list.
	debug	(handle)	None	Debug module handle
Output	None	-		-
Process	• Initialize the parameters.			

	• Reset the output data, set the data obtain methods of job/monitor events.			

Name	reset			
Input	ave_uti	(list)	None	-
	debug	(handle)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	<User Defined Method>			
Input	None	-	-	Input and output are always None
Output	None	-		-
Process	• This stands for the methods user defined to get the data. • After implementing these methods, you need to connect it to the data name you want to set. • You can use the all the known data for calculating. And you are supposed to know them when you build this method.			

Name	reset_info_data			
Input	None	-	-	-
Output	None	-		-
Process	• Reset the output data.			

Name	add_info_data			
Input	data_name	(string)	-	Dictionary name of the data
	j_func	(method)	None	The method running at job event
	m_func	(method)	None	The method running at monitor event
Output	None	-		-
Process	• Add the item to **[info_data]** which concluding dictionary name, job event method and monitor event method. • Create the corresponding overall buffer. • Reset the data number.			

Name	reset_state_date			
Input	date	(date)	-	
Output	None	-		-
Process	• Reset the start date.			

Name	info_collect			
Input	time	(float)	-	Virtual time of this information

	event	(int)	-	1:Job, 2:Monitor, 3:Extend, -1:Initial
	uti	(float)	-	The utilization at this time
	extend	(list)	None	Other new characters may be added.
	current_para	(list)	None	Current parameter
Output	None	-		-
Process	• Receive formatted system information and store them as a new item in the list. • Call **calculate_ave_uti()** to get the required average utilization. • Call **info_analysis ()** to get the required data.			

Name	info_analysis			
Input	event	(dictionary)	-	Event information
Output	None	-		-
Process	• Call every data calculate method to get data			

Name	get_info			
Input	index	(int)	-	The index of the request information. If it is None, return the whole list.
Output	(dictionary)	(dictionary)		Return the request system information
Process	• Return the request system information list. • Return None if index is exceeded			

Name	get_len			
Input	None	-	-	-
Output	(int)	(int)		Return the length of the system information list.
Process	• Return the length of the system information list.			

Name	get_current_index			
Input	None	-	-	-
Output	(int)	(int)		Return the current data index.
Process	• Return the current data index.			

Name	calculate_ave_uti			
Input	None	-	-	-
Output	None	-		-
Process	• Calculate the average utilization for the most new system information.			

Name	reset_avg_interval			
Input	None	-	-	-
Output	None	-		-
Process	• Reset the average interval list			

Name	reorder_uti_interval			
Input	None	-	-	-

Output	None	-		-
Process	• Reorder the utilization interval list by reset the order list. • The order list is for the module to calculate average utilization quicker.			

3.10 Log_print

Name	__init__			
Input	filePath	(string)	-	file name
	mode	(int)	0	0: renew file 1: add log
Output	None	-		-
Process	• Initialize the parameters. • Call **file_open** method to open the specified			

Name	reset			
Input	filePath	(string)	None	-
	mode	(int)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	file_open			
Input	None	-	-	-
Output	(int)	(int)		1: success 0: Fail
Process	• Open the specified file.			

Name	file_close			
Input	None	-	-	-
Output	(int)	(int)		1: success 0: Fail
Process	• Close the opened file if any file is opened. • Return 1 if success, otherwise return 0			

Name	log_print			
Input	context	(string)	-	Context to print.
	isEnter	(int)	1	1: print Enter after context otherwise: not print enter
Output	(int)	(int)		1: success 0: Fail
Process	• Print the log to the file specified before. • Return 1 if success, otherwise return 0			

3.11 Debug_log

Name	__init__			
Input	lvl	(int)	2	0 to 5, 0 is no debug log printed

	show	(int)	2	The lowest level which will be print on the screen.
	path	(string)	None	Debug log path and name.
Output	None	-		-
Process	• Initialize the parameters.			

Name	reset			
Input	lvl	(int)	None	-
	show	(int)	None	
	path	(string)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	reset_log			
Input	None	-	-	-
Output	None	-		-
Process	• Clean the specified debug log.			

Name	set_lvl			
Input	lvl	(int)	0	0 to 4, 0 is no debug log printed, 3 is printing all debug log.
Output	None	-		-
Process	• Reset the debug level.			

Name	debug			
Input	context	(all type)	-	Debug content, will be changed into string.
	lvl	(int)	3	1 to 4, 0 is no debug log printed, 3 is printing all debug log.
	isEnter	(int)	1	1 for enter after the context, 0 for not enter.
Output	None	-		-
Process	• Call the log print module to add the content to the debug log if **[lvl]** is smaller than the print log level.			

Name	line			
Input	lvl	(int)	1	1 to 4, 0 is no debug log printed, 3 is printing all debug log.
	signal	(string)	"-"	Signal to form the line
	num	(int)	15	Duplication number of the signal
Output	None	-		-
Process	• Call the log print module to add the content to the debug log if **[lvl]** is smaller than the print log level.			

3.12 Output_log

Name	__init__			
Input	output	(dictionary)	None	Output file name dictionary
Output	None	-		-
Process	• Initialize the parameters.			

	• Initialize all the output file name

Name	reset			
Input	output	(dictionary)	None	-
Output	None	-		-
Process	• Reset the parameters.			

Name	reset_output			
Input	None	-	-	-
Output	None	-		-
Process	• Reset the output file path and name.			

Name	print_sys_info			
Input	sys_info	(dictionary)	-	System information needed to be printed.
Output	None	-		-
Process	• Print the current system information to the system information file.			

Name	print_adapt			
Input	adapt_info	(dictionary)	-	Adapt information needed to be printed.
Output	None	-		-
Process	• Print the adapt information to the adapt information file.			

Name	print_result			
Input	job_module	(handle)	-	Job trace module
Output	None	-		-
Process	• Print all the job result.			

3.13 Cqsim_sim

Name	__init__			
Input	module	(dictionary)	-	The dictionary of the input module handle.
	monitor	(float)	None	Monitor event time interval.
	mon_para	(list)	None	Monitor parameter list
	debug	(handle)	None	Debug module handle
Output	None	-		-
Process	• Initialize the parameters.			

Name	reset			
Input	module	(dictionary)	None	-
	monitor	(float)	None	-
	mon_para	(list)	None	-
	debug	(handle)	None	-

Output	None	-		-
Process	• Reset the parameters.			

Name	show_module_info			
Input	None	-	-	-
Output	None	-		-
Process	• Show module information in debug file.			

Name	cqsim_sim			
Input	None	-	-	-
Output	None	-		-
Process	• The main process of the simulator. • Initialize the event sequence with the job submit event, monitor event and extend event. • Scan the event sequence and deal with all the event in the sequence. • Output the job result.			

Name	insert_event_job			
Input	None	-	-	-
Output	None	-		-
Process	• Read the job trace and insert the job submit event in the event sequence in time order. • event information: type : 1 time: submit time priority: 2 para: [1,job index], means this is a submit event.			

Name	insert_event_monitor			
Input	start	(float)	-	Start time of the start job
	end	(float)	-	End time of the start job
Output	None	-		-
Process	• Insert the monitor event in the event sequence from **[start]** to **[end]**.(Contain **[start]**, not **[end]**) • event information: type : 2 time: monitor time priority: 5 para: **[mon_para]**			

Name	insert_event_extend			
Input	None	-	-	-
Output	None	-		-
Process	• Insert the extend event in the event sequence in time order. • event information: type : 3			

	time: user designed priority: user designed para: user designed

Name	insert_event			
Input	type	(int)	-	1: job 2: monitor 3: extend
	time	(float)	-	Virtual time of the event
	priority	(int)	-	Priority of the job
	para	(list)	None	Parameter list of the event.
	quick	(index)	-1	Quick insert signal,1 for just add it to the end of the queue
Output	None	-		-
Process	• Insert the event in the sequence, automatically find the place by parameters **[time]** and **[priority]**.			

Name	delete_event			
Input	type	(int)	-	1: job 2: monitor 3: extend
	time	(float)	-	Virtual time of the event
	index	(int)	-	The index of the deleting event
Output	(int)	(int)		1: Success 0: Fail
Process	• Delete the selected event which is indicated by **[index]** or **[time** & **type]** • If invoker provides **[index]** and **[time** & **type]**, the **[index]** parameter has higher priority. • Return 1 if success, otherwise 0.			

Name	get_index_monitor			
Input	None	-	-	-
Output	(int)	(int)		Return the current monitor pointer.
Process	• Return the current monitor pointer. • This helps inserting the monitor event			

Name	scan_event			
Input	None	-	-	-
Output	None	-		-
Process	• Scan the event sequence recursively. • Call the corresponding method to deal with the current event in the sequence, then move the pointer to the event. • Stop when no event left in the sequence.			

Name	event_job			
Input	para_in	(list)	None	Parameter list of the event.
Output	None	-		-
Process	• Deal with the job event (submit/finish). • Calculate the scores of the waiting job after the event is done. • Call the start scan method group: window - start new job - backfill • Store the system information.			

	• Insert monitor event from current time to time of the next event. • Call the user interface module to show the current system state.

Name	event_monitor			
Input	para_in	(list)	None	Parameter list of the event.
Output	None	-		-
Process	• Deal with the monitor event. • Call the adapt functions. • Call the **print_adapt()** method if needed.			

Name	event_extend			
Input	para_in	(list)	None	Parameter list of the event.
Output	None	-		-
Process	• Deal with the extend event. • Call the extend process.			

Name	submit			
Input	job_index	(int)	-	Index of the submitting job.
Output	None	-		-
Process	• Submit the job by calling the corresponding method in **job_trace** module.			

Name	finish			
Input	job_index	(int)	-	Index of the finish job.
Output	None	-		-
Process	• Finish the job by calling the corresponding method in **job_trace** module.			

Name	start			
Input	job_index	(int)	-	Index of the finish job.
Output	None	-		-
Process	• Start the job by calling the corresponding method in **job_trace** module. • Insert job finish event			

Name	score_calculate			
Input	None	-	-	-
Output	None	-		-
Process	• Calculate the score for all jobs in waiting list. • Reorder the waiting list depending on the score list.			

Name	start_scan			
Input	None	-	-	-
Output	None	-		-
Process	• Scan the jobs in waiting list till no job can be start or backfill. • Window function will be used before job start.			

	• Backfill function will be used when no job can be started.

Name	start_window			
Input	temp_wait_B	(list)	-	Job wait list
Output	(list)	(list)		New list after window check
Process	• Call the window function to modify the order of the waiting job. • Return the new reorder list.			

Name	backfill			
Input	temp_wait	(list)	-	Job wait list
Output	(int)	(int)		1: Success 0: no
Process	• Call the backfill function and get the backfill job list. • Start them if any job in the list. • Return 1 for some jobs are backfill, 0 for no.			

Name	sys_collect			
Input	sys_info_list	(dictionary)	-	Current system information list
Output	None	-		-
Process	• Collect the current system information and call the **Info_collect** module to store them. • Print the current system information.			

Name	interface			
Input	sys_info	(dictionary)	None	Current system information need to be shown
Output	None	-		-
Process	• Call the running time user interface module to show the inforamtion.			

Name	backfill_adapt			
Input	None	-	-	-
Output	(int)	(int)		1: modify 0: not modify
Process	• Call the **adapt** method in **backfill** module to modify the parameter of backfill in the monitor event process.			

Name	alg_adapt			
Input	None	-	-	-
Output	(int)	(int)		1: modify 0: not modify
Process	• Call the **adapt** method in **Basic_algorithm** module to modify the algorithms in the monitor event process.			

Name	window_adapt			
Input	None	-	-	-
Output	(int)	(int)		1: modify 0: not modify
Process	• Call the **adapt** method in **Start_window** module to modify the parameter of window in the monitor event process.			

Name	print_sys_info

Input	sys_info	(dictionary)	-	System information needed to be printed.
Output	None	-		-
Process	• Print the current system information to the system information file.			

Name	print_adapt			
Input	adapt_info	(dictionary)	-	Adapt information needed to be printed.
Output	None	-		-
Process	• Print the adapt information to the adapt information file.			

Name	print_result			
Input	None	-	-	-
Output	None	-		-
Process	• Print all the job result.			

4. Data

4.1 Overall

All modules are suppose to know the format of all public data although they do not really know them. Hence, they can get the right data from the incoming dictionary.
So, any change on data format should be record clearly. This section list all public data in every module, the corresponding format are discussed in the next section.

4.2 Public Data

White data are list or dictionary. Gray data are variable.
Some data have not commentary, because they are not important or have been explained.

	Filter_job	jobList	job data list
		config_data	list of data information which will be stored into the config file.
		start	start virtual time
		sdate	start date
		density	job submit density modification rate
		anchor	position of the first read job in the original job trace file
		rnum	read job number
		trace	original job trace file name
		save	formatted job trace file name
		config	config file name
		jobNum	read job number
		debug	

	Filter_node	nodeList	node data list
		config_data	list of data information which will be stored into the config file.
		struc	original node structure file name
		save	formatted node structure file name
		nodeNum	total node number
		config	config file name
		debug	
	Job_trace	jobTrace	formatted job data list
		job_submit_list	
		job_wait_list	
		job_run_list	
		job_done_list	
		job_wait_size	
		start	virtual start time
		start_date	start date
		anchor	
		read_num	
		density	
		start_offset_A	This is the offset time made by user input virtual start time in job filter. It is get from the config file.
		start_offset_B	This is the offset time made by user input virtual start time in job trace.
		debug	
	Node_struc	nodeStruc	formatted node data list
		nodePool	idle node index pool.
		temp_nodePool	
		job_list	running job index list
		predict_node	predict node index
		predict_job	predict job index
		tot	total node number
		idle	idle node number
		avail	max available node number
		debug	
	Backfill	para_list_in	
		ad_para_list_in	
		current_para	
		ad_ current_para	

		wait_job		
		para	mode	
			ad_mode	
			size	
			ad_config	
		node_module		
		debug		
		adapt_data_name		
		adapt_data_para		
		check_data_name		
		check_data_para		
		ave_uti_interval		
		ave_uti_index		
		adapt_item		
		bound_item		
		adapt_info_name		
	Start_window	para_list		
		ad_para_list		
		current_para		
		seq_list		
		temp_list		
		wait_job		
		para	mode	
			ad_mode	
			win_size	window size
			check_size	the first x job will be reorder to find the quickest sequence
			max_start_size	The max number of job can be start between 2 window function
			ad_config	
		node_module		
		info_module		
		temp_check_len		
		debug		
		adapt_data_name		
		adapt_data_para		
		check_data_name		
		check_data_para		
		ave_uti_interval		

		ave_uti_index		
		adapt_item		
		bound_item		
		adapt_info_name		
	Bacis_Algorithm	ad_para_list		
		scoreList		
		para	mode	
			ad_mode	
			element	algorithm element
			sign	algorithm sign
			ad_config	
		algStr	algorithm string	
		debug		
		adapt_data_name		
		adapt_data_para		
		check_data_name		
		check_data_para		
		ave_uti_interval		
		ave_uti_index		
		adapt_item		
		bound_item		
		adapt_info_name		
	Info_collect	sys_info	system information list	
		avg_inter_in	Average interval list	
		order_seq	The index of average utilization interval in order.	
		eventType	monitor	‘C’
			submit	‘Q’
			start	‘S’
			end	‘E’
		info_data	Data information list Contain all data item which need to be store.	
		overall_info	This provide the buffer of each item in **[info_data]**	
		current_index	current information index	
		start_date	start date	
		alg_module		
		total_uti		
		data_num	item number of **[info_data]**	
		debug		

	Log_print	modelist	mode list (write or add)
		filePath	
		mode	mode
		logFile	log file object
	Debug_log	debugFile	
		path	
		lvl	
		show	
	Output_log	event_seq	
		sys_info	
		adapt_info	
		job_result	
	Cqsim_sim	module	contain all input module handles
		mon_para	monitor parameter.
		event_seq	event sequence list
		event_pointer	current event index
		monitor_start	next monitor event index
		current_event	current event
		job_num	total job number
		currentTime	current virtual time
		startTime	virtual start time
		monitor	monitor interval time
		debug	

5 Format

5.1 User Command Line Format

5.1 Cqsim Command Line						
ID	Name1	Name2	Type	Default	Dest	Comment
1	-j	--job	string	None	job_trace	job trace file name
2	-n	--node	string	None	node_struc	node structure file name
3	-J	--job_save	string	[job trace name]	job_save	formatted job trace data file name
4	-N	--node_save	string	[job trace name]+"_node"	node_save	formatted node structure data file name
5	-f	-- frac	float	1	cluster_fraction	job density adjust

6	-s	--start	float	0	start	first job start virtual time
7	-S	--start_date	date	None	start_date	first job start date
8	-r	--anchor	int	0	anchor	first job position in job trace
9	-R	--read	int	-1	read_num	number of jobs read from the job trace
10	-p	--pre	string	"CQSIM_"	pre_name	previous file name
11	-o	--output	string	[job trace name]	output	simulate result file name
12		--debug	string	“debug_”+[job trace name]	debug	debug file name
13		--ext_fmt_j	string	".csv"	ext_fmt_j	formatted job data extension type
14		--ext_fmt_n	string	".csv"	ext_fmt_n	formatted job data extension type
15		--ext_fmt_j_c	string	".con"	ext_fmt_j_c	temp job trace config extension type
16		--ext_fmt_n_c	string	".con"	ext_fmt_n_c	temp job trace config extension type
17		--path_in	string	“InputFiles/”	path_in	input file path
18		--path_out	string	“Reults/”	path_out	output result file path
19		--path_tmp	string	“Temp/”	path_tmp	temp result file path
20		--path_debug	string	“Debug/”	path_debug	debug file path
21		--ext_jr	string	".rst"	ext_jr	job result log extension type
22		--ext_si	string	".ult"	ext_si	system information log extension type
23		--ext_ai	string	".adp"	ext_ai	adapt information log extension type
24		--ext_d	string	".log"	ext _debug	debug log extension type
25	-v	--debug_lvl	int	4	-debug_mode	debug mode
26	-a	--alg	list	None	alg	basic algorithm list
27	-A	--sign	list	None	alg_sign	sign of the basic algorithm element
28	-b	--backfill	int	0	backfill	backfill mode
29	-B	--bf_para	list	None	bf_para	backfill parameter list
30	-w	--win	int-	0	win	window mode
31	-W	--win_para	list	None	win_para	window parameter list
32	-l	--ad_bf	int	0	ad_bf	backfill adapt mode
33	-L	--ad_bf_para	list	None	ad_bf_para	backfill adapt parameter list
34	-d	--ad_win	int	0	ad_win	window adapt mode
35	-D	--ad_win_para	list	None	ad_win_para	window adapt parameter list
36	-g	--ad_alg	int	0	ad_alg	algorithm adapt mode
37	-G	--ad_alg_ para	list	None	ad_alg_para	algorithm adapt parameter list
38	-c	--config_n	string	"config_n.set"	config_n	config file - file name and path
39	-C	--config_sys	string	"config_sys.set"	config_sys	system config file
40	-m	--monitor	int	None	monitor	monitor interval time
41	-M	--mon_para	list	None	mon_para	monitor parameter list
42	-u	--uti	list	None	ave_uti	average utilization interval list
43	-e	--ver	string	“ORG”	ave_uti	version name

5.2 Basis Algorithm Format

The basic algorithm use some simple letters to represent the different informations of a job. The algorithm method stores the information in these buffers and then calculate the scores with them.

s	Job submit time
t	Job estimated running time
n	Job required nodes #
w	Job waiting time
m	Current idle nodes #
l	Longest job estimated time (in waiting list)
z	Longest job waiting time (in waiting list)

.

The structure of the algorithm string is stored as [elements of the algorithm string, the signal of the element] pairs in a list.

element	A string contain the element.
signal	1: The element will be changed in future 0:The element will not be changed in this simulator

For example the algorithm list is:

"0.75"	"* w/z+"	"0.25"	"*l/t"
1	0	1	0

So, the algorithm string is "0.75* w/z+0.25*l/t " and the elements will be changed in future are "0.75" and "0.25".

5.3 Job Trace Format

The type of the job trace is list of dictionary.

Dictionary Name	Type	Comment	Initial
id	int	The id of the job	-1
submit	float	Submit time of the job	-1.0
wait	float	Actual waiting time	-1.0
run	float	Actual running time	0.0
usedProc	int	Actual processes the job takes	0
usedAveCPU	float		0.0
usedMen	float	Actual used memory	0
reqProc	int	The processes required by user	0
reqTime	float	The running time required by user	0.0
reqMem	float	Kilobytes per processor	0.0
status	int	Status of the job	0
userID	int	User ID	-1
groupID	int	Group ID	-1
num_exe	int	Executable number	0

num_queue	int	Queue number	0
num_part	int	Partition number	0
num_pre	int	Preceding job number	0
thinkTime	int	Think time from preceding job	0
start	float	Job start time	-1.0
end	float	Job end time	-1.0
score	int	Job scores, shows the priority of the job	0
state	int	0: Not submit, 1:In waiting list, 2:Running, 3:Done	0
happy	int	0: Not happy, 1:Happy, -1:Not care	-1
estStart	float	Estimated start time, the time predicted to run when the job is submitted considering no backfill or any other modification in job order.	-1.0
extend	list	Other new characters may be added.	None

5.4 Node Structure Format

The type of the node structure is list of dictionary.

Dictionary Name	Type	Comment	Initial
id	int	The id of the node.	-1
location	list	The location of the node, kind of [x,y,z] or [x,y]. Can also be None if you do not care about the location of the node.	None
group	int	Group ID of the node.	1
state	int	-1: Idle, Other: The index of the job which takes the node	-1
proc	int	Processes number in the node.	1
start	float	Start time of the occupy of the node.	-1
end	float	Estimated end time of the occupy of the node.	-1
extend	list	Other new characters may be added.	None

The type of the predict node structure is list of dictionary.

Dictionary Name	Type	Comment	Initial
time	float	Time of the event take place	-
idle	int	Idle process number	-
avail	int	Available process number	-

The type of the predict job structure is list of dictionary.

Dictionary Name	Type	Comment	Initial
job	int	Job index	-

start	float	Job estimate start time	-
end	float	Job estimate end time	-

5.5 Event Sequence Format

The type of the node strucutre is list of dictionary.

Dictionary Name	Type	Comment	Initial
type	int	1:Job, 2:Monitor, 3:Extend, -1:Initial	-1
time	float	Virtual time when the event takes place	-1.0
priority	int	Priority of the event, higher priority will take place earlier if there is another event at the same time.	5
para	list	Parameter list which will be transferred into the corresponding method. Job event: submit: [1, job index] (Q) start: [3, job index] (S) finish: [2, job index] (E)	None

5.6 System Information Format

The type of the system information is list of dictionary. It will make a record when an event takes place (event here includes job start).

Dictionary Name	Type	Comment	Initial
date	date	Date of the job trace start time **[date]**+**[time]** suppose to be the real time when the event happen if user did not modify any of them.	None
time	float	Virtual time of this information	-1.0
inter	float	Interval time between this information and next one.	-1.0
uti	float	The utilization at this time	-1.0
waitNum	int	Waiting job number at this time	-1
waitSize	int	Total size of all waiting job	-1
event	string	‘Q’: submit ‘S’: start ‘E’: end ‘C’: monitor	None
tot_ave_uti	float	Overall average utilization	0.0
ave_uti	list	Average utilization list in order.	[]
extend	list	Other new characters may be added.	None

5.7 Config File Format

Every line contains a data: [data name]=[data value]

No rest space should appeared in the line. If there are some spaces, the regular expression function will not take them as “useless” signal, sp some error may occur because the system can not transform the space into a number or can not find the file because of the addition space.
Or you may want to add some codes to ignore the additional space. But these codes are not there now.

5.7.1 File Name And Path Config File

Name	Type	Comment
pre_name	string	previous file name
ext_fmt_j	string	formatted job data extension type
ext_fmt_n	string	formatted job data extension type
ext_fmt_j_c	string	formatted job trace config extension type
ext_fmt_n_c	string	formatted node structure config extension type
path_in	string	input file path
path_out	string	output result file path
path_tmp	string	temp result file path
path_debug	string	debug file path
ext_jr	string	job result log extension type
ext_si	string	system information log extension type
ext_ai	string	adapt information log extension type
ext_debug	string	debug log extension type

5.7.2 System Parameter Config File

Name	Type	Comment
cluster_fraction	float	job density adjust
start	float	first job start virtual time
start_date	date	first job start date
anchor	int	first job position in job trace
read_num	int	number of jobs read from the job trace
debug_lvl	int	debug level
alg	list	basic algorithm list
alg_sign	list	sign of the basic algorithm element
backfill	int	backfill mode
bf_para	list	backfill parameter list
win	int	start window mode
win_para	list	start window module parameter: [window size],[check size],[max start size],[max window size]
ad_win	int	start window adapt mode
ad_bf	int	backfilladapt mode
ad_alg	int	algorithm adapt mode
ad_win_para	list	adapt start window parameter list

		It contains the config file name
ad_bf_para	list	adapt backfill parameter list It contains the config file name
ad_alg_para	list	adapt basic algorithm parameter list It contains the config file name
config_n	string	config file - file name and path
monitor	float	interval time of monitor event
mon_para	list	monitor parameter list
ave_uti	list	The interval list of the average utilization. This parameter will be transmitted into the info_collect module.
job_trace	string	job trace file name
node_struc	string	node structure file name
avg_uti	list	average utilization interval list
module_ver	string	average utilization interval list

5.7.3 Adapt Config File(Basic Algorithm/Backfill/Start Window)

Name	Type	Comment
adapt_data_name	list	Adapt data name in order: names should not combine if they are same. **example:** [name 1],[name 2],…,[name X]
adapt_data_para	list	Adapt data parameter in order: In most time, the parameter is the index of the corresponding data, -1 mean this data is not a list. This is really depend on the design of the config file reading method. **example:** [para 1],[para 2],…,[para X]
check_data_name	list	The name of data need to be check when adapt. **example:** [name 1],[name 2],…,[name Y]
check_data_para	list	The parameter of data need to be check when adapt. **example:** [para 1],[para 2],…,[para Y]
avg_uti	list	Interval list. This list contain all the average data need to be check
adapt_item	list	This is the main part of the adapt function. One **adapt_item** can be add if you want a new adapt choice. For example, you can add an **adapt_item** to indicate that the *ith* data in **adapt_data_name** will -1 if the data in **check_data_name** is in case A. And add another **adapt_item** to indicate that the *ith* data in **adapt_data_name** will +1 if the data in **check_data_name** is in case B. Hence the *ith* data can be modified in running time depending on different cases of the check data. One thing needed to be mentioned is you can add

		conflicted case, but the function will only choose the first one who satisfy the request. All **adapt_item** should be written in the right format: All data should be written as in a list separating by”,” without no addition space.	
		0	Index of the data in **adapt_data_name**
		1	0: change the adapt data to the next value 1: add the next value to the adapt data
		2	The new value will be set to/ad to the corresponding adapt data.
		3~(3+2*Y+1)	Y is the number of check data – 1. These data indicate the case request. For jth check data, it can be considered as “in the case” if **adapt_item[3+j*2]≤check_data[j]< adapt_item[3+j*2+1]** If all the check data is in the case, then this adapt item is the right one.
bound_item	list	This is similar to the **adapt_item**. It defines the bound of all the adapt data when you add the new value in adapt item to them.	
		0	Index of the data in **adapt_data_name**
		1	Smallest value
		2	Biggest value

5.8 Formatted File

2 kinds of formatted file(job/node data temp file) have the same structure:

- Each item takes a single line. For each line, the data are stored in the order which is described in previous section(white part). Every single data in the extend part should be store as a single data.

data 1	data 2	data 3	...another data

- “;” is used as the separated signal in a line. "\n" are used to separate lines.

Formatted config file:

- Each value takes a single line: [data name]=[data value]
- No additional space

5.9 Parameters Format

5.9.1 wait_job (Method: backfill Class: Backfill)

wait_job (Method: backfill Class: Backfill)		
Name	Type	Comment
index	int	Job index
proc	int	Request processes number
node	int	Request nodes number
run	float	Request running time
score	float	Job score

5.10 Output Format

The output data separated with ";".

5.10.1 Job result

Name	Comment
ID	Job ID (not index)
Request process	Request processes number
Request node	Request nodes number
Request time	Request time
Run	Run time
Wait	Waiting time
Submit	Job submit time
Start	Job start time
End	Job finish time
Node list	The nodes which the job take

5.10.2 Event Log

Name	Comment
Start date	Job trace start date Format: %m/%d/%Y &H:%M:%S
Event type	Q: submit S: job start E: job end C: monitor
Virtual event time	virtual event time
Other parameter	[data name 1]=[data value 1] [data name 2]=[data value 2] … Different data separate by space

Other parameter in Event Log	
Name	Value
uti	System ultilization
waitNum	Wait job number at that time
waitSize	Wait job total size

5.10.3 Adapt Log

Name	Comment
Virtual time	virtual time
Start window adapt data	Start window adapt data, separated with “;”
Basic algorithm adapt data	Basic algorithm adapt data, separated with “;”
Backfill adapt data	Backfill adapt data, separated with “;”

5. Extension

3.1 Overall

The program is designed to be an extendable one. All module except **Info_collect*** can be modified to fit new request with keeping the port same.

*In order to keep **Start_window**, **Basic_algorithm** and **Backfill** module independent and efficient, they know the inside structure of the **Info_collect** module. So you need to modify the three module when you modify the **Info_collect** module.

It can be extended in 3 ways:

1. Build new subclass of modules to fit special request. You should import the subclass in the **factory_import.py**, and also add a new module group for it.
2. Add new method. All old functions remain same in this way. New function is added, but you can choose not to use it.
3. Modify the original code. You should make this kind of modification only when it fit all application. For example, you may want to modify the original code when you need to trace more running time information, the additional information is useful in most case and you can easily choose not to track them if you don’t need.

   You should make sure that all related parts know that change and call the new function in the right way. This is easy to implement because the modules are all highly independent.