CRIBEL: LIFELONG LEARNING SOCIAL NETWORK GOVERNED BY ACADEMIC INSTITUTIONS: AN AFFORDABLE SERVERLESS MODEL IN THE CLOUD

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Abstract

Academic institutions, teachers, students and workers are facing important changes in the way they organise work and training in new skills demanded by companies in the face of the new challenges of society in general due to the digital transition. One of the accepted strategies for these subjects is the Lifelong Learning model that prepares them in knowledge, skills and competences they need to thrive in the labour market and in their personal and private life.

Communication and motivation are key elements in the educational process in general and in Lifelong Learning in particular, and it is here where online social networks services (SNSs) are a tool of great potential in this sense given their capacity to offer information and contents, as well as to facilitate the interconnection between subjects involved in the process. But, are popular and public SNSs sites like Facebook, Twitter or Youtube the networks we need in our academic institutions?

SNSs including Facebook, Youtube, and Twitter are widely used for educational purposes. And they have potential and interesting aspects. But of course, there are also difficulties associated with the use of these online social networks by academic institutions.

Among the difficulties mentioned, we will focus on three categories. The first is the loss of student time filtering high quality and useful content for their training and the lack of expert guidance in this task. The second is the lack of control of the social network by the academic institution, which has little power of governance and decision-making in a social network such as Facebook or Twitter, governed by private entities according to non-educational interests. And the third is the economic cost and technical challenge for an academic institution to create and maintain its own online social network.

We present a model of a new social network oriented to Lifelong Learning we have named *Cribel,* whose main characteristics are its simplicity and agility, its motivational elements of the user experience, the control of the quality of the contents, and its simplicity and low cost of implementation, maintenance, and automatic scaling due to its serverless design model in the cloud.

Keywords: Lifelong Learning, Social Networks, Cloud Computing, Serverless, Amazon AWS

1 ONLINE SOCIAL NETWORKS IN EDUCATION

Educational processes are being strongly affected by new digital technologies in general and specifically by the value provided by social networking tools, web 2.0, and public sharing of knowledge and experiences among professionals. These professionals are constantly updating their training and skills (upskilling and reskilling) to adapt to a labour market that is constantly demanding it.

The development of lifelong learning (LLL) [1] culture, is not only a necessity for our better adaptation to the ever-changing globalised labour market, it is also necessary for the sustainability of the planet [2], or for the improvement of our private lives [3]. Therefore, lifelong learning opportunities should be part of the strategy of education and training institutions to improve their responsiveness to the rapidly changing needs of employers and learners [4] in a blended learning environment where the formal learning process already has more than one approach.

In addition, it is necessary to consider the effect of other elements, such as the ideology of open science [5], [6] and global knowledge, which promotes making scientific knowledge and research available to society as a whole for its advancement. In this scenario, online social networks (OSNs) or social network services (SNSs) are also being increasingly used by students, graduates and professionals as part of his lifelong learning strategy [7]. But the well-known public online social

networks available today, such as Facebook, Twitter, Youtube, etc., were not initially conceived for educational purposes and are difficult for institutions to adapt to their academic activities.

In this paper we present a model of a new social network focused on lifelong learning, which we have named 'Cribel'. Its main features are its great user experience combined with its user-friendly interface, its content quality control, its cost optimisation leading to low implementation and maintenance costs, and its reliability with automatic scaling due to its serverless design model in the cloud.

The following sections of this article are structured as follows. In section 2 we present the general approach to the problem of the use of online social networks for lifelong learning activities by universities or other academic institutions. Section 3 identifies the difficulties that users of these online social networks face. In section 4 we introduce the *Cribel* social network and the cost model in the public cloud. Section 5 outlines the main results and, finally, section 6 describes obtained conclusions.

2 THE ACADEMIC INSTITUTION AND ONLINE SOCIAL NETWORKS

Almost all academic institutions today frequently use blogs, wikis, media-sharing services, collaborative editing tools and online social networks such as Facebook, Twitter or Youtube as part of their academic activities, thus promoting collaboration and the sharing of knowledge and experiences among users [8], [9].

Communication and motivation are key elements in the educational process in general and in lifelong learning in particular, and it is here where online social networks (SNSs) are a tool of great potential in this sense given their capacity to offer information and contents, as well as to facilitate the interconnection between subjects involved in the process. But, are SNSs like *Facebook*, *Twitter* or *Youtube* the networks we need in our academic institutions?

Academic institutions find it difficult to use social network services in their educational programmes because the social networks available online do not facilitate the rigour, control of participation and control of the quality of publications and collaborative interactions that is part of their identity and is required, for example, in the field of higher education. This rigour is also required in any other field of education, but we focus specifically on higher education.

Our vision highlights the positive value of the use of social networks in education, but also highlights the difficulty of the use and control of SNSs by the academic institution.

3 LIFELONG LEARNING USER VERSUS ONLINE SOCIAL NETWORKS SERVICES

The profile of people engaged in lifelong learning processes is becoming increasingly broad. This is a consequence of the fact that the use of online social tactics has proven useful in motivating people to participate in these processes [10]. But the use of SNSs is not without difficulties.

To begin with, users face an enormous amount of content that is impossible to cover. Users get lost without order, structure or method, and without any help from the academic institution, teachers or professionals to guide them in the process. It is obvious that in this way, the loss of time, motivation and effectiveness in the learning process is assured.

On the other hand, how can students evaluate the quality of the content they access through SNSs? This is undoubtedly a complex and even controversial question, with many interpretations and interests of all stakeholders and few certainties. What is certain is that the content published, and thus supervised by the academic institution and its professionals, is of unquestionable quality because that is precisely the aim of any academic institution: to provide high quality educational resources.

Our proposal highlights the importance of collaborative learning and the validity of social networks as a model, but supervised, controlled and governed under the scientific and academic rigour of the academic institution. This is impossible with SNSs such as *Facebook*, *Twitter* or *Youtube.* We

therefore propose a new model of social networking that is entirely controlled by an academic institution.

4 CRIBEL: SOCIAL NETWORK HOSTED AND GOVERNED BY ACADEMIC INSTITUTIONS

We propose a new social network controlled by the educational institution that is easy and inexpensive to implement through a serverless model in the cloud. We call this new social network Cribel in relation to the Spanish word 'criba' (sieve, filter, selection) as the contents published in the different channels accessible to the public are selected by the teaching staff of the academic institution or by people they designate. Thus, subscribers to the different channels will only read selected quality content as a result of the academic rigour of the academic institution that governs the social network.

Subscribers can also participate by giving their rating of the content, which will be taken into account to show subscribers the overall rating of the published content.

The main problem with using this type of social network, hosted and managed by the institution itself, is the difficulty of its implementation and its economic cost, without forgetting the problem of scaling the system, since it is to be used by a large number of users. Each of these aspects will be discussed below. Solving both problems is one of the main objectives of our contribution and for this we will use an implementation model based on Cloud Computing.

There are a variety of cloud vendors such as Amazon, Google, Microsoft, IBM and Alibaba that offer cloud services. We will implement Cribel using Amazon Web Services since it is the platform in which we have the most experience with.

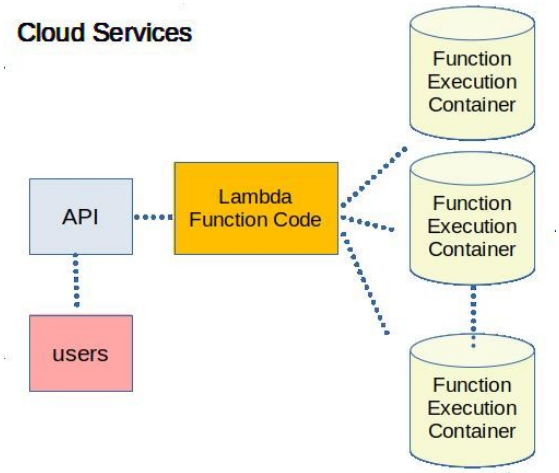


Figure 1: Lambda Function Paradigm Simplification

4.1 Serverless Cloud Computing Model for Flexible, Scalable, and Cheap Development Costs

Within all the services offered by AWS, we will focus on serverless architectures and its Serverless Lambda Services [11]. In a Serverless Computing based system [12] the developer only needs to provide the code (lambda function code in Fig. 1) of the function that will execute the application for each event and does not need to worry about the necessary computing infrastructure as it will be located on-demand in the cloud. The system will receive requests through a programming API from different points from which users interact with the system and triggers calls to the corresponding functions. Each function has a code (Fig. 1) and uses memory in isolation in a container or in a virtual machine assigned to it at any given time in what is called the Lambda paradigm. This on-demand model allows to automatically scale (auto-scaling) any application easily eliminating the worry of locating expensive resources based on assumptions, on-premises, that we do not know if they will be used or not and, what is very important, with a cheaper deployment cost.

The costs of this model are calculated on the basis of two main factors: compute costs for the execution of each lambda function (execution time and memory used) and number of API calls, although there are also a series of additional optional factors that we will not consider in our case as they have not been activated and their activation is not generally necessary. These economic cost aspects are dealt with in a following section.

4.2 Serverless Architecture

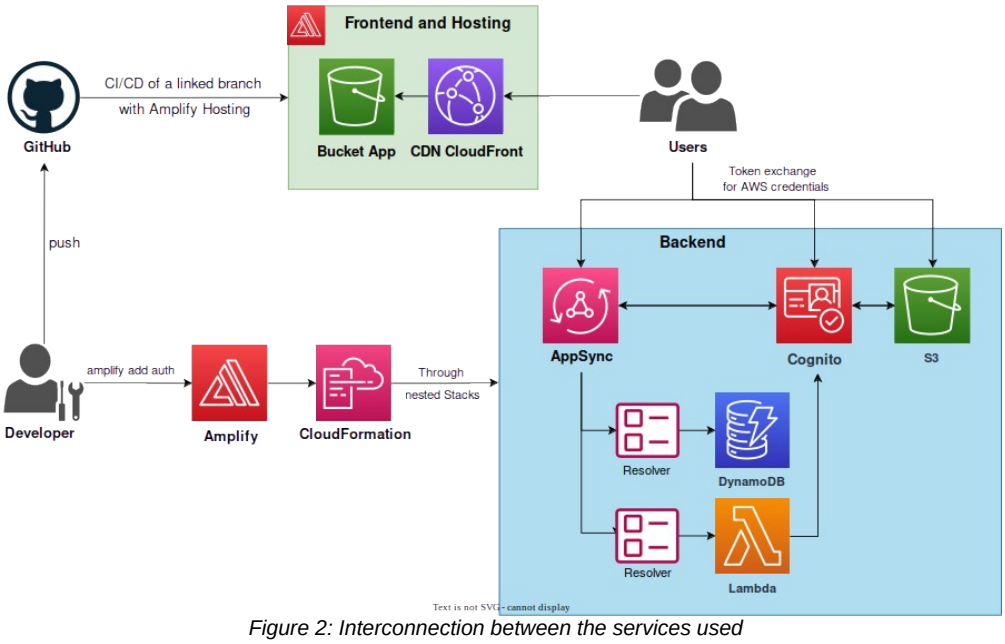


Figure 2: Interconnection between the services used

Figure 2 shows a schematic representation of the connections between the Amazon AWS Cloud Services used in the development of Cribel. Users log in via the AWS Cognito identity and access control service so that each user is assigned the appropriate permissions to interact with other AWS resources such as the *S3* storage service, the *DynamoDB* database, *Lambda* functions or the serverless GraphQL API service *AppSync*. Users will access and interact with the social network via a web client hosted in an *S3* bucket behind a content delivery network (CDN).

Backend resources will be created through the AWS Amplify service framework via *CloudFormation*'s nested stacks. While the frontend will be linked to its corresponding branch of the *GitHub* repository thus establishing an automatic Continuous Integration/Continuous Delivery (CI/CD) model [13].

4.3 Cost Model

Many factors affect the cost in the cloud of an application with multiple users like Cribel (perhaps thousands) making requests involving reads and writes to a database.

One of the main goals of our work is to present a real use case, the social network Cribel, and its actual cost in Euros for its implementation in the cloud, as well as an estimate of the cost depending on the number of users of the social network. Given the difficulty of such a calculation across all cloud providers (whether Amazon, Microsoft, Google, etc.) and the lack of publications reporting on the actual costs of applications, we believe that our cost model will be of great use to the academic community.

4.3.1 Actual Cost Estimation Assumptions

To simplify the results of the cost estimate, we will consider the following assumptions. First, we have assumed that a regular Cribel user makes about 40 generic requests per day to the social network. This is a fairly high estimate to ensure that our calculations will be higher than the actual final cost (this will be the criteria we will follow for all estimates).

In order to calculate costs more accurately and considering the Amazon AWS cost model, we will assume that 32 of these requests will be read requests and 8 will be write requests. These are factors

used by Amazon AWS to calculate the cost. We will also assume that the average response size of each request is 15KB.

Furthermore, with respect to the DynamoDB database, we assume that the item that is written to the database each time is the largest item for our application, i.e. about 6KB, which occurs when inserting a new article in a social network channel. To cover the estimates, we also assume a DynamoDB database of 25GB, an average page size served to a user of 2MB, and total space taken up by the web application's files will be 40MB.

4.3.2 Actual Cost of Implementation

Table 1 shows a summary of the Monthly Active User (MAU) expenses estimated with the above assumptions and considering that Lambda and Cognito costs are negligible. The last row shows the formula obtained for the expenditure model in our case.

Table 1. Estimated total monthly cost per active user (MAU)

	cost/month (MAU)
AppSync	0.0167 * MAU
Lambda	~ 0
DynamoDB	0.0042 * MAU
Cognito	~ 0
S3	0.0037 * MAU
Amplify Hosting	0,0009 + (0.0038 * MAU)
TOTAL	(0,0284 * MAU) + 0,0009

Figure 3 shows the evolution of the total monthly cost of the implementation of the Cribel social network in the Amazon AWS cloud according to the estimates we have made for each service and according to the number of monthly active users (MAU) in a range between 1000 and 15000 users.

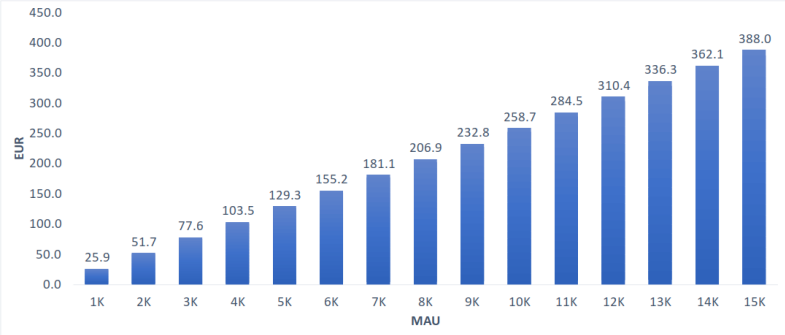


Figure 3: Total costs in a month per Monthly Active Users (MAU) that month

5 RESULTS

5.1 The academic institution Controls the Quality of the Content

Cribel [14] is a fully operational social network and is very easy to use. Users can register into the website and subscribe to channels ruled by teachers or by people they designate so the order, content structure, method and content quality is asured. Thus, subscribers to the different channels will only read selected quality content because of the academic rigour of the academic institution that governs the social network.

Cribel has a notification system of new content for users and subscribers can also participate by giving their rating of the content, which will be considered to show subscribers the overall rating of the published content.

Documentation on its installation and use is beyond the scope of this work but it is accessible from the site cribel.uco.es/cribel. Code is available in a GitHub repository for any educational community to use and/or improve it (more information at cib.uco.es/cribel). Figure 4 shows a screenshot of the home page of a website where Cribel has been deployed. You can find more pictures and information about Cribel in cib.uco.es/cribel.

5.2 The academic institution Easily Controls the Deployment and Spending of the Social Network

We presented a realistic cost model for the implementation in Amazon AWS Cloud Services of the social network based on the number of active users in a realistic range of between 1000 and 15000 users (data refer to the date of publication of this paper). And an indication of the cost in euros, which is rarely found in the literature but is very useful to estimate the convenience of carrying out the project in a university or academic institution.

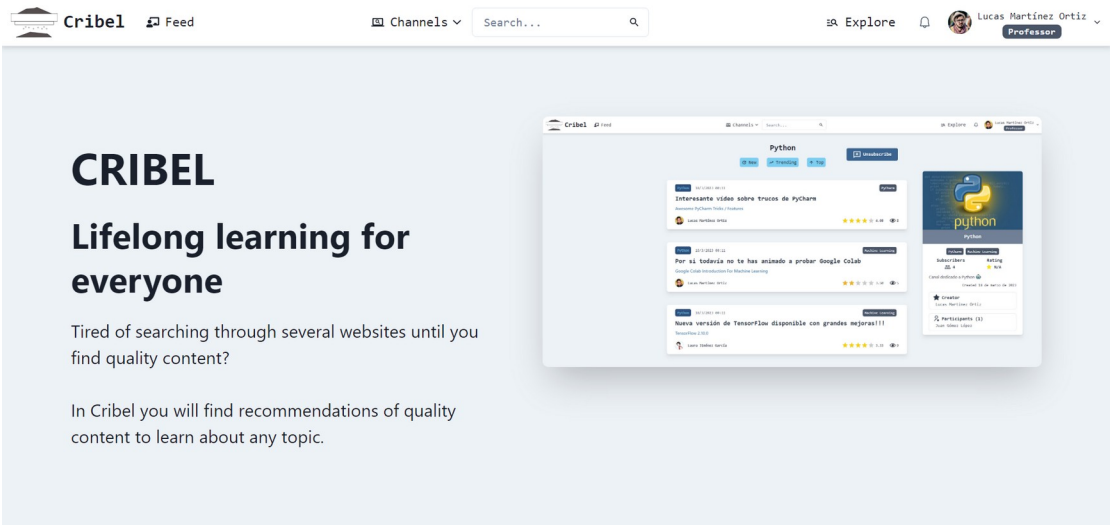
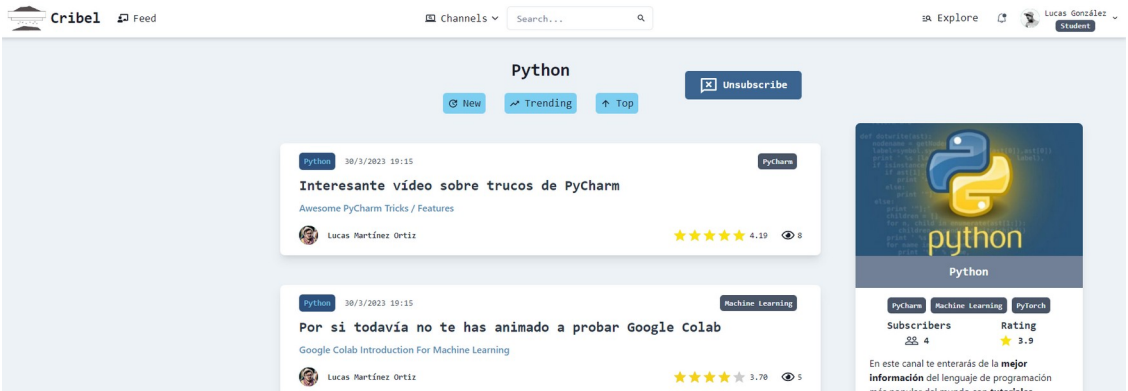


Figure 4: Screenshot with the front page of the Cribel social network

6 CONCLUSIONS

We have developed a social network useful in lifelong learning processes which we have called Cribel. The social network is easy to implement under the cloud model (we have used Amazon AWS but any other can be used) based on serverless architectures which means very low costs and totally assumable by any academic institution.

In this way, academic institutions can exercise full governance and control of these tools that have become essential today. So, we encourage academic institutions, like universities and other institutions, to self-deploy and take control of their own social networks and use their full potential for their academic activities.



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