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Proposing New Intelligent System for Suggesting Better Service Providers in Cloud Computing based on Kalman Filtering

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Abstract

There are lots of different companies which present IT services to the users and other companies. IT services are include as hosting web pages, delivering storage and processing capacities, hosting organization's servers and etc. Selecting one service provider among such companies is become very difficult and need high level of knowledge and expertise about organization needs and systems, and on the other hand, information about the creditability of service provider and security of different services which propose by that service provider. In this paper, we suggest and demonstrate new system which will gather all of the service provider's information, and also the needs and system requirements of clients or organizations which needs those services, and propose the customers the best and reliable service providers according to their needs and requirements.

Keywords: Cloud Computing, Service Providers, Kalman Filtering.

Introduction

Management and security of Information Technology (IT) services and environments attracts lots of attentions in recent century.

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In recent century, by rapid and unbelievable adoption of information technology to different industries and personal usages of different users, security and execution speed of different services are become very important challenges for each service. By advent of cloud computing, every documents

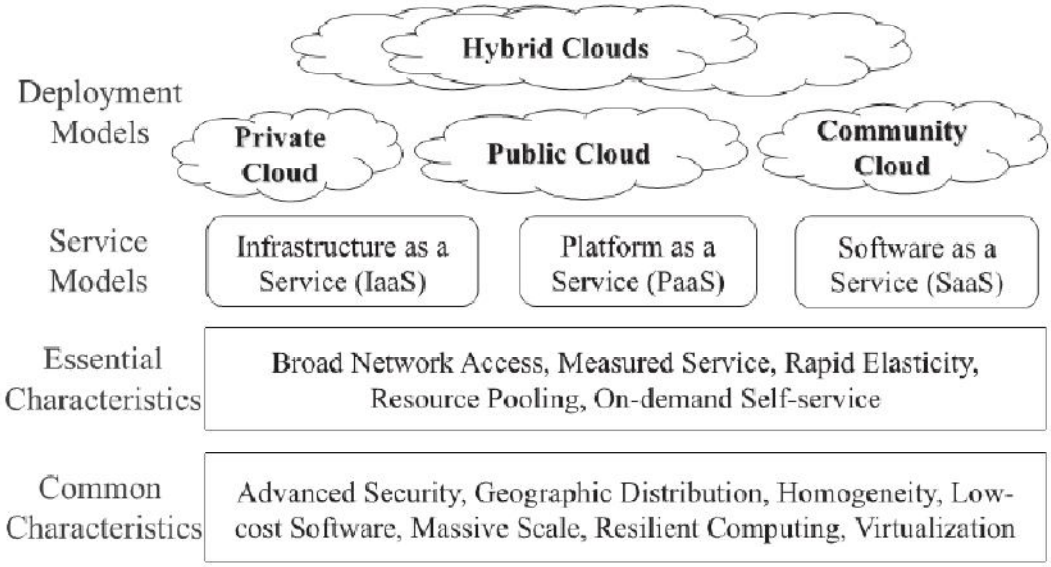

Fig. 1: Different cloud models based on NIST definitions [4].

and files can accessible from anywhere (Fig. 1, illustrates different cloud models based on standard definitions [4]). By using of this technology you will need no more laptops or external storage device, because you can store all of your documents and data in clouds and access to them from everywhere. Even you can use your mobile phone to login into your cloud account and do your own project. Because the necessity storage and processing power is provided through cloud resources and you will find cloud powers through using of broadband internet connection. According to this potential of cloud computing, you will need no more servers or advanced computer systems in your office; so you can save lots of money and lots of physical space, that up to now, you need to allocate them to your computerized systems. Also, because you didn't have any more server or computer systems, you will not waste lots of electrical energy and you will indirectly help in green energy developing. Furthermore, you didn't need to employ anymore staffs as IT manager or operators of the systems; because you didn't have any server to hire someone as IT expert for maintain and remove system errors. Moreover, by using of cloud computing, you wouldn't have any anxiety about crashing or hanging of your server or system, because the powers which you need will provide by

clouds and all the time several powerful servers are ready to support your needs. In cloud computing, you will pay nominal charges for using of each services, and you only pay according to your usages; you wouldn't pay any more money for the hours which you didn't use the services. So, again you can save lots of money and in future, you can spend these monies for developing different sections of your company. Because of the intrinsic characteristic of cloud computing, which is based on the internet, you will use the latest versions of each software and applications whenever you login into your account. You didn't need to buy any licenses for such updated software's and you didn't need to pay any more money for updating or using the latest version of software's. suppose you use traditional systems and you receive one file from one of your friends, but you didn't know how to open that file, or which software is better to use for running that file, what will you do in this situation? Cloud computing answer all of the user's needs, you upload your file inside of your cloud account and your file will open within a second by appropriate and updated version of related software's. So, by using of cloud computing you didn't need high level of knowledge about computer systems or software's. Cloud computing support you and your team by ability of team working, I mean, you and your team can works on one specific project simultaneously and see the results of each other works. Up to now, we review on basic definitions and potentials of cloud computing as comprehensive and intelligent solution for growing needs of computer users. The aim of this paper is to present and demonstrate new system for the users and different organizations to propose them the best service provider for their needs. The proposed system will used Kalman filtering as smart estimator to study the backgrounds of the users and organizations and also survey in their present needs to extract a pattern for their use, and in future, use such pattern to propose them the best service provider according to their needs. So for doing such, in the next section we will provide reader with an introduction into Kalman filtering. The third section will discuss about our scheme and we explain different aspects of our system and adoption of Kalman filtering with cloud computing. The fourth section will be conclusion and the fifth section will be references.

Introduction to Kalman Filtering

Our proposed algorithm is based on Kalman filtering and by use of such algorithm; we are able to study precedent needs and usages of specific organization or user. We can give such information as an input to Kalman filtering along with present needs and expectations of users from the system. By use of precedent usages information of the users along with their present needs and expectations, we can estimate and predict the best service provider among other service providers for them. But, before demonstrating our scheme we review some basic principles of this filtering. One of the finest

schemes which draw lots of attentions in recent decades knows as statistical filtering. This motivating and its ground-breaking usages comes from this fact that it used all available data of the system. It means that, statistical filtering will employ the noise of the system and also the state of the system.

Weiner was invented the filtering and statistical estimation in 1930's. His algorithm and system investigation criteria's was advanced by Kalman in about 1960's. He minimized the error in model of the estimation of the system by employing, covariance matrix in linear filter. The Kalman filter is class of statistical filters and employed in existence of uncorrelated white noise. By employing of Kalman filter, the classification concern is degraded into state estimation of the dynamic system. Filter development pursue for linear case studies which is pursued by its logical extension to the nonlinear case.

Specifying the Optimized Linear Filter

The formulas for the state-space modeling of one dynamical system are [1, 3]:

$$\dot{\underline{x}} = \underline{f}\left(\underline{x}, \underline{u}, \underline{p}\right) + \underline{w} \quad (1)$$

$$\underline{z} = H\underline{x} + \underline{V} \quad (2)$$

In these formulas linear relationship is present among state and output. For simplifying the noise parameters $\underline{w}$ and $\underline{V}$ will removed. So, dynamic system equation is reduced to [1, 3]:

$$\dot{\underline{x}} = \underline{f}\left(\underline{x}, \underline{u}, \underline{p}\right) \quad (3)$$

$$\underline{z} = H\underline{x} \quad (4)$$

Also, t is the time of estimation of true state [1]. If we compute the parameters of the system several times, the values which acquired will approximate a Gaussian distribution. So, the optimum state estimation of one system $\underline{\hat{x}}$:

$$\underline{\hat{x}} = \overline{\underline{x}} = \int_{-\infty}^{+\infty} \underline{x}\, P\left(\underline{x}|\underline{z}\right) d\underline{x}$$

The following formula shows the error is such estimation [1, 3]:

$$\underline{e} = \underline{\hat{x}} - \underline{x}$$

And covariance matrix of such errors:

$$E = \overline{\left(\underline{\hat{x}} - \underline{x}\right)\left(\underline{\hat{x}} - \underline{x}\right)^T} = \overline{\underline{e}\,\underline{e}^T} \quad (5)$$

With referring into Gaussian distribution, we understand that the mean of $\underline{x}$ denotes the climax of its PDF [1, 3]:

$$P(\overline{\underline{x}}) = \max[p(\underline{x})]$$

So, an optimum scheme for specifying optimized estimation of $\underline{x}$ is through specifying the value of $\underline{x}$ which climaxing it's PDF. For specific random variable$y$, the standard form of Gaussian PDF is [1, 3]:

$$P(y) = \frac{1}{\sqrt{2\pi}\,\sigma}\, e^{\frac{-(y_0-\overline{y})^2}{2\sigma^2}} \qquad (-\infty \le y \le \infty)$$

For an unlimited system with n state factors:

$$P(\underline{x}) = \frac{1}{(2\pi)^{\frac{n}{2}} E^{\frac{1}{2}}}\, e^{\frac{-(\underline{\hat{x}}-\underline{x})(\underline{\hat{x}}-\underline{x})^T}{2E}}$$

In the above formula, E denotes the variance. So the problem is to climaxing $P(\underline{x})$, under the confines of measured output [1, 3]:

$$\underline{z} = H\underline{x}$$

$log[p(\underline{x})]$ Acquires the climax value for$\underline{x}$, so we can identify the problem with using of Lagrangian multipliers as follows:

$$F(\underline{x}) = log[p(\underline{x})] + \underline{\lambda}^{\mathrm{T}}(\underline{Z} - H\underline{x}) = \log\left[\frac{1}{(2\pi)^{\frac{n}{2}} E^{\frac{1}{2}}}\right] - \frac{(\underline{\hat{x}} - \underline{x})(\underline{\hat{x}} - \underline{x})^T}{2E + \underline{\lambda}^{\mathrm{T}}(\underline{\mathrm{Z}} - \mathrm{H}\underline{\mathrm{x}})}$$

Derivation of $F(\underline{x})$ by $\underline{x}$ is [1, 3]:

$$\frac{dF(\underline{x})}{d\underline{x}} = (\underline{\hat{x}} - \underline{x})^T E^{-1} - \underline{\lambda}^{\mathrm{T}} H$$

Maximization means [1, 3]:

$$\frac{dF(\underline{x})}{d\underline{x}} = 0 \rightarrow (\underline{\hat{x}} - \underline{x})^T E^{-1} = \underline{\lambda}^{\mathrm{T}} H$$

By taking transpose, we have:

$$(\underline{\hat{x}} - \underline{x})\,(E^{-1})^T = \underline{\lambda}\, H^T$$

By using symmetry:

$$(\underline{\hat{x}} - \underline{x}) = \underline{\lambda}\, EH^T$$

$$\underline{x} = \underline{\hat{x}} - \underline{\lambda}\, EH^T \qquad (6)$$

From measurement function, we will have [1, 3]:

$$\underline{z} = H\underline{x} = H(\underline{\hat{x}} - \underline{\lambda}\, EH^T)$$

Or:

$$\underline{\lambda} = \frac{(H\underline{\hat{x}} - \underline{z})}{HEH^T} \quad (7)$$

By substituting (7) formula into (6) formula:

$$\underline{x} = \underline{\hat{x}} + EH^T\,[HEH^T]^{-1}(\underline{z} - H\underline{\hat{x}}) \quad (8)$$

This formula, will maximizing the PDF and also the optimized estimation of the system; also, if we enter (V) (measurement noise) in the (4) formula, then the state estimate [1, 3]:

$$\underline{\hat{x}'} = \underline{\hat{x}} + EH^T\,[HEH^T + R]^{-1}(\underline{z} - H\underline{\hat{x}}) \quad (9)$$

Where:

$$R = \overline{(\underline{\hat{V}} - \underline{V})(\underline{\hat{V}} - \underline{V})^T} \quad (10)$$

For determining new covariance matrix by using of (9) formula we will have [1, 3]:

$$E = \overline{\underline{e}\,\underline{e}}^T$$

Thus,

$$E' = E - EH^T(H^T + R)^{-1}HE \quad (11)$$

By doing some simplification on (9) and (11), we would have new factor k as the gain:

$$k = EH^T\,[HEH^T + R]^{-1} \quad (12)$$

Make some lessening on (9) and (11):

$$\underline{\hat{x}'} = \underline{\hat{x}} + k(\underline{z} - H\underline{\hat{x}}) \quad (13)$$

$$E' = E - kHE \quad (14)$$

As we told above, we have [1, 3]:

$$\underline{\dot{x}} = \underline{f}\left(\underline{x}, \underline{u}, \underline{p}\right) + \underline{w}$$

Optimized estimation for $\underline{\dot{x}}$:

$$\underline{\hat{\dot{x}}} = \underline{f}\left(\underline{\hat{x}}, \underline{u}, \underline{p}\right) \quad (15)$$

By hypothesis of process noise to be zero-mean the above formula can declared as [1, 3]:

$$\underline{\hat{\dot{x}}} = B\underline{\hat{x}} \quad (16)$$

B is matrix of coefficients:

$$B = \frac{\partial \underline{f}\left(\underline{\hat{x}}, \underline{u}, \underline{p}\right)}{\partial \underline{x}} \quad (17)$$

State estimation error can be declared as [1, 3]:

$$\underline{\dot{e}} = \underline{\hat{\dot{x}}} - \underline{\dot{x}} = B\underline{\hat{x}} - (B\underline{x} + \underline{w})$$

So, the time derivation of the error covariance matrix is:

$$E = \frac{d}{dt}\left(\underline{e}\,\underline{e}^T\right) = \underline{\dot{e}}\,\underline{e}^T + \underline{e}\,\underline{\dot{e}^T}$$

In conclusion [1, 3]:

$$\dot{E} = BE + EB^T + (\overline{ww^T})$$

The process noise covariance matrix is:

$$Q = \overline{ww^T} \qquad (18)$$

Time rate of variation of error covariance matrix can be presented as [1, 3]:

$$\dot{E} = BE + EB^T + Q \qquad (19)$$

The above formula (19) is controlling equation in the shifting of covariance matrix alongside the dimension function over time. By using of (13), (14), (15) and (19) any kind of estimation problems can be explained. (13) Formula will confirm the optimized estimation, $\underline{\hat{x}'}$ of the state factors at specific time. This will do by climaxing the model PDF by use of previous estimation of the system $\underline{\hat{x}}$, and also the present measured output $\underline{z}$. By employing (14) formula, we can resolve error covariance matrix. (15) and (19) will update the error covariance and state matrices. Such values are employed to optimize the model and process estimations [1, 3].

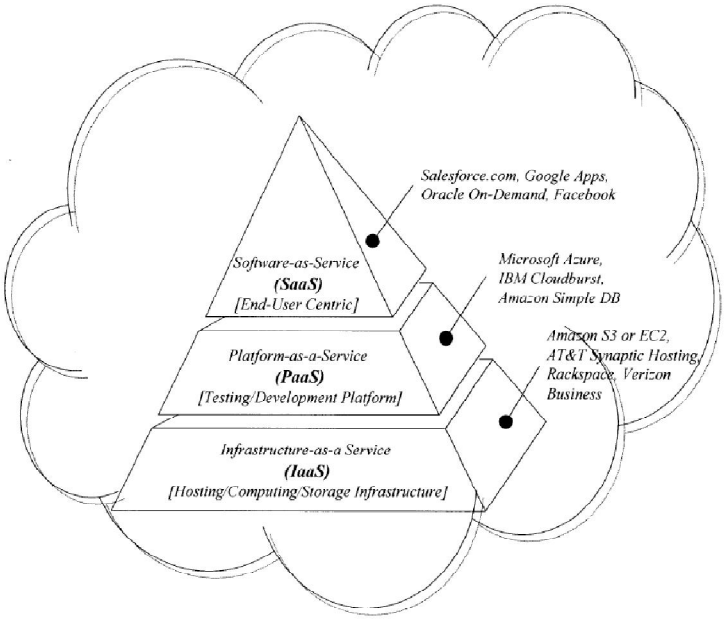

Fig. 2: Different cloud service providers [15].

Significant factor in being able to model one dynamic system is to being able to model that system through series of differential formulas. To do this, various identifications and aspects of the particular system should be recognized, to be able to do accurate estimation and prediction. But in our research (cloud computing technology), we do not knowing anything about significant criteria's and even layers of such network. So, we only introduce our scheme [1, 3].

Adoption of Kalman Filtering with Cloud Computing

The main goal of this paper is to present and demonstrate new system for estimating and predicting the best service provider for one specific user or organization, according to his precedent needs and usages and also their present expectations (fig. 2, illustrates types of different services in cloud computing and some well-known service providers in cloud computing [15]). We will give background needs of one user along with his present expectations and his present needs as an input to our system and the system will suggest the best service provider according to his needs. The Kalman filter will extract a pattern from precedent data of the user and will update the pattern by more sampling from the user usages and studying his behaviors and his keen and eagerness in different software's. The proposed system will use such pattern along with present needs and expectations of the user, to estimate and predict the best service provider.

Conclusion

Cloud computing delivers different processing and storage capacity services, in these days' lots of different service providers launch their own services in cloud computing. For one specific user or organization, its different to select one service provider among others; he will not have enough expertise to do fair comparison between different service providers or he will not knowing all of the service providers and maybe he accidentally miss the best service provider. So, for better and smart selecting of one service provider through others, in this paper we propose new system for suggesting the best service provider according to user needs and expectations. Our system is based on Kalman filtering and will use precedent usages and needs of the users along with their present needs and expectations to suggest them the best service provider.

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