

Google cluster-usage traces

Dataset presentation
and
possible activities

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Introduction

- Traces from parts of the Google cluster management software and system.
- Cluster size: ~ 12,5 K machines
- Observation time: 29 days (May 2011)
- Start time: 19:00 EDT - May 1st, 2011



Introduction

- Available CSV files:
 - **Job events**
 - **Task events**
 - Task constraints
 - Task usage
 - **Machine events**
 - Machine attributes

Introduction

- Work arrives in the form of **jobs**
- A job is comprised of one or more **tasks**
- Each task is a Linux program that is run on a single **machine**

Introduction

- Heterogeneous machines
 - Platform (capacity and micro-architecture)
 - Attributes (configuration and position)
- Heterogeneous workload
 - Duration
 - Resources usage
 - Priority
- Dynamic workload

Format

- Timestamp
 - It is in **microseconds**
 - It starts at 600 s
 - Time = 0 s → events that occurred before the beginning of the trace window
 - Time = $2^{63}-1$ s → events that occurred after the end of the trace window

Format

- Obfuscation
 - Hashed (e.g. users name, jobs name, etc.)
 - Rescaled (e.g. resources utilization)
 - Other techniques
- Unique identifiers
 - Job: unique ID, generally it is **not** the same when the job is stopped and restarted
 - Machine: unique ID, it can stay the same when a machine is removed and returned
 - Task: job ID + internal index, it can stay the same when a task is stopped and restarted

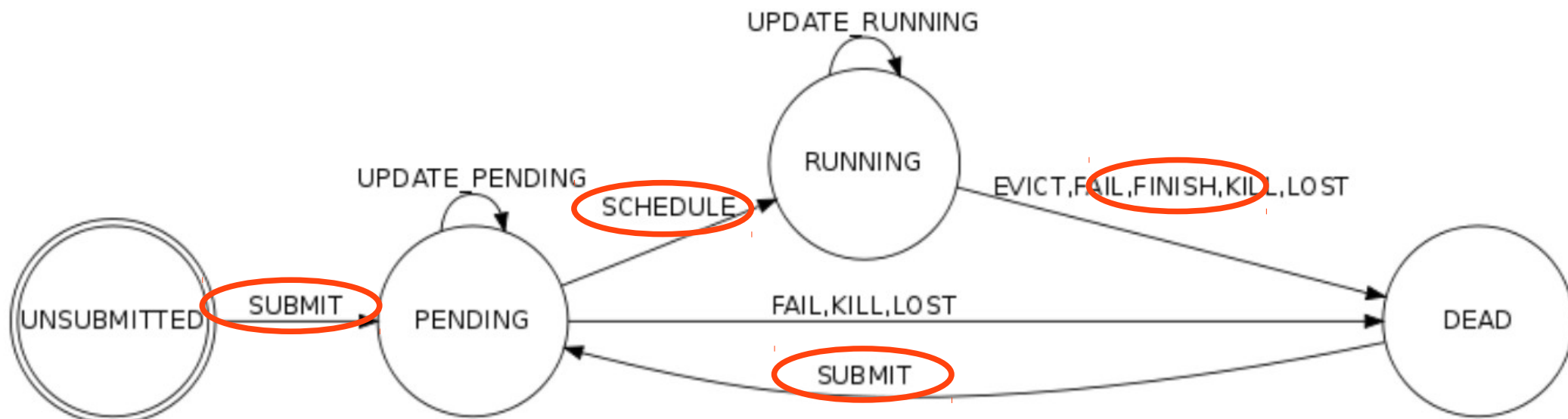
Data tables

The *schema.csv* file describes the columns of each table of the dataset.

file pattern	field number	content	format	mandatory
job_events/part-?????-of-?????.csv.gz	1	time	INTEGER	YES
job_events/part-?????-of-?????.csv.gz	2	missing info	INTEGER	NO
job_events/part-?????-of-?????.csv.gz	3	job ID	INTEGER	YES
job_events/part-?????-of-?????.csv.gz	4	event type	INTEGER	YES
job_events/part-?????-of-?????.csv.gz	5	user	STRING_HASH	NO
job_events/part-?????-of-?????.csv.gz	6	scheduling class	INTEGER	NO
job_events/part-?????-of-?????.csv.gz	7	job name	STRING_HASH	NO
job_events/part-?????-of-?????.csv.gz	8	logical job name	STRING_HASH	NO
task_events/part-?????-of-?????.csv.gz	1	time	INTEGER	YES
task_events/part-?????-of-?????.csv.gz	2	missing info	INTEGER	NO
task_events/part-?????-of-?????.csv.gz	3	job ID	INTEGER	YES
task_events/part-?????-of-?????.csv.gz	4	task index	INTEGER	YES
task_events/part-?????-of-?????.csv.gz	5	machine ID	INTEGER	NO
task_events/part-?????-of-?????.csv.gz	6	event type	INTEGER	YES
task_events/part-?????-of-?????.csv.gz	7	user	STRING_HASH	NO
task_events/part-?????-of-?????.csv.gz	8	scheduling class	INTEGER	NO
task_events/part-?????-of-?????.csv.gz	9	priority	INTEGER	YES
task_events/part-?????-of-?????.csv.gz	10	CPU request	FLOAT	NO
task_events/part-?????-of-?????.csv.gz	11	memory request	FLOAT	NO
task_events/part-?????-of-?????.csv.gz	12	disk space request	FLOAT	NO
task_events/part-?????-of-?????.csv.gz	13	different machines restriction	BOOLEAN	NO
machine_events/part-00000-of-00001.csv.gz	1	time	INTEGER	YES
machine_events/part-00000-of-00001.csv.gz	2	machine ID	INTEGER	YES
machine_events/part-00000-of-00001.csv.gz	3	event type	INTEGER	YES
machine_events/part-00000-of-00001.csv.gz	4	platform ID	STRING_HASH	NO
machine_events/part-00000-of-00001.csv.gz	5	CPUs	FLOAT	NO
machine_events/part-00000-of-00001.csv.gz	6	Memory	FLOAT	NO

Job and Task Events

- **Submit**
- **Schedule**
- **Finish**
- **Evict, Fail, Kill, Lost**
- **Update_Pending, Update_Running**



Machine Events

- Add
- Remove
- Update

job_events table

	A	B	C	D	E	F	G	H	I
7962	0		6251658466	1	d2VTjfYNax8Fa/Wdwdbo7zTYZ1UWfJEyx/DBfhaR/PA>	1	dEyCvwXN31mRiPw2lNBILYCCbQKMO3xCSDOfmGU	Dyb9ZLrgZBGa2c4TKqzthkCZ+OSmhwKcIBHw7tuQvBc=	
7963	0		6251658528	1	d2VTjfYNax8Fa/Wdwdbo7zTYZ1UWfJEyx/DBfhaR/PA>	1	oGnxcHGpwOh/Hc45wyuhuu8/fD50VkwM8MGwjlDaC>	MW8tcTvQrf5pq7+4iGzi8Y64+fAPCFnOjEhFtpAloU=	
7964	0		6251658759	1	d2VTjfYNax8Fa/Wdwdbo7zTYZ1UWfJEyx/DBfhaR/PA>	1	4Z3zNOML3cI85SzJvWUY/KU5kKh5yrxB7FmsmWJzu>	BQFV6/s12bRnR6utp1ZOLsxAPxekt0jip62IAIHotXk=	
7965	0		6251660941	1	RvqPbzcYVpWRGsqXd+PVsDiyS2pJxa2BogyAARJVlo>	1	iaQgK2L0xkJykR8lRg5dEJUqgX0wYRRB6AcND4gigl8>	00c3/JkKF5DRzSTdM/C1s1+cFanFyfJYruRED0719Wo=	
7966	0		6251663901	1	0r3naaX+ybfsUlahb35AvYPC6MarnPhbqkAtRjor0xE=	1	OafiPifvQnxASpEzqv5PZFhdPez2XToCdM/WB9Ga1xk>	rSp0GRW2y6HCnfQZgbkAs2goPID6fYmtJcGoIvFj3c=	
7967	0		6251664424	1	RvqPbzcYVpWRGsqXd+PVsDiyS2pJxa2BogyAARJVlo>	1	z2O1yWE+RCIxDiuffB3dcNrS9BjQ0j8LDCjpyqPei4=	MlovevxnjRcg4m9mpXYyHqW2P5eqfa70Mu4A433csRM=	
7968	0		6251664479	1	RvqPbzcYVpWRGsqXd+PVsDiyS2pJxa2BogyAARJVlo>	1	gCF2PGcVwOTbC6j+V4P9knyn/NlRw1FnO9Qd7Hhkn>	UT5lf+zTd84Kivgig73WNZu+WHy7pQS5tAWeseDgqK0=	
7969	0		6251664801	1	XzZHR6eXZamIB7ISFTc/NXTbAKtt3SoOI8Fp/RtnwU>	2	Dak9tgVohhwVjNUJs8UZ4GON38RQ6n1KXgCOPK1N>	oVQW4BB6g9OxJY1p0jZg3hr00UZ169KuGc0FzEDJoUE=	
7970	0		6251664990	1	RvqPbzcYVpWRGsqXd+PVsDiyS2pJxa2BogyAARJVlo>	1	35GtgFidryCyMyM8hk05My3FOOw4l5LWTXx2V2LTgz>	+vbGpOyqb5wylZrP+xpm7XRuicw+TY8q/kqfMzvKLqE=	
7971	604046276		6251639640	4	0yO12LxPGQxL+Xki4hS6Tlyx5V3K0vjHS0DQSOJeM>	1	0VRH1Jd5MGmAfJ9/rKwhsafRxNYi77rYxgsqb1q2OJw>	Y+cfHMX6f6uUQjHk6eR09YEJfat+HtYJMC6R3J2WPAA=	
7972	604046279		6251639646	0	0yO12LxPGQxL+Xki4hS6Tlyx5V3K0vjHS0DQSOJeM>	1	EYDyc8ljuNDS9uG3CvLOMS9KBVlgFP1tGmQ06NOY>	evBe1ewvZ0q51pd/HQXLBschAlhrg5nR0Sj7efCvfE=	
7973	605569012		6251639646	1	0yO12LxPGQxL+Xki4hS6Tlyx5V3K0vjHS0DQSOJeM>	1	EYDyc8ljuNDS9uG3CvLOMS9KBVlgFP1tGmQ06NOY>	evBe1ewvZ0q51pd/HQXLBschAlhrg5nR0Sj7efCvfE=	
7974	612141652		6251668759	0	JcpU581OuLad5EHnHS+e+YrY4kEW8pN6ymudnkWM>	1	CqfZVu4CITCIBh9mnk2+DneN9QluBm4N3wwLmjz9u>	PqaHcqiH62FESqU41XFHq+UbXe0VvgZXuw+kdGrOucs=	
7975	613690829		6251668759	1	JcpU581OuLad5EHnHS+e+YrY4kEW8pN6ymudnkWM>	1	CqfZVu4CITCIBh9mnk2+DneN9QluBm4N3wwLmjz9u>	PqaHcqiH62FESqU41XFHq+UbXe0VvgZXuw+kdGrOucs=	
7976	617115444		6251668917	0	ZpQmujQYX55FcN2RFvqqUkcZ5z/Tovj2FaG8sFtlG48>	0	iB8Tw/GqCzLi7HijJBWd0almryTPVvwqEx7nH++sAeQ>	Id4Jo+D+JJ4Xh+VfkZk+ByyUzeel+CZCCPqnXMN3bsg=	
7977	618605848		6251668917	1	ZpQmujQYX55FcN2RFvqqUkcZ5z/Tovj2FaG8sFtlG48>	0	iB8Tw/GqCzLi7HijJBWd0almryTPVvwqEx7nH++sAeQ>	Id4Jo+D+JJ4Xh+VfkZk+ByyUzeel+CZCCPqnXMN3bsg=	
7978	619396391		6251668761	0	VEldGnEYLP+j9YJHh5dEBhUdpD2fs+PKTWwQo5ZrJ>	1	+COS6nbTa5cQQbZsV5xj51k4TFGV8dqpVhlu4czqzVl>	RfO/XZs68BkB9UwJNf0YK1rt2SSwD/DSIZa1cMtfba8=	
7979	620915255		6251668761	1	VEldGnEYLP+j9YJHh5dEBhUdpD2fs+PKTWwQo5ZrJ>	1	+COS6nbTa5cQQbZsV5xj51k4TFGV8dqpVhlu4czqzVl>	RfO/XZs68BkB9UwJNf0YK1rt2SSwD/DSIZa1cMtfba8=	
7980	633214029		6251668915	0	VEldGnEYLP+j9YJHh5dEBhUdpD2fs+PKTWwQo5ZrJ>	1	zXostV9tbQGnXU6uFfAjOzoe8gToH3sDCKZNm0RAw>	1H3WBVCen2RS9lximFVb5A/HIAxc6rH8XBp0lStE/Co=	
7981	633230952		6251669132	0	0r3naaX+ybfsUlahb35AvYPC6MarnPhbqkAtRjor0xE=	1	/b6B6jmt2L08s33038SQme69Agi/XxFJ9rP5HMCA8hQ>	8oJmGF4eGO9S3a0Zq118cJR6nEOGLZhH+3eirZ5cEc=	

task_events table

	A	B	C	D	E	F	G	H	I	J	K	L	M
133387	2506195981613		6486519055	51	351664184	4	d2VTjfYNax8Fa/Wdwdbo7zTYZ1UWfJEyx/DBfhaR/	1	4	0,03125	0,009323	0,0001545	0
133388	2506195981707		6486519055	89	4820184623	4	d2VTjfYNax8Fa/Wdwdbo7zTYZ1UWfJEyx/DBfhaR/	1	4	0,03125	0,009323	0,0001545	0
133389	2506196529597		6474229340	92	38667193	1	GM4DjoOesQwnBXWsubNNHnF16P+LPay0GXAgA	0	0	0,0125	0,05438	0,001158	0
133390	2506196552444		6486519055	88	4820017998	4	d2VTjfYNax8Fa/Wdwdbo7zTYZ1UWfJEyx/DBfhaR/	1	4	0,03125	0,009323	0,0001545	0
133391	2506196552787		515042969	4		5	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133392	2506196552790		515042969	4		0	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133393	2506197116875		515042969	3		5	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133394	2506197116878		515042969	3		0	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133395	2506197644189		515042969	4	3349150081	1	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133396	2506198209912		515042969	3	4223853595	1	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133397	2506198229177		515042969	18		5	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133398	2506198229180		515042969	18		0	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133399	2506198229237		6486611683	0	284738145	4	fJeARlnTaljFrdXGqap6x2T3TpJB84y9zvFsoGGhjK	1	8	0,03125	0,00795	0,00003815	0
133400	2506198229513		6486161686	925	336074406	4	HxdST/yDI1Tllkr0Povf9KaXGGG8x4iVXX6o/iSlghM	0	6	0,03687	0,0199	0,0007715	0
133401	2506199589479		515042969	18	255692392	1	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133402	2506199602664		515042969	14		5	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133403	2506199602667		515042969	14		0	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133404	2506199602819		515042969	2		5	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133405	2506199602822		515042969	2		0	/fk1fVcVxZ6iM6gHZzqblyq56m5zrmHfpdcZ/zzkq4c	2	0	0,01562	0,01553	0,0002155	0
133406	18446744073709600000	0	6176871439	53	1436501713	8	+cz+wEXttqDjld+YWLmrgqExjdqiHMZ2WZODThyR	2	1	0,01874	0,003887	0,0000267	0
133407	18446744073709600000	0	6176871439	54	2357728300	8	+cz+wEXttqDjld+YWLmrgqExjdqiHMZ2WZODThyR	2	1	0,01874	0,003887	0,0000267	0
133408	18446744073709600000	0	6176871439	55	8055066	8	+cz+wEXttqDjld+YWLmrgqExjdqiHMZ2WZODThyR	2	1	0,01874	0,003887	0,0000267	0
133409	18446744073709600000	0	6176871439	56	1666577	8	+cz+wEXttqDjld+YWLmrgqExjdqiHMZ2WZODThyR	2	1	0,01874	0,003887	0,0000267	0
133410	18446744073709600000	0	6176871439	57	6639212	8	+cz+wEXttqDjld+YWLmrgqExjdqiHMZ2WZODThyR	2	1	0,01874	0,003887	0,0000267	0

machine_events table

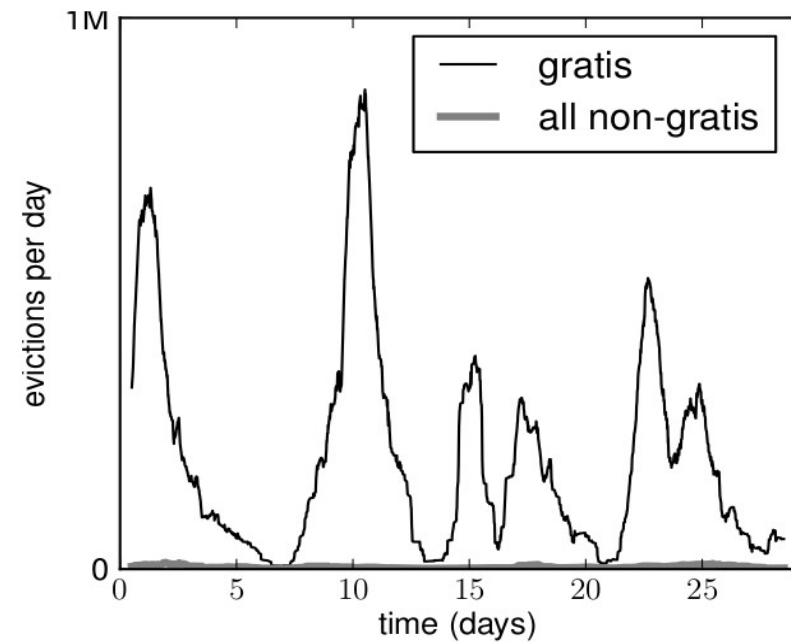
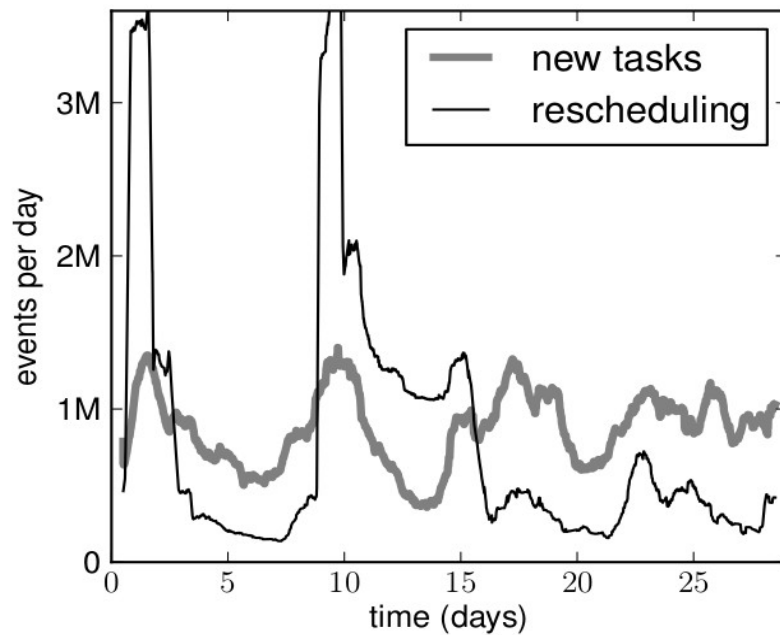
	A	B	C	D	E	F
12472	0	6219933940	0	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995
12473	0	6220020360	0	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,2493
12474	0	6226704737	0	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995
12475	0	6235724787	0	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995
12476	0	6240379586	0	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,2493
12477	0	6248206732	0	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,2493
12478	779231019	5782512	1	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,2493
12479	974363601	1438195245	2	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995
12480	1460219913	4820073668	1	GtXakjpd0CD41brK7k/27s3Eby3RpJKy7taB9S8UQF	1	1
12481	2071421510	1272981	1	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995
12482	2580105468	294985247	1	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,2493
12483	2975233122	6226704737	2	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995
12484	3016500490	8631300	1	HofLGzk1Or/8lldj2+Lqv0UGGvY82NLoni8+J/Yy0RU	0,5	0,4995

Possible projects

- Jobs inter-arrival time (considering different moments of the day)
- Jobs response time
- Task per Job distribution
- Task inter-arrival time (for each machine)

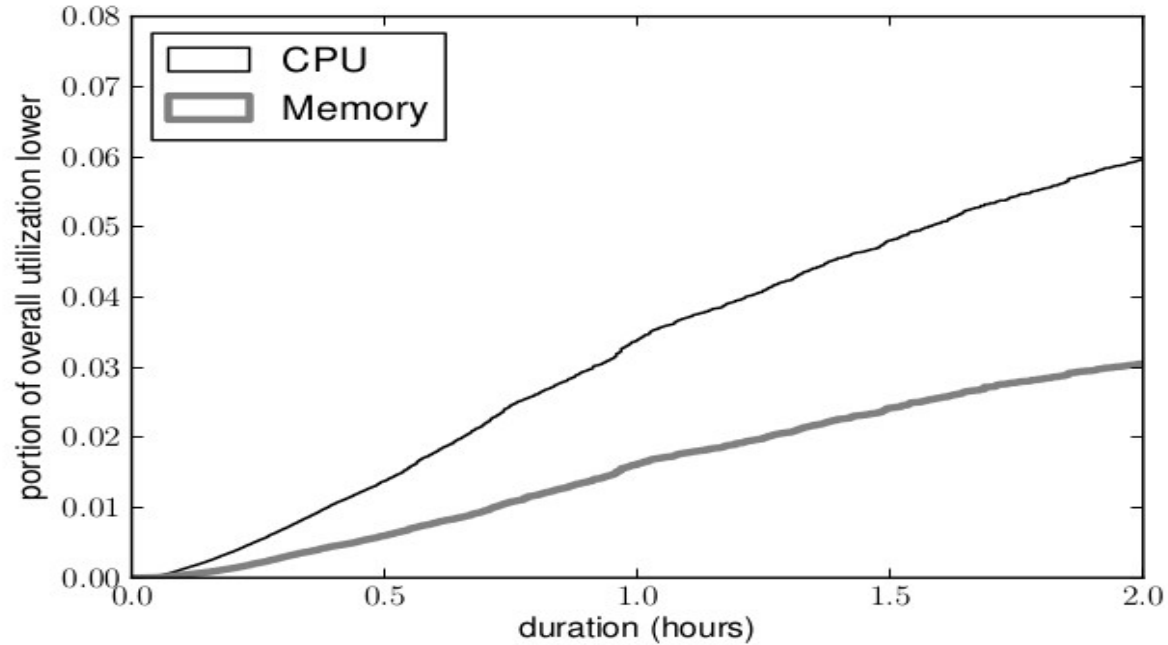
Some results

Evictions



Some results

Utilizations



Useful links

- To download the dataset see
<https://commondatastorage.googleapis.com/custerdata-2011-2/SHA256SUM>
- The trace is described at
https://drive.google.com/file/d/0B5g07T_gRDg9Z0lsSTEtTWtpOW8/view

References

- **REISS, Charles; WILKES, John; HELLERSTEIN, Joseph L. Google cluster-usage traces: format+ schema. Google Inc., Mountain View, CA, USA, Technical Report, 2011.**
- REISS, Charles, et al. Heterogeneity and dynamicity of clouds at scale: Google trace analysis. In: Proceedings of the Third ACM Symposium on Cloud Computing. ACM, 2012. p. 7.