

Online Judge System under a Cloud Computing Environment

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Abstract – Cloud computing is the trends of next generation of Internet. In the field of education, Cloud Computing is the basic environment and platform in the future. This paper proposes an Online Judge System under a cloud computing environment. The proposed Online Judge System which is based on GAE can judge online, share the problems, generate topic automatically and rank users. It can process the large scale data easily and mine more interesting information from users and problems which is very useful for information-oriented education.

Index Terms – online judge, cloud computing, GAE.

I. INTRODUCTION

An online judge [5,6] is an online system to test programs in programming contests. The system can compile and execute code, and test code with pre-constructed data. Submitted code may be run with restrictions, including time limit, memory limit, security restriction and so on. The output of the code will be captured by the system, and compared with the standard output. The system will then return the result. In most Online Judge System, Some statistical information is presented such as the biggest number of accepted solutions, rank list of users and so on. There exist many online judges on the internet such as UVa Online Judge [5], Peking University Online Judge, Zhejiang University Online Judge. An online judge is in general a server, which contains descriptions of problems from different contests, as well as data sets to judge whether a particular solution solves any of these problems. A user from anywhere in the world can register himself (or herself) with an online judge for free and solve as many problems as he likes. He can send as many solutions as he want till receiving satisfactory information, not only about the verdict, but also about the time that the code takes to run after improving the program and/or the algorithm used to solve the selected challenge. One of the main distinctive trait of the online judges is that they allow the users this self-competitive behavior to learn informatics, not only algorithms but also programming.

But there are some flaws in the traditional online judge system, such as, user cannot test the algorithm in the very large scale data environment, user cannot share the problems, user cannot collect and generate the useful information from user's learning process, more and more online judge system becomes isolated island on the network. In this context, a new type of service computing model --- Cloud Computing

Platform provides the required information technology, and the Cloud Computing Platform also provides the necessary foundation for integration of platform and technology environment for a variety of scattered of programming teaching resources, under the existing conditions as much as possible to meet the demand of the teaching, research activities for resources [1-4,7]. At present, the international well-known IT companies, like Google, Amazon, Yahoo, Microsoft, IBM and so on, attaches great importance to cloud computing, and are actively promoting the research and application of cloud computing.

This paper is arranged as follows: Section II surveys the background and related research, Section III provides details of the proposed system, Section IV provide conclusions and future research efforts.

II. BACKGROUND AND RELATED RESEARCH

A. The concept of cloud computing

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid.

In cloud computing, the applications needed by users are not run on users' personal computers, mobile phones and other terminal equipment, but on a large-scale cluster of servers running on the Internet. The user does not deal with the data stored locally, but stored in the Internet data center inside. The normal operation of management and maintenance of these data center is taken charge of enterprises which provide cloud computing services, and ensure strong enough computing power and storage space for the users. At any time and any place, any user can connect to the Internet terminals. Therefore, whether businesses or individuals, they can achieve on-demand in the clouds with the use [1].

B. The characteristics of cloud computing

- On-Demand: All resources are allocated and just refer to a user's request.
- Ultra Large-scale: The scale of cloud is large, they have more than hundreds of thousands servers.
- High Abstraction: User only focuses on their own individual interests.
- High Efficiency: Gathers all resources and is managed by software distribute computing IT resource management efficiency.

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- **High Reliability:** Cloud uses data multi-transcript fault tolerant, the computation node isomorphism exchangeable and so on to ensure the high reliability of the service. Using cloud computing is more reliable than local computer.

C. The system architecture of cloud computing platform

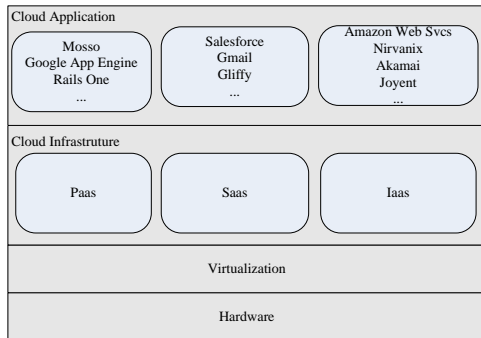


Fig. 1 System architecture model of Cloud Computing Platform

- The lowest layer of cloud computing architecture is hardware layer which is virtualized to provide a flexible adaptive platform to improve resource utilization.
- In virtualization layer, the physical hardware is being sliced into virtual machines that each has their own small operating system installed. The virtual machines are then collected into pools based on the resources they have.
- **IaaS (Infrastructure-as-a-service, or IaaS)** layer extends the virtualization layer by providing the mechanisms to provision and control the virtual machines in a utility computing manner. IaaS is the leasing of infrastructure (computing resources and storage) as a service. This means not only virtualized computers with guaranteed processing power but reserved bandwidth for storage and Internet access. In essence, it's the capability of leasing a computer or data center with specific quality-of-service constraints that has the ability to execute an arbitrary operating system and software.
- **PaaS (Platform-as-a-Service, or PaaS)** layer extends and abstracts the IaaS layer by removing the hassle of managing individual virtual machine instances. This layer seeks to minimize the hassle and complexity in deploying an application in the cloud.
- **SaaS (Software-as-a-Service, or SaaS)** is the model of deploying software from a centralized system to run on a local computer (or remotely from the cloud). As a metered service, SaaS allows you to lease an application and pay only for the time used.

III. ONLINE JUDGE SYSTEM UNDER A CLOUD COMPUTING ENVIRONMENT

A. Use Case

- **UC1:Online Judge**

The system can compile and execute user's code, and test code with pre-constructed data. Submitted code may be run with restrictions, including time limit,

memory limit, security restriction and so on. The output of the code will be captured by the system, and compared with the standard output.

- **UC2: Share the problem**

The User can share the problem with others.

- **UC3: Automatic Topic Generation**

System can generate the topic from the problems automatically, so that users can select the interesting topic easily.

- **UC4:Rank**

System gives the rank list of all users according user's experience and problem's difficulty coefficient.

B. Architecture

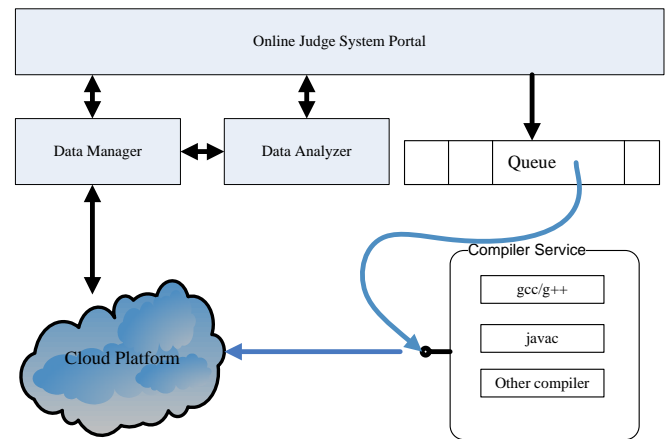


Fig. 2 System architecture

The conceptual system architecture for the proposed online judge system based on a cloud computing environment is shown in Fig. 2.

The proposed system consists of Online Judge System Portal, Data Manager, Data Analyzer, and Compiler Service.

Online Judge System Portal (OJSP) is the web portal of Online Judge System. OJSP can visit the cloud platform via **Data Manager (DM)**. **Data Analyzer (DA)** collects the information of users and problems, and mining some amusing results from large scale data. **Compiler Service(CS)** is the SOA wrap of some language compiler, such as gcc/g++, javac.

C. Automatic Topic Generation

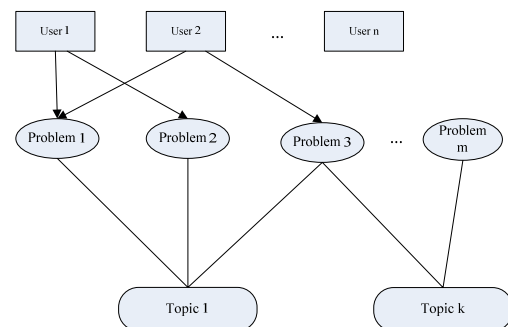


Fig. 3 schematic model

How to find the topic from the documents is the common task in the data mining community [8-10]. In online judge system, each user can tackle multiple problems, and each topic is generated from multiple problems (Fig. 3). So we can generate topic from problems automatically using text mining algorithm. In this paper, we adopt the algorithm proposed in [10], which is named latent Dirichlet allocation (LDA).

Latent Dirichlet allocation (LDA) is a generative model that allows sets of observations to be explained by unobserved groups which explain why some parts of the data are similar. For example, if observations are words collected into documents, it posits that each document is a mixture of a small number of topics and that each word's creation is attributable to one of the document's topics.

D. Implementation

We implement our proposed system using Google App Engine (GAE) as a prototype. GAE, as a new generation of cloud computing-based web application development platform, enables its users to develop and operate web applications within the Google infrastructure. GAE is easy to build and maintain, and can be easily expanded based on user access traffic and data storage needs. The employment of GAE makes maintenance server unnecessary; it could immediately provide services for users, as long as the developers upload their applications, and can also restrict them to authorized users [4].

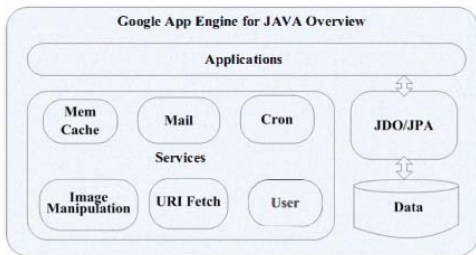


Fig. 4 GAE for Java overview



Fig. 5 Screenshot of judge online system based on GAE

As early as April of 2008 when GAE was first released, it provided a running environment which uses Python programming language. In April 2009, GAE already announced support for Java language. Fig. 3. is the overview of Google App Engine for Java. In the Web application development, GAE supports JSP and Servlet technologies. In data storage, GAE supports two sets of mechanisms---

JDO and JPA, and the developer only needs to consider the data persistence in the object-oriented dimension without care about relational database. In addition, GAE also provides a range of commonly used services, such as sending and receiving e-mail, image processing and caching.

The Screenshot of prototype is shown in Fig.5.

IV. CONCLUSIONS AND FUTURE WORK

Cloud computing is an important trend in the field of information, and also a hot topic of research in educational information. In this paper, we proposed an online judge system design and implementation under Cloud Computing environments.

The proposed system provides the function of Online Judge, Problem Share, Automatic Topic Generation, and Rank list. The System is based on Google App Engine (GAE) and it can be used to build web applications on scalable systems. The two advantages of GAE over other cloud computing solutions are user-friendliness and tool-support.

In future research efforts, we will focus on mining from data which will indicate user's learning behavior.

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REFERENCES

- [1] Zhang Guoli, and Liu Wanjuan, "The applied research of cloud computing platform architecture in the E-Learning area," *3rd International Conference on Computer and Automation Engineering*, vol. 3, pp. 356-359, Feb 2010.
- [2] Hemant Kumar Mehta, Manohar Chandwani, and Priyesh Kanungo, "Towards development of a distributed e-Learning ecosystem," *The 2nd Annual Intl Conference on Technology for Education*, pp. 68-71, July 2010.
- [3] Bo Dong, Qinghua Zheng, Jie Yang, Haifei Li, and Mu Qiao, "An E-learning ecosystem based on cloud computing infrastructure," *9th IEEE International Conference on Advanced Learning Technologies*, pp. 125-127, July 2009.
- [4] Huibin Yin, Jun Han, Jing Liu, and Xu Hongyun, "Development and research of multimedia courseware sharing platform based on GAE," *1st International Conference on e-Health Networking, Digital Ecosystems and Technologies*, pp. 409-412, April 2010.
- [5] Miguel A. Revilla, "Competitive learning in informatics: the UVa online judge experience," *Olympiads in informatics*, vol. 2, pp. 131-148, 2008.
- [6] Andy Kurnia, Andrew Lim and Brenda Cheang, "Online judge," *Computers & Education*, vol. 36, pp. 299-315, March 2001.
- [7] SeungGwan Lee, Daeho Lee, and Sungwon, "Personalized DTV program recommendation system under a cloud computing environment," *IEEE Transaction on Consumer Electronics*, vol. 56, pp. 1034-1042, May 2010.
- [8] Chengxiang Zhai, Atulya Velivelli, and Bei Yu, "A Cross-Collection mixture model for comparative text mining," *The 10th International Conference on Knowledge Discovery and Data Mining(KDD)*, pp. 271-277, Aug 2004.
- [9] Daniel Ramage, David Hall, Ramesh Nallapati, and Christopher D. Manning, "Labeled LDA: A supervised topic model for credit attribution in multi-labeled corpora," *Proceeding of the 2009 Conference on Empirical Methods in Natural Language Processing*, pp. 248-256, Aug 2009.
- [10] David M. Blei, Andrew Y. Ng, and Michael I. Jordan, "Latent Dirichlet Allocation," *Journal of Machine Learning Research*, vol. 3, pp. 993-1022, 2003.