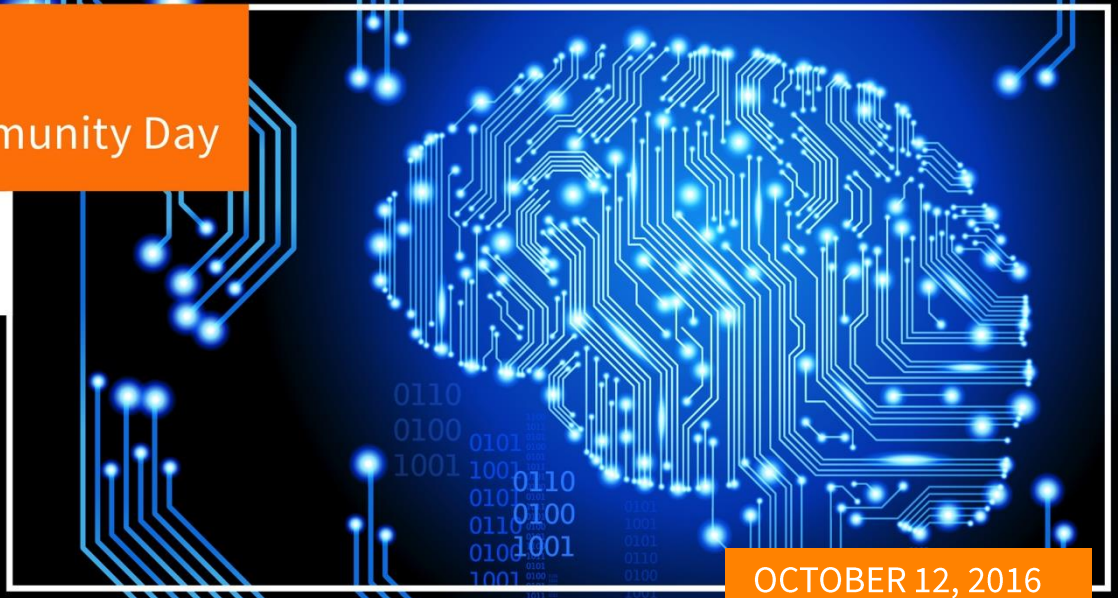
2016 HPCC Systems
Engineering Summit – Community Day

Powering Forward with Machine Learning and Deep Learning



OCTOBER 12, 2016

HPCC SYSTEMS®

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Principal Software Engineer
Research Management / Elsevier

RELX Group

Leveraging the AWS Cloud to Create Scalable Research Performance Analytics

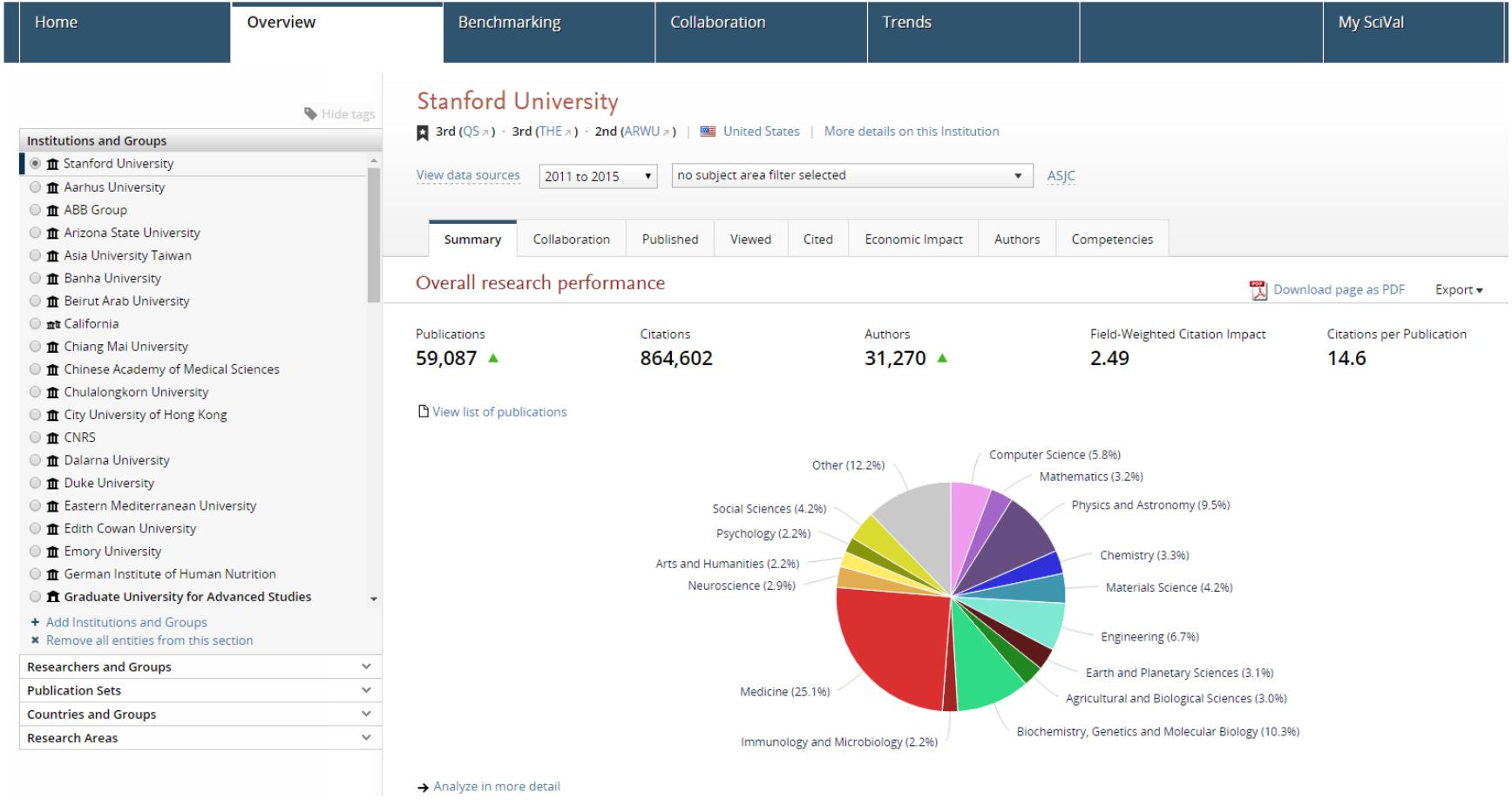
Introduction

- Principal software engineer with Reed Elsevier
- Worked on development of Elsevier products on HPCC for 7 years
- Worked on SciVal for past 3 years.

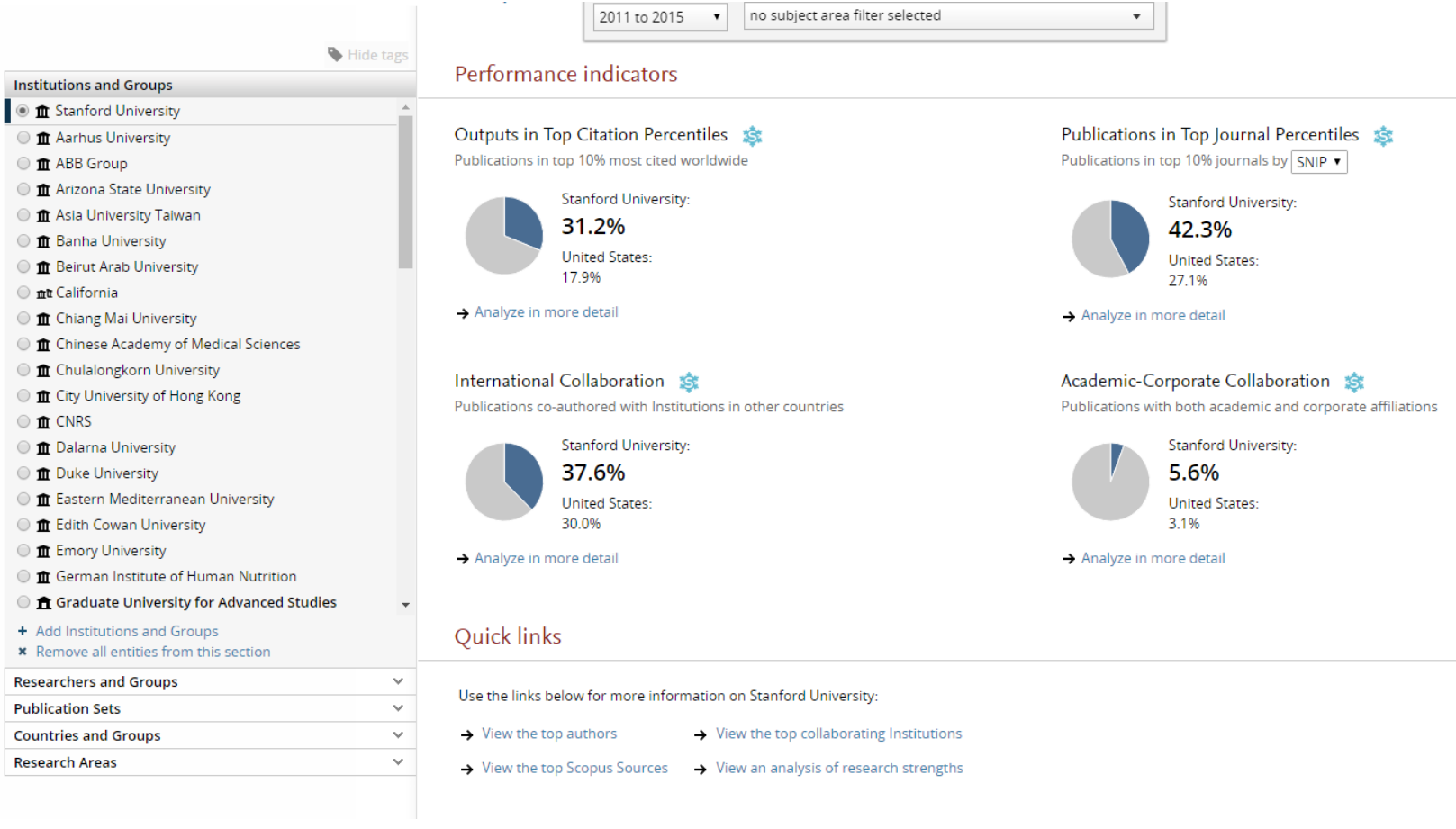
SciVal

- Research performance analyzer
- Used by research administrators, department heads, researchers at academic institutions to evaluate research performance.
- Based on Scopus Abstracts and Citation Database
- Scopus database contains over 60 million articles from 20,000 peer reviewed journals and over 550 million citations
- Other Data sources
  - Scopus Usage data
  - Patent Data
- SciVal Metrics
  - Metrics measuring amount of output
  - Metrics measuring quality of output
  - Metrics measuring Collaboration between institutions

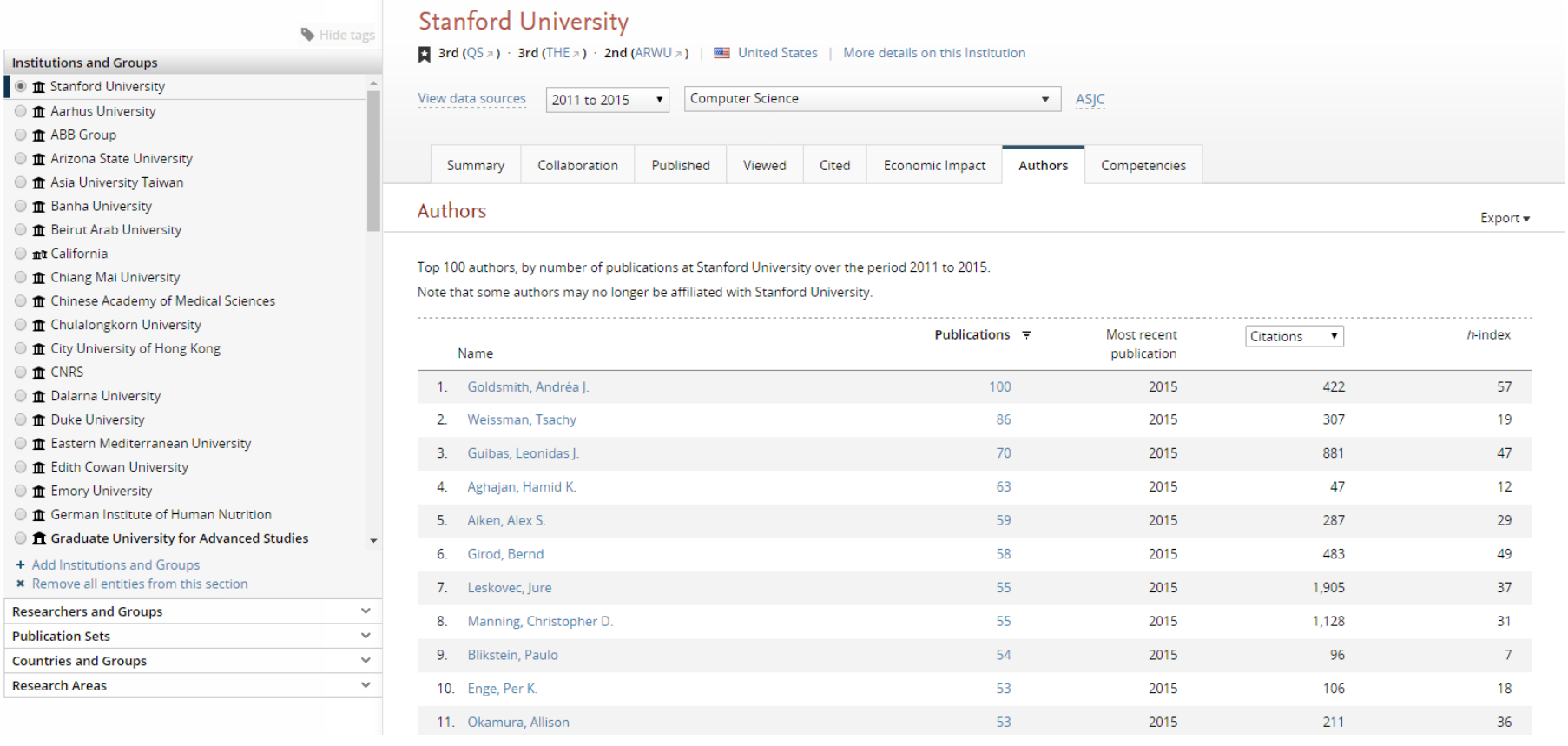
SciVal Modules



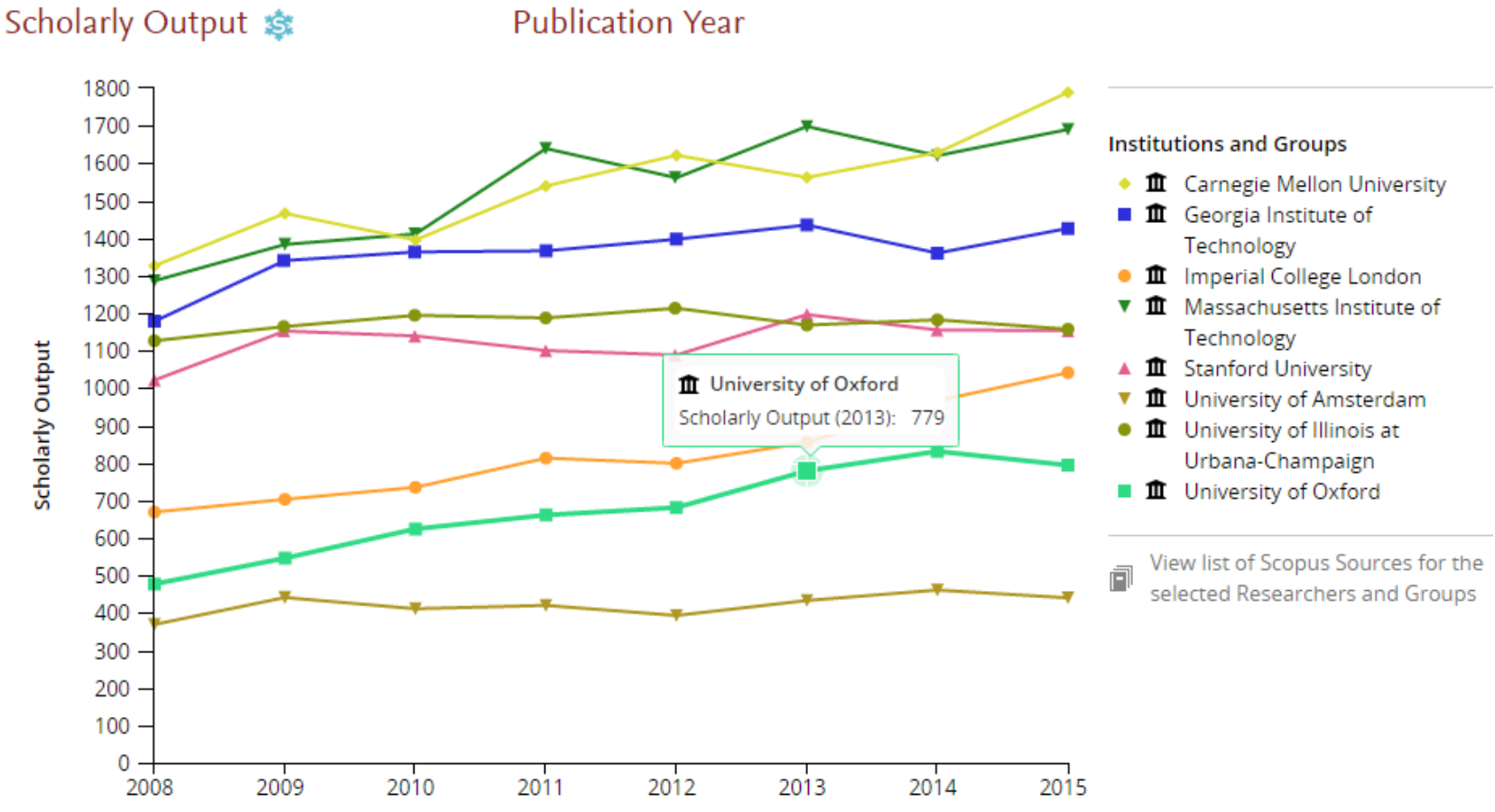
SciVal Module - Overview



SciVal Module - Overview



SciVal Module - Benchmarking

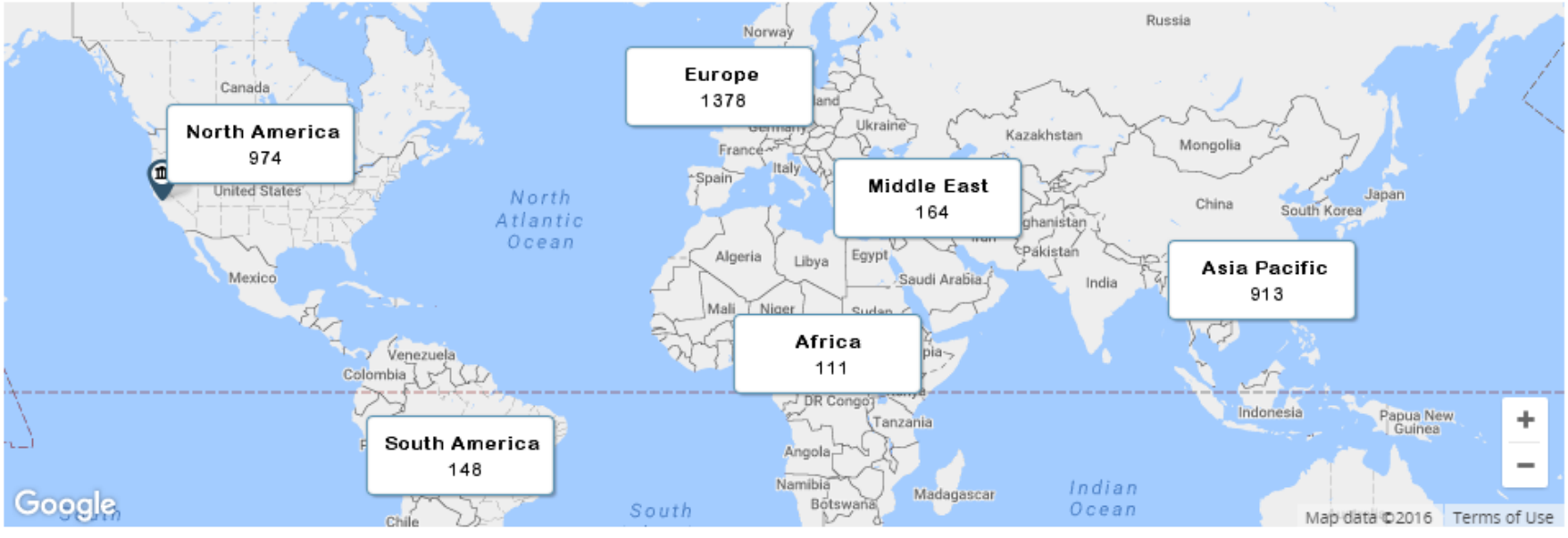


SciVal Module - Collaboration

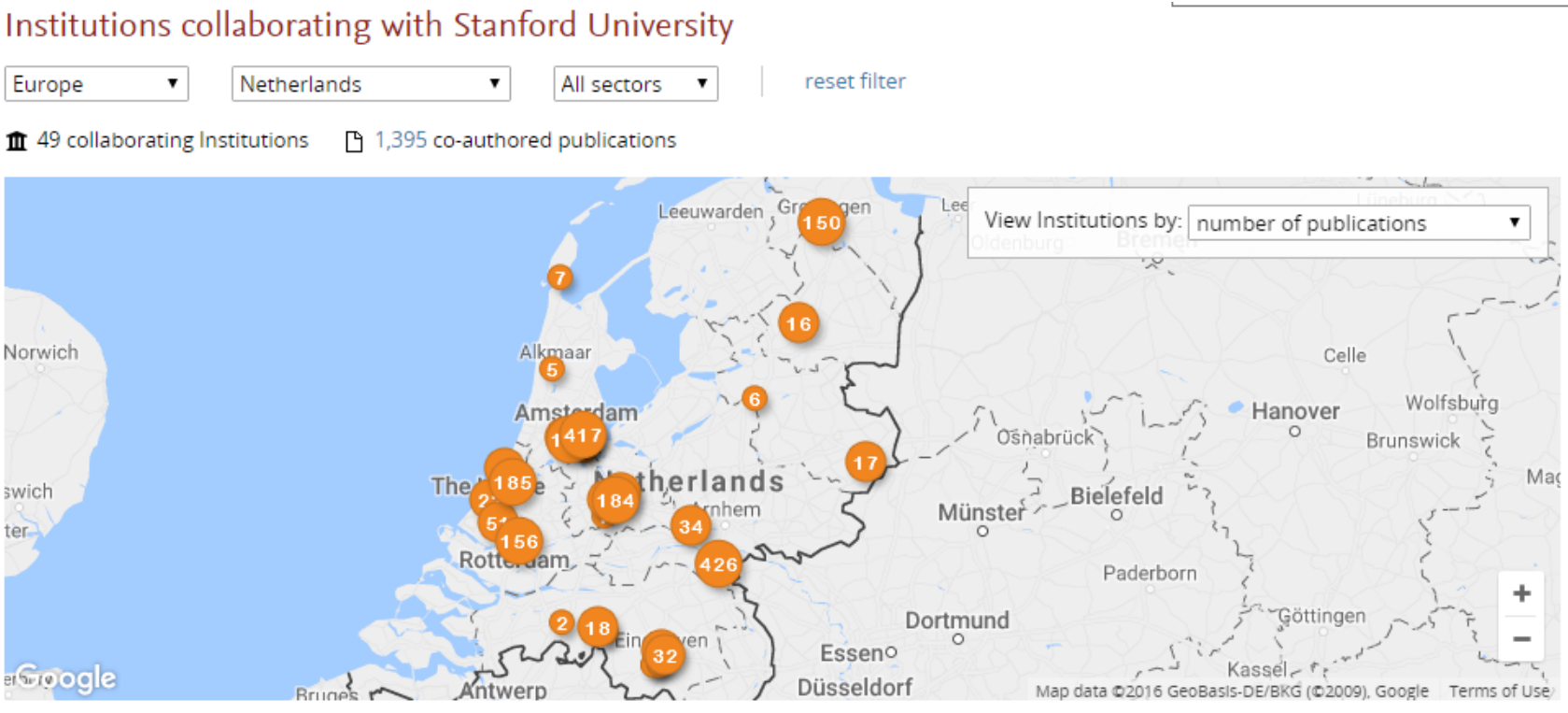
Institutions collaborating with Stanford University

Worldwide ▾ | All sectors ▾ ← Filter for more (regional) detail or filter by field at the top of the page

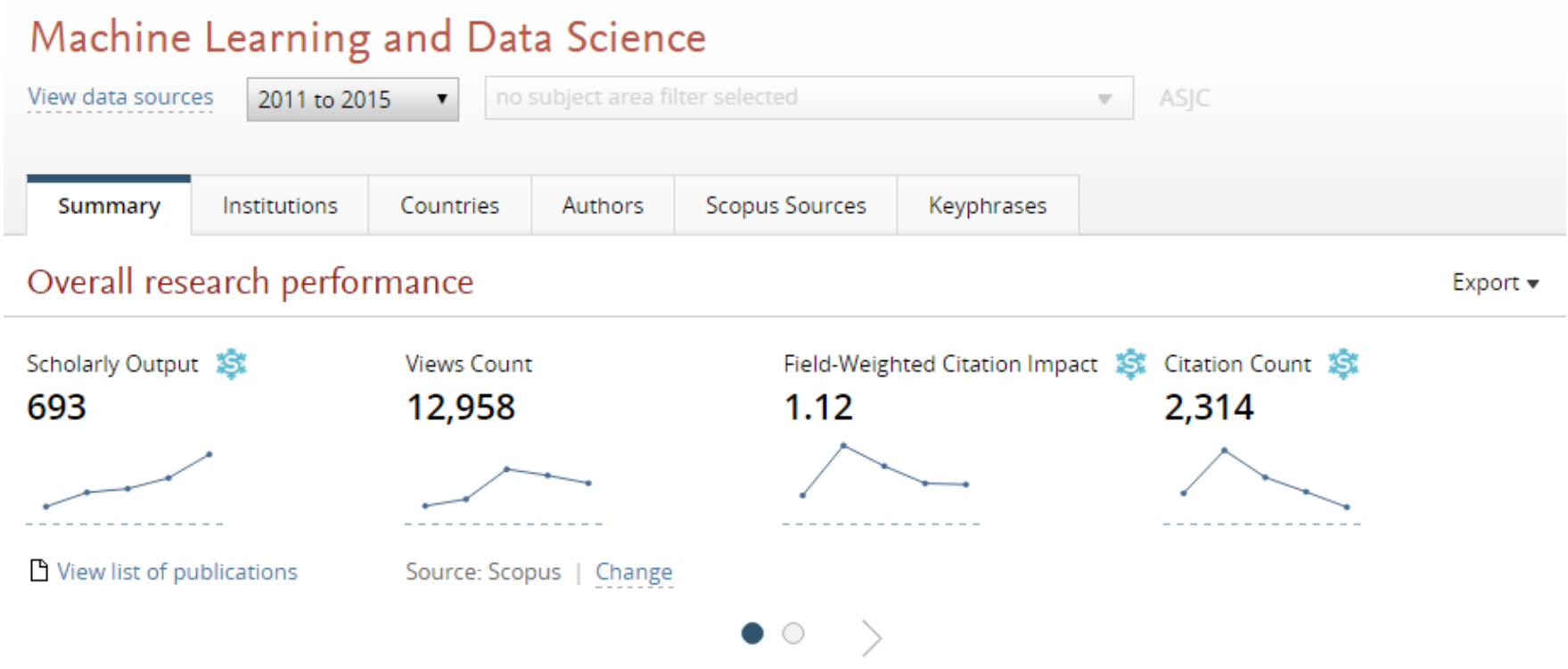
3,688 collaborating Institutions | 25,366 co-authored publications



SciVal Module - Collaboration



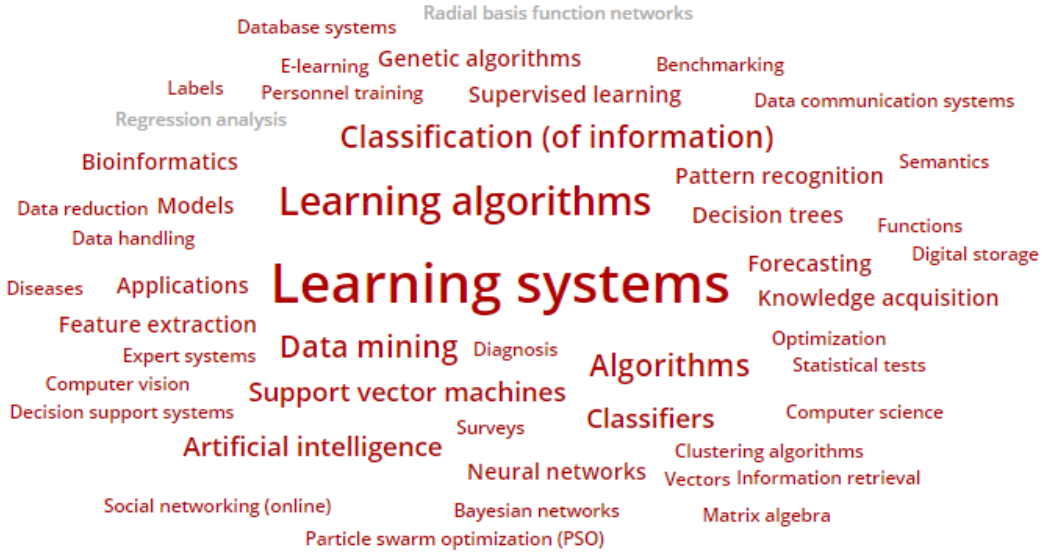
SciVal Module - Trends



SciVal Module - Trends

Keyphrase analysis

Top 50 keyphrases by relevance, based on 693 publications | Learn about keyphrase calculations ↗

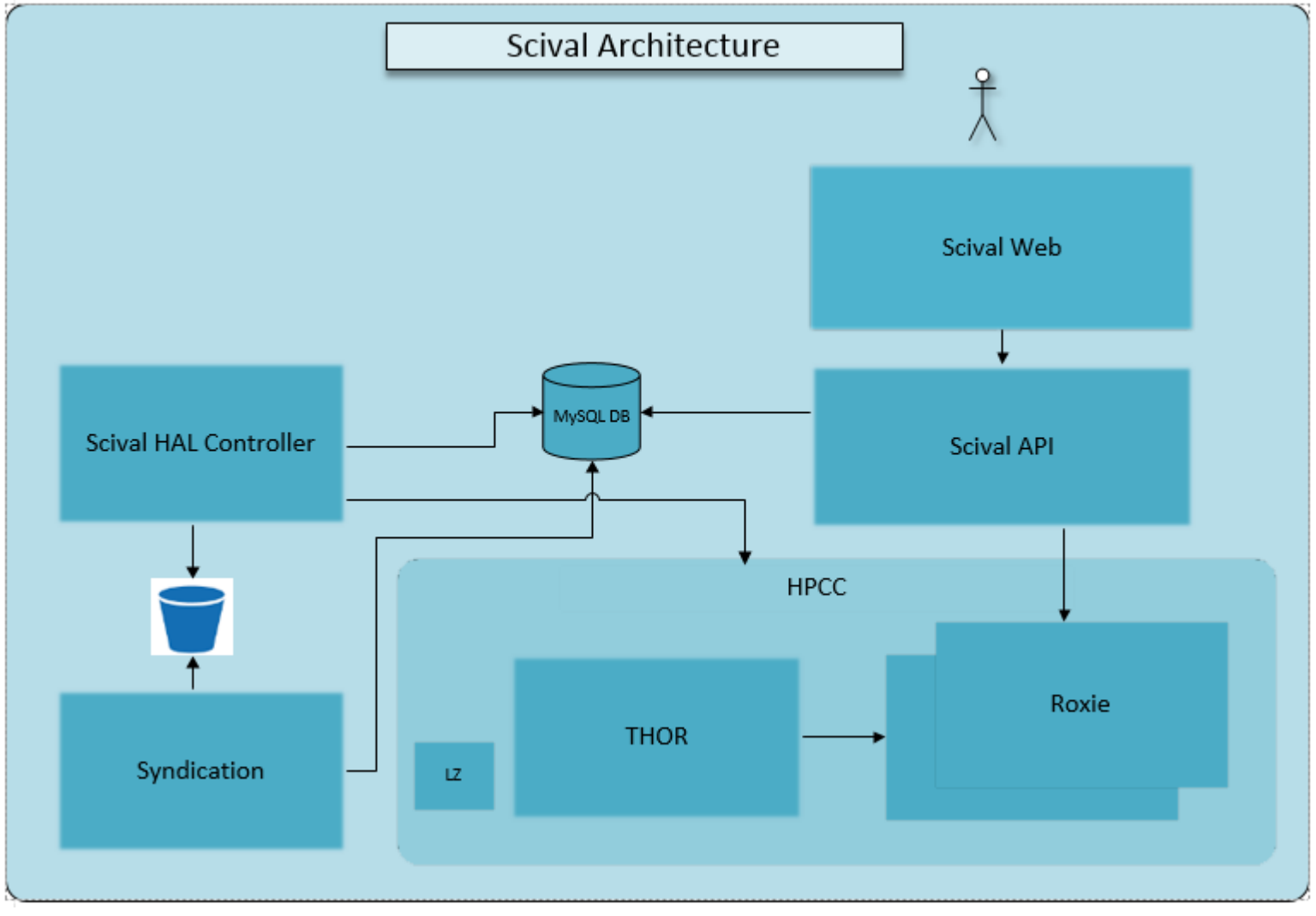


→ Analyze in more detail

SciVal Entities And Metric Computation

- Precomputed entities
  - Entities with over 5000 documents
  - Metrics precomputed on Thor
- Dynamic entities
  - Entities containing <= 5000 documents
  - Metrics are computed on the fly on Roxie

- Computations
  - Total number of Precomputed Entities is about 600,000
  - # Years : 21 ， # Subject Areas : 1050
  - Number of Metrics : 30
  - Number of Top-N lists : 15


Scival Architecture
Scival Web
Scival HAL Controller
MySQL DB
Scival API
HPCC
Syndication
LZ
THOR
Roxie

SciVal Growing Computation And Storage Needs

- Growth in user entities - research areas, research groups, institutional and country groups.
- Scopus publication and citation data growth.
- Usage data growth
- New features and more metrics
- New data sources - Patents data, News flow data

- Because of this, we were looking for options to migrate SciVal cluster out of traditional data center hosting environment to Cloud platform.
- Amazon Cloud Platform (AWS) was the obvious choice because HPCC was already supported on that.

AWS HPCC Installation/Configuration

- HPCC installation and configuration scripts available from LexisNexis Risk Solutions at
  - https://github.com/tlhumphrey2/EasyFastHPCCoAWS
- Made enhancements to scripts to productionize.
- AWS has many instance types available with varying memory, disk space and CPU capacity.
- Used smaller EC2 instances to prototype installation and configuration
  - c3.2xlarge – 8 vCPU, 16G Mem, 160 SSD Storage, High Network Performance (1G)

Thor AWS EC2 Instances

- Large multi-core EC2 instances with very high network bandwidth (10G) used for Thor
- Thor master, HPCC middleware server processes (DALI, ECL Server, DFU , ECL Agent …) share a single EC2 instance.

Model	vCPU	Mem (G)	Storage (G)	Cost per hour (reserved all upfront)
c3.8xlarge	32	64	2 x 320 SSD	$0.99

- Thor Slave

Model	vCPU	Mem (G)	Storage (G)	Cost per hour(reserved all upfront)
d2.8xlarge	36	256	24 x 2000 HDD	$2.69

- Run in multi-slave mode with 16 Thor slaves per EC2 instance.

Roxie AWS EC2 Instances

- Picked Smallest EC2 instance with high bandwidth (1G) for Roxie

ModelvCPU	Mem (G)	Storage (G)	Cost per hour (reserved all upfront)
i2.2xlarge	8	64	2 x 800 SSD $0.71

- 4 instances used to have enough disk capacity to fit in data/indexes
- Single EC2 to run all HPCC middleware admin processes

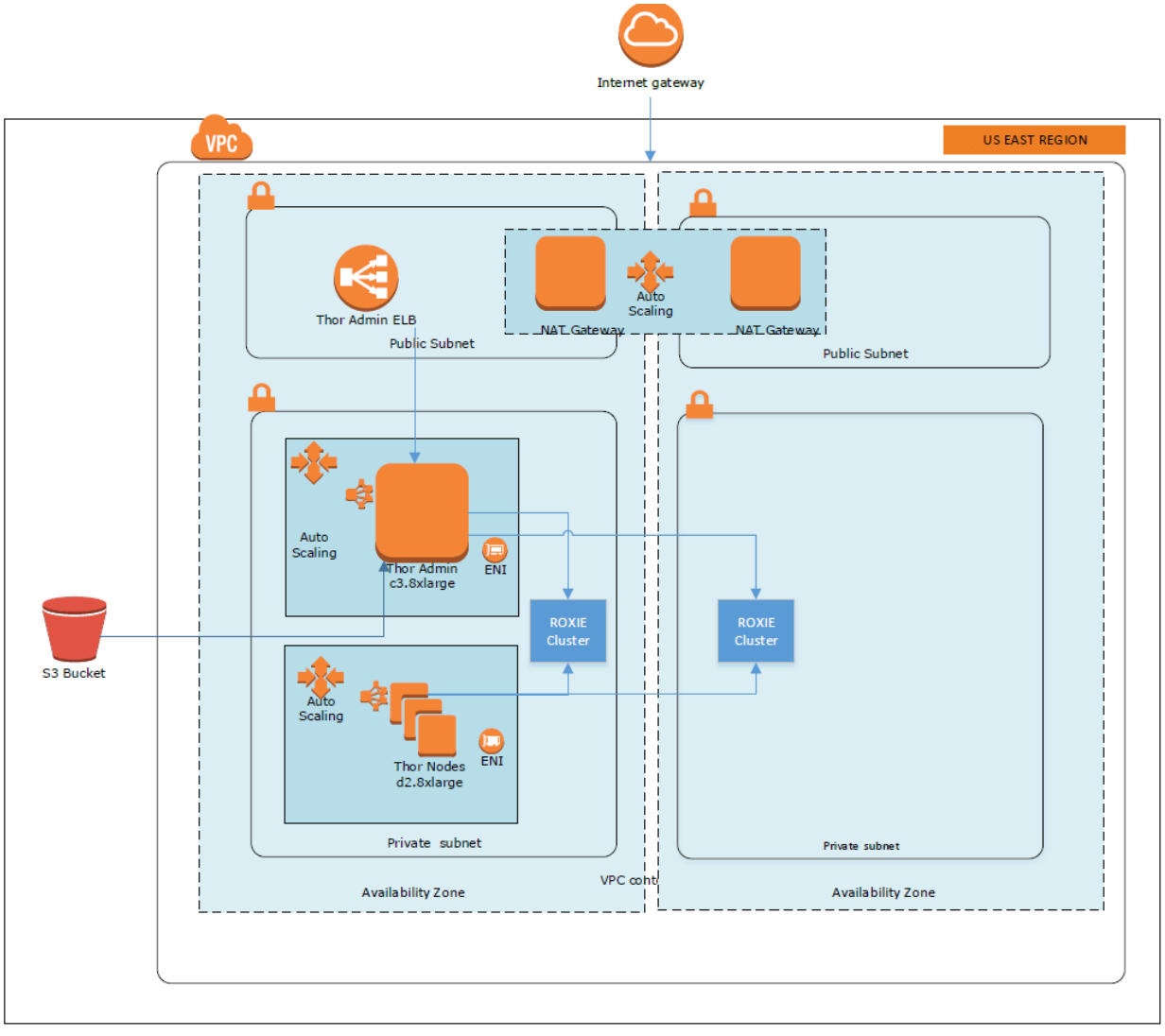
ModelvCPU	Mem (G)	Storage (G)	Cost per hour (reserved all upfront)
c3.4xlarge	16	32	2 x 160 SSD $0.50

- Ran load tests to verify performance

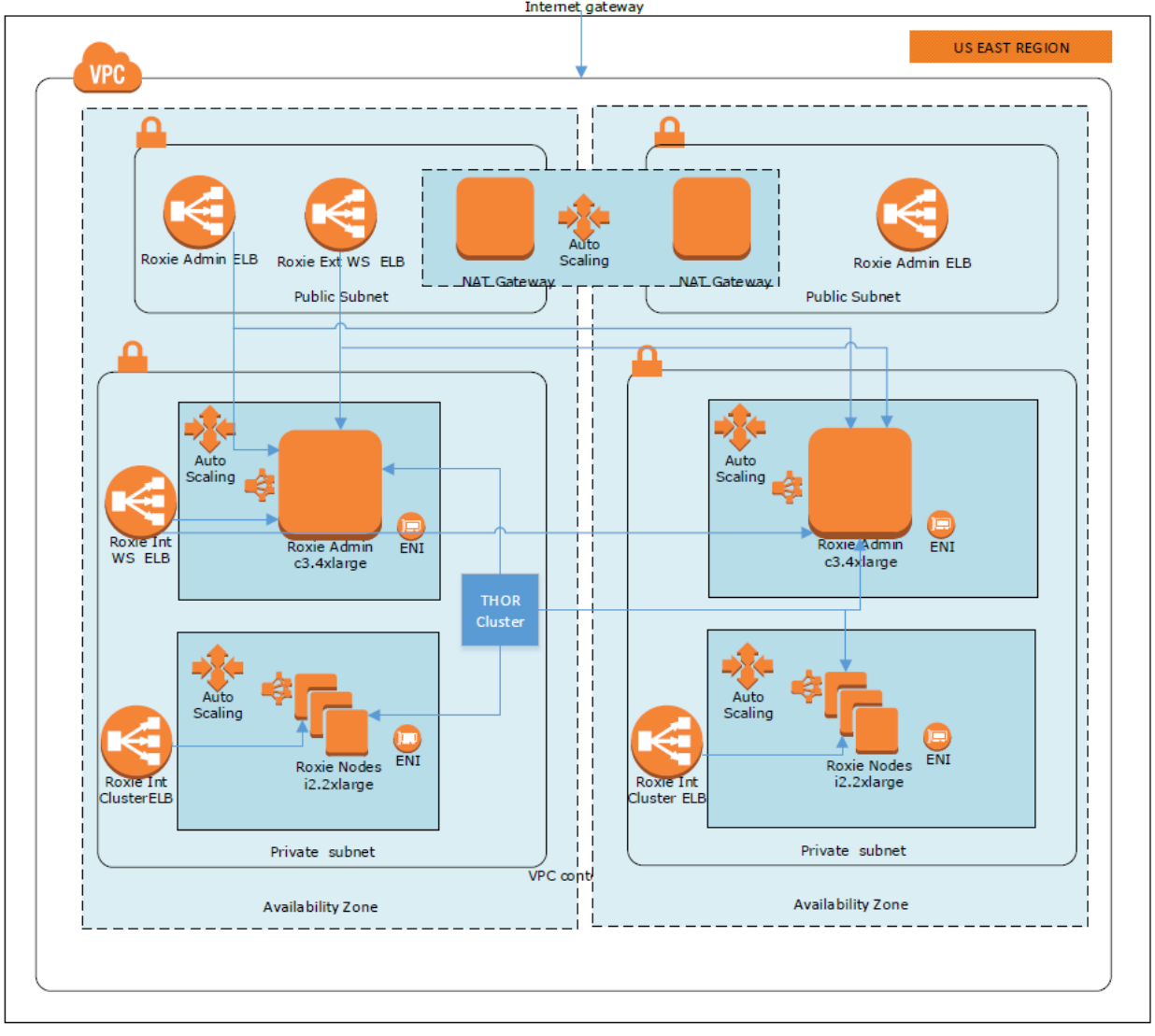
AWS Resources

- Virtual Private Cloud (VPC)
  - Virtual network dedicated to your AWS account
  - Create private and public subnets in VPC
  - public subnet used for resources that must be connected to the Internet, and a private subnet used for resources that are isolated from Internet.
- Elastic Load Balancers (ELB)
  - Balance traffic across multiple EC2 instances.
  - Makes it easy to create an internet-facing entry point into your VPC in a multi-tier architecture.
- Auto Scaling Groups (ASG)
  - Detect impaired Amazon EC2 instances and unhealthy applications, and replace the instances without your intervention
  - Automatically scale up/down Amazon EC2 Fleet
- Security Groups (SG)
  - Acts as a virtual firewall that controls the traffic for one or more instances.
  - Specify IP ranges, protocols and ports

AWS Thor Architecture



AWS Roxie Architecture



Thor Cluster Recoverability And Redundancy

- Auto Scaling Group detects impaired instances, terminates the instance and brings up new one in its place.
- New instance comes up with different IP, hence not recognized by HPCC configuration.
- All Instances bound to Elastic Network Interfaces (ENI) to maintain stable secondary private IP.
- Secondary Private IP are used in HPCC configuration by binding to secondary Ethernet interface (eth1)
- Recovery from Thor Slave Instance loss
  - Thor has replication is turned on by default.
  - Thor Slave data recovered from adjacent instance by running “start_backupnode” command
- Recovery from Thor master Instance loss
  - Configured HPCC to turn on DALI replication
  - DALI metadata recovered from Dali replication instance.

Roxie Cluster Recoverability And Redundancy

- Recovery from Roxie slave Instance loss
  - Configured HPCC to turn on cyclic redundancy.
  - Data automatically recovered when the replacement instance comes back up.
  - Even with the loss of a node, Roxie continues to function

Disaster Recovery

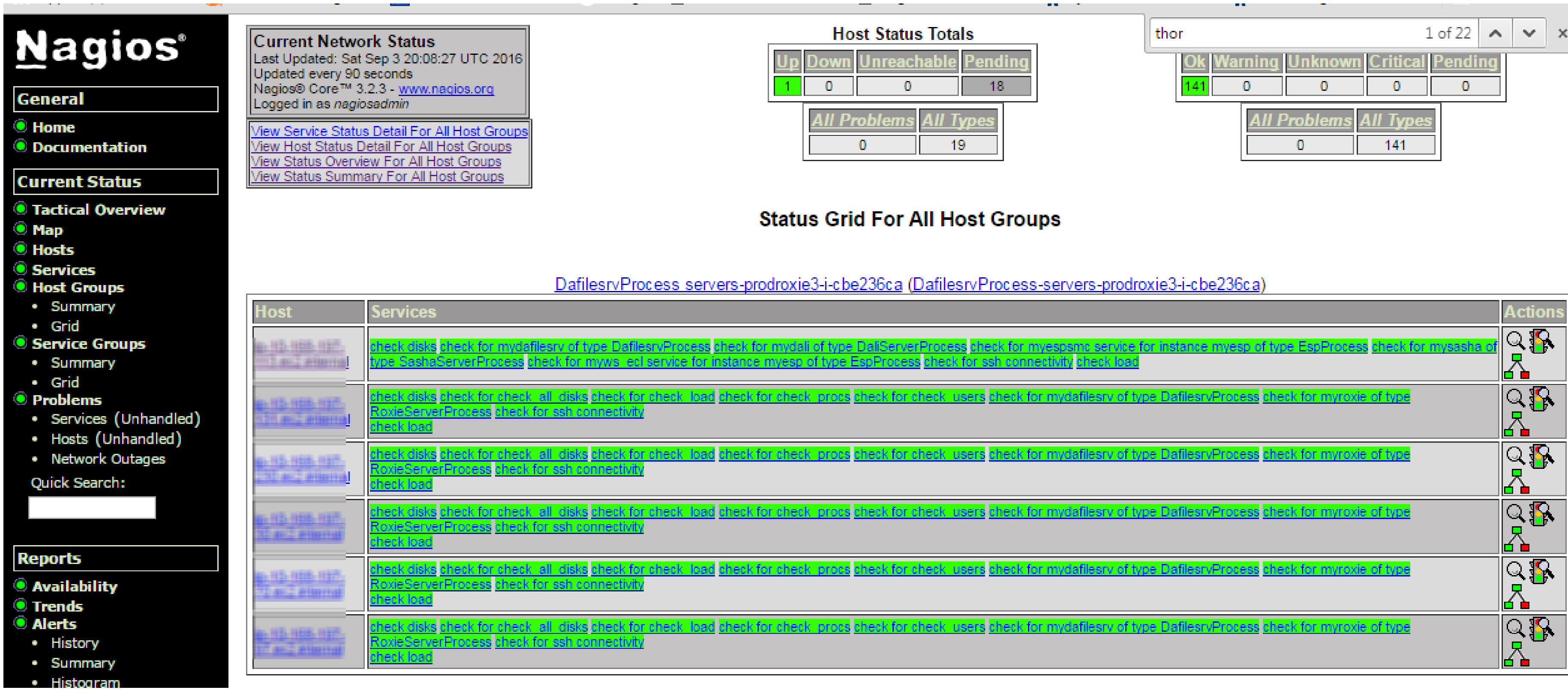
- Thor
  - Periodic backups to AWS S3 storage
  - New Thor can be spun up and data recovered from AWS S3 in 7 hours.

- Roxie
  - Two Roxies in different Availability zone.
  - Back up of Roxie data in Thor and also in AWS S3.
  - New Roxie can be spun up and data recovered in 2 hours.

Monitoring - Nagios

- Nagios
  - Open source monitoring tool.
  - Monitors processor load, disk usage, network services and system logs.
  - HPCC provides plugins to monitor Thor, Roxie and Middleware processes.
  - Provides alerts to users when things go wrong and alerts second time when problem is resolved.
  - Configured to send alerts to chat Slack channel.

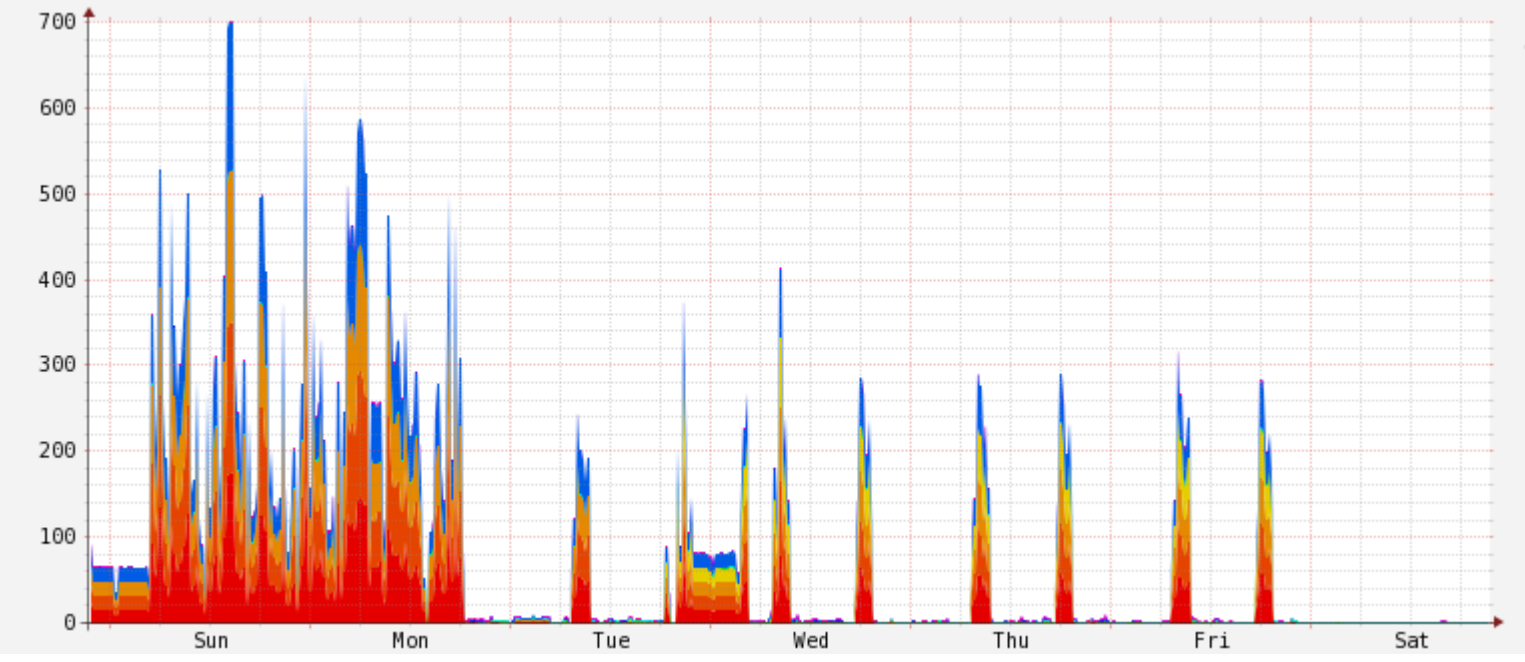
Monitoring - Nagios



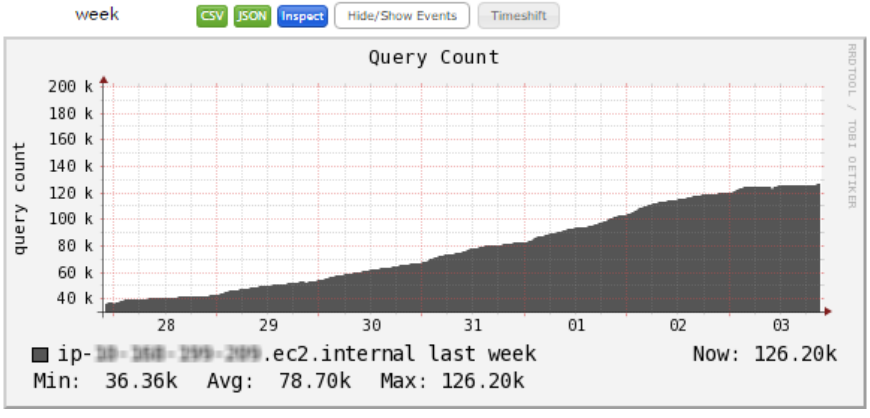
Monitoring - Ganglia

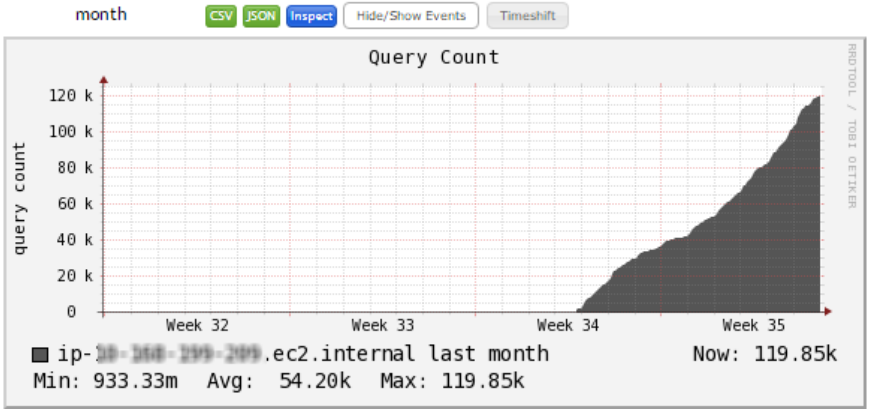
- Open source system monitoring tool
- Allows user to view live or historical statistics like CPU load averages/ network utilization.
- HPCC plugin for Roxie metrics allows to view historical data on Roxie metrics
    - Query Count
    - Cache Hits
    - Query Failures

Monitoring Ganglia CPU Load



Monitoring – Ganglia Roxie Metrics





Thor Cloud Formation Template

Parameters

ClusterNameSuffix	1	Cluster Name is formed by combining environment parameter with this suffix
Environment	cert	The environment these instance(s) will support
MasterInstanceType	c3.8xlarge	HPCC Thor Master EC2 instance type
NagiosS3BucketFolder	s3://	S3 bucket folder that contains the scripts/configs for Nagios
NumberOfSlaveInstances	5	Minimum number of THOR Slave instances to be launched
NumberOfSlavesPerNode	16	Number of THOR Slave nodes per Slave instance
ScriptsS3BucketFolder	s3://	S3 bucket folder that contains the scripts that are executed in the UserData section.
SlaveInstanceType	d2.8xlarge	HPCC Thor Slave EC2 instance type
UserNameAndPassword		(Optional) Enter like: username/password Used to log into ECL Watch and ECL IDE.

Future Enhancements

- Cut down S3 backup times - copy only deltas
- Tools for expansion of cluster
- Upgrade HPCC Version to resolve following issues,
  - Restore super files from S3
  - Roxie ESP should handle change of IP for Load balancer.

Summary

- HPCC on AWS has worked great.
- Easy installation/configuration of HPPC on AWS Cloud Platform
- New cluster can be brought up in 30 minutes
- Robust and requires very little maintenance.
- Nagios and Ganglia – monitoring tools
- Easy to scale up/down
- AWS Cloud provides layer of security
- More and more cost effective as Amazon comes up with new instance types

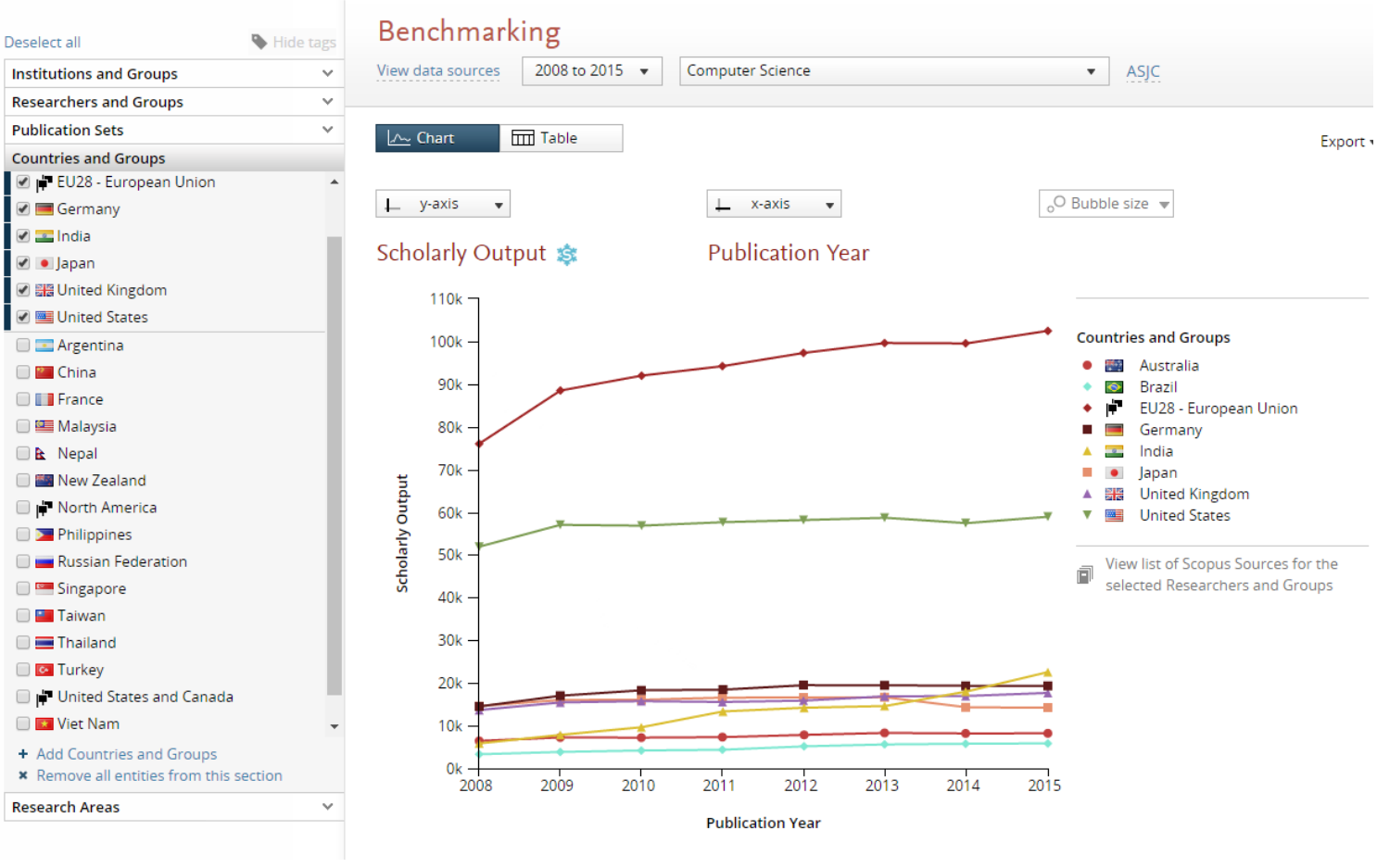
Acknowledgements

- Bob Mann
- Edward Lewis
- Tim Humphrey
- Jake Smith
- Anthony Fishbeck
- Richard Chapman
- John Holt
- Stuart Ort
- Arjuna Chala
- Jonathan Burger
- Fernando Uceta
- Gleb Aronsky

Thank You

Appendix

SciVal - Benchmarking



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Model	vCPU	Mem	Storage	Cost per hour (reserved all upfront)
c3.8xlarge	32	60	2 x 320 SSD	$0.99

- Run in multi-slave mode with 16 Thor slaves per EC2 instance.

Model	vCPU	Mem	Storage	Cost per hour(reserved all upfront)
i2.8xlarge	32	244	8 x 800 (Inst SSD)	$2.84
d2.8xlarge	36	244	24 x 2000 (Inst HDD)	$2.69
c4.8xlarge	36	60	2 T (EBS SSD) $0.99 + 1.71 = $2.70	

(Instance + Provisioning cost - 4 volumes, each with 2T , 400 IOPS)

- Same SciVal Weekly Job was run with following configurations,

Slave	# Slaves	Master	Time Taken Hours
i2.8xlarge	2	c3.8xlarge	28
d2.8xlarge	2	c3.8xlarge	29
c4.8xlarge	2	c3.8xlarge	45

- Configured in Multi-Thor mode with two queues.

AWS Roxie Instances

- Picked Smallest EC2 instance with high bandwidth (1G) for Roxie

ModelvCPU	Mem	Storage	Cost per hour (reserved all upfront)
i2.2xlarge	8	64 2 x 800 SSD	$0.71

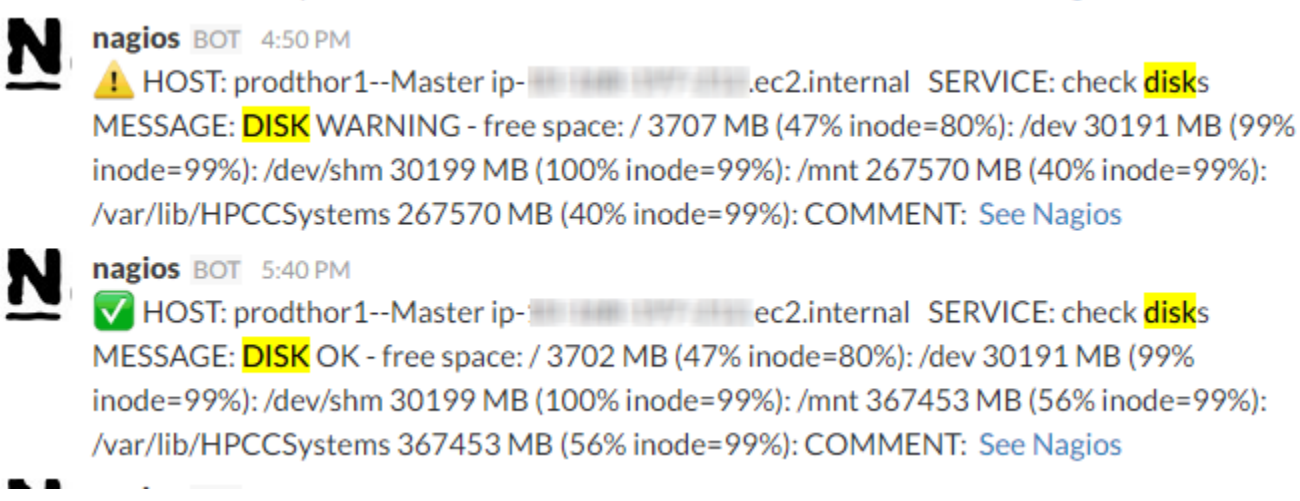
- 4 instances used to have enough disk capacity to fit in data/indexes
- Single EC2 to run all HPCC middleware admin processes

ModelvCPU	Mem	Storage	Cost per hour (reserved all upfront)
c3.4xlarge	16	32 2 x 160 SSD	$0.50

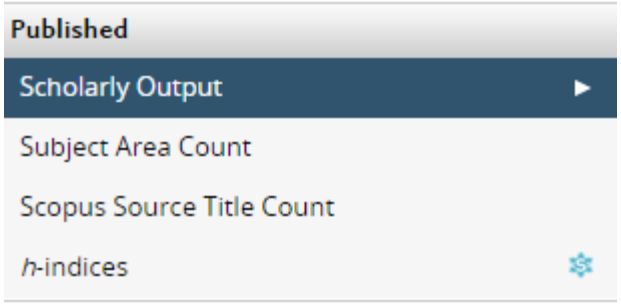
- Ran load tests to verify performance

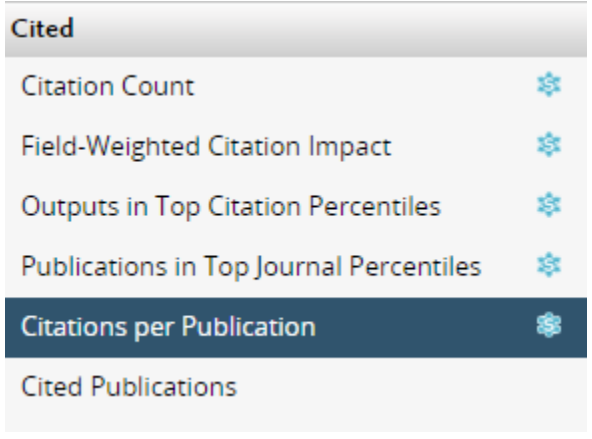
Monitoring Nagios

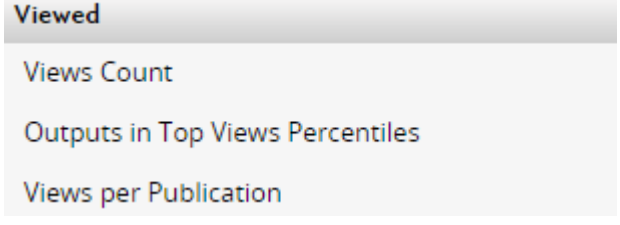
Nagios alerts posted on Slack channel

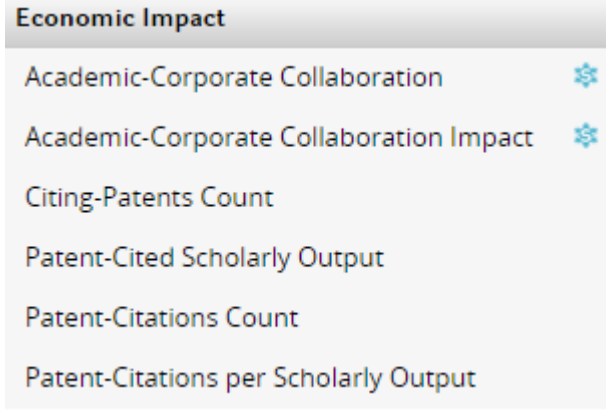


SciVal Module – Benchmarking Metrics









SciVal Module - Collaboration

Collaboration with the University of Amsterdam

Year range: 2013 to 2015

Export ▾ Shortcuts ▾

Overview | Current co-authors | Potential co-authors

	Stanford University	Co-authored	University of Amsterdam
	419 ▼ co-authors with the University of Amsterdam	417 ▲ publications	441 ▲ co-authors with Stanford University
	2.47 Field-Weighted Citation Impact	5.15 Field-Weighted Citation Impact	1.99 Field-Weighted Citation Impact
Authors	24,218 ▲	-	11,630 ▲
Scholarly Output	36,634 ▲	-	21,572 ▲
Views count (from Scopus)	548,325	27,383	307,893
Field-Weighted Views Impact	1.39	8.62	1.43
Citation Count	336,221	10,699	157,504

Show all

SciVal Entities And Metric Computation

- Predefined Entities
  - Institution / Group of Institutions
  - Country / Group of Countries
  - Institution departments
  - Predefined Research Area
- User Defined Entities
  - User Created Group of Institutions
  - User Created Group of Countries
  - User Created Researcher and Group of Researchers
  - User Created Research Areas

- Predefined Defined Entities are large so always precomputed
- User Defined Entities are precomputed when entity contains > 5000 documents
- User Defined Entities containing <= 5000 documents are dynamic. Metrics are computed on the fly.
- Computations
  - Total number of Precomputed Entities is about 600,000
  - # Years : 20 , # Subject Areas : 1050
  - Number of Metrics : 30
  - Number of Top-N lists : 20

SciVal Jobs

- Weekly Job
  - Full latest Scopus snapshot
  - All Predefined Entities
  - Larger User Entities with over 5000 documents
- Delta Job
  - Same Scopus Snapshot
  - Any new large user defined entities created since last weekly or delta job.

Roxie Cloud Formation Template

Parameters

ClusterNameSuffix	1	Cluster Name is formed by combining environment parameter with this suffix
Environment	cert	The environment these instance(s) will support
HpccPlacementGroup	scival_large	The Placement group for an Availability Zones in the region in your VPC
MasterInstanceType	c3.4xlarge	HPCC Roxie Admin EC2 instance type
NagiosS3BucketFolder	s3://	S3 bucket folder that contains the scripts/configs for Nagios
NumberOfRoxieNodes	5	Number of Roxie nodes in deployed HPCC System
RoxieInstanceType	i2.2xlarge	HPCC Roxie EC2 instance type
ScriptsS3BucketFolder	s3://	S3 bucket folder that contains the scripts that are executed in the UserData section.
UserNameAndPassword		(Optional) Enter like: username/password Used to log into ECL Watch and ECL IDE.