**BABES-BOLYAI UNIVERSITY CLUJ-NAPOCA**

**FACULTY OF MATHEMATICS AND COMPUTER SCIENCE**

**SPECIALIZATION COMPUTER SCIENCE ENGLISH**

**DIPLOMA THESIS**

**Job Recruitment with Intelligent Recommender Engine**

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# **Abstract**

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# **Chapter I**

# **Introduction**

E-recruitment, also known as online recruitment, represents the modern equivalent of finding various job candidates using web-based technology, in order to enhance its efficiency compared to the classic method of face-to-face/in-person encounters.

Nowadays, due to the exceptional and spontaneous growth of technology in the last decade, almost every company out there broke in the area of online recruitment. This doesn’t mean that the new approach needs to replace the old, but to work alongside each other to extend the growth and standards of a company.

Some of the most important reasons that propelled investors and entrepreneurs in taking another step towards the future of their businesses are the minimized hiring costs (less HR-human resources required during the process), broader scope of audience (enables targeting far wider, locally or abroad without paying extra taxes) and the accessibility (job ads and campaigns can be published through various social media sites, 3rd party websites, in order to reach the target group). It is also good practice to take into consideration that disadvantages also exist, such as a much larger number of unsuitable candidates applying to the offer versus the standard method, the lack of knowledge about the personality traits of the applicants (as these online elements tend to focus more on the technical side) and complications regarding the senior positions that are not very accustomed with technology.

The paper is centered around the concept of finding a job, both from the perspective of people on the lookout for new opportunities and from the perspective of a company wanting to recruit/expand. It is structured in 5 chapters that will be shortly described below.

The first chapter summarizes the main theme of the thesis and how it is structured.

The second chapter dwells in the domain of E-Recruitment, as the title suggests. It starts off with an introduction, followed by a couple of definitions. As recruitment and technology always evolve and change, a perfect definition that covers the entire concept doesn’t exist. Then, some advantages and challenges that commonly appear upon interacting with online environments are stated. In continuation, the players that are interacting with such system are presented (jobseeker, company, recruitment market and administrator) followed by how the hiring process takes place from beginning to end. The chapter ends with a brief comparison between e-recruitment and the traditional counterpart.

The third chapter enters the world of A.I. (Artificial Intelligence) and describes how intelligent agents can improve and shape the interaction with online recruitment in order to achieve more realistic results related to each individual’s personal preferences.

The fourth chapter breaks down the technologies used in the application.

The last chapter contains conclusions after completing the thesis.

# **Chapter II**

# **The Domain of E-Recruitment**

# **2.1 Backgrounds**

Recruitment is mainly composed of practices and activities carried out by the firms with the primary purposes of identifying/attracting potential employees, sorting through the applicants, making contact with the potential fits and closing the deal with the best candidates. (Breaugh & Starke, 2000).

E-recruitment has grown exponentially in the last decade, as the Internet became the most popular tool in hiring and is now widely used by both recruiters and job seekers across the world (Cober & Brown, 2006). In order to draw human capital, the process is split in mainly two categories: corporate websites and commercial job boards. Corporate websites are private web pages that belong to companies where users can browse for current openings, while job boards are third party websites that contain offers from multiple recruiters that paid a certain fee for publicity. (Kapse & Patil, 2012). Lately, social networks are increasingly being used because of their efficiency as a middle agent between the other two. (involving a free third party website where each company can create a personal page with all the information needing to attract human resources).

Technology can ease the selection of employees over the traditional method, and so every website evolved into a complex interactive engine that tries to automate every aspect of cyber recruitment, making it accessible to a wider audience over longer distances. ( Galanaki, 2005; Joe Dysart, 2006). The world wide web became a powerful tool for recruiting in the mid-1990s and was advertised by the media as a handler behind a “recruiting revolution” caused by all the potential improvements that it could bring to the table over the more traditional method. Easier access to information and reduced costs in human resources resulted in more sophisticated and interactive methods of finding the right person for a specific opening. (Boydell,2002; Freeman & Autor, 2002).

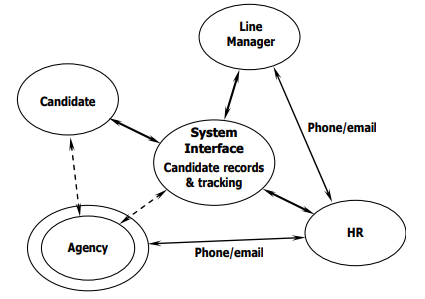
When we are talking about what are the highest chances of finding the most suitable candidates for a job opening, the flexibilities and capacities of e-recruitment are standing out. It can offer a global geographical spread with unlimited access at any time. People from all over the world can find attractive job offers, greatly increasing the reputation and brand of company. Also, it can be a time saver, as more and more automated tools and engines are cutting out the work for employers. Nevertheless, everything has some flaws. In this particular case, the lack of internet in some undeveloped countries, the low technical knowledge of senior people that prevent a best experience of an online environment and the insufficiency of accessible website to allow people with disabilities equal chances.

Given all that, as technology always evolves and changes, the cracks that come with e-recruitment have a full potential to be fixed and all the domain, as a whole, to be improved.

# **2.2 Definition**

Recruitment is a process that implies looking for potential candidates to fill available vacancies in organizations. With the help of effective human capital work and following a linear process composed of multiple steps, the services of the most suitable and capable personnel are being secured. The rapid growth of technology suddenly changed the way companies are conducting business and lured almost all of them to more non-traditional forms of enrolling practices, precisely “e-recruitment”.(Erica, 2007).

Vidot (2000) suggested that “e-recruitment is the use of internet to attract high quality candidates, screening of suitable profiles, streamlining the application and selection process.”



**Figure 1**. Landscape of e-recruitment (*Source*: IES, 2003).

Galanaki (2002) said that “The words e-recruitment, online recruitment, cyber-recruiting, or internet recruiting are synonymous. They imply formal sourcing of jobs online.”

Edwin B. Flippo stated that “Recruitment is the process of searching the candidates for employment and stimulating them to apply for jobs in the organization”, meaning that recruitment stands as a link between employers and job seekers, as Figure 1 shows. The candidate interacts with the System Interface, a website in our case, and the application information is processed by the HR ( Human Resources) department, either directly or through phone/email, then finally reaching the organization.

E-recruitment can also be defined as “a way of implementing [recruitment] strategies, policies, and practices in organizations through a conscious and directed support of and/or with the full use of web-based channels” (Girard & Fallery, 2010, p. 1). This statement affirms that in order for a recruitment process to be categorized as e-recruitment, it must have a “significant portion” taking place online, as rejecting candidates through emails and chatting applications or inviting them to take a quiz/survey by providing a link doesn’t mean you are not using a variant of traditional methods.

To put it shortly, web-based recruitment means the use of technology in supplementing and improving the classic method, without trying to eliminate it. To show how dominant this trend became, Taleo conducted a research in 2003, finding out that over 93% of the Global (that operate and distribute in many countries around the world) 500 companies were already using online recruitment. Another investigation, also by Taleo, showed that a large number of firms are only allowing the job seekers to apply in an online environment ( from 27% in 2000 to 77% in 2005).

# **2.3 Advantages**

More and more companies started to invest in their own websites or using 3rd party services because of the various benefits the online environment could bring to their businesses. The most important feature would be the availability, as the Internet provides unlimited and continuous access to the possible future employees at any time and almost anywhere and by doing so it broadens the timetables that would be provided by the HR (Human Resources) workers.

Another important facility are the reduced costs that come hand in hand with going online. First of all, posting a new job vacancy on your own website is free, relatively cheap on an external service compared to a recruitment agency or getting a headline in a newspaper. Second of all, as processing applications online means that an automated algorithm/system is doing all the work for you, this implies that the administration burden of the HR department can be greatly reduced as well. (Kerrin M 2005).

Wider access results in a higher chance of finding the most suitable candidates in a fair and efficient way. Online advertising provides a larger pool of local, national and international offers. Having people from all around the world encourages diversity, different opinions and various knowledge on a common subject. (Kerrin M 2005). By using an online recruiting tool, information about all the applications is stored in a database and can be used later for future openings and thus giving a second chance to the people that didn’t manage to close the deal in the first place.

An additional very important feature is time saving. Completing online quizzes, surveys, forms and attaching your CVs (Curriculum vitae) can now be processed by engines in a matter of minutes, saving valuable time. This is particularly useful in larger companies where some vacancies can attract a large volume of job seekers. All the steps from preparing the job description and specification to the pre-selection of candidates to the interviews and the decision making can be tailored to fit the best interests of both the user and the organization. Receiving quick responses to questions and information on certain subjects are easily achieved, as a lot of companies often have forums where anyone can post their concerns and get an answer from a qualified worker. (Elkington T 2005; IDS Study Plus 2000).

The reputation and brand can also be a deciding factor when done properly. Lots of websites have sections where they describe the organizations accomplishments, the most impressive and large projects, the most skilled and renown employees that walked through their door, the culture and maybe the future goals. Lately, it is common for “virtual tours”, “employee of the month” and “a day in the life of ” videos to be presented in order to immerse in the feeling of how it would be like to work there and how you would be treated by others. Having more features and putting work to describe your firm can greatly increase how an outsider is viewing and formulating his first opinion about you, resulting in a better image. (Kerrin M 2005).

Some other smaller advantages of e-recruitment are the attraction of passive jobseekers, as having a very attractive job post can stimulate even someone who is not necessarily on the hunt to take a peek, the reduction of unqualified candidates, as the offers can be very precisely tailored to very specific needs, more opportunities for smaller firms, as any application can become popular overnight due to recommendation systems and it can often be less intrusive than the traditional method, as some people are more comfortable in front of a screen rather than in front of a committee.

# **2.4 Disadvantages/Challenges**

As any other domain, E-recruitment has its own share of challenges and shortcomings, but they are not written in stone and can always take a turn for the better.

The main problem is related to the number of applications and their authenticity that need to be processed. Even though an online platform generates a high amount of suitable candidates and also reduces the number of unsuitable candidates, their number can still be quite large, especially for a popular job post. However, automation can only take you so far and afterwards it turns into a time costly operation of sorting out unwanted offers. Another difficulty is keeping a clean record of both online and offline offers, which can lead to a chaotic internal organization and can affect the state of the company. In some cases, overloading of the website’s capacity due to high traffic can create some technical, IT-related problems, which again need time and resources to solve.(IRS 2005).

A really important issue is the lack of Internet in a lot of underdeveloped countries around the world, which affects the chances of their inhabitants to get an equal chance of obtaining a job as someone in a more thriving place. Also, companies need to take into consideration the population that is not accustomed to technology and usually encounter technical difficulties when interacting with an online environment, thus firms shouldn’t solely depend on online recruitment methods. Various disabilities can often limit or even negate the use of a website and a lot of employers are unaware of this implications and are not providing an accessible environment or an alternative medium depending on the situation. (IRS 2005).

Smaller complications also exist, like the preference of individuals for face-to-face traditional recruitment in the case of a company where only online applications are allowed and the absence of “personal touch” of a website. To elaborate, the online platforms provide a more technical resume of a candidate, often neglecting their personality, temper and emotions thus obtaining a robotic environment that cannot learn how a possible future employee will behave.

# **2.5 Players in E-Recruitment**

* Job Seeker: An individual that is looking for new opportunities. On a website, they have permissions to create an account, participate in various quizzes and tests organized by companies, browse the available vacancies in the job posts and of course to submit their CV/resume to any organization they see fit. They can be split in two categories:

a) Active job seekers: Candidates that are searching regularly for jobs that can offer them a change of scenery in another domain, higher salaries, better opportunities for growth and many other personal or professional reasons.

b) Passive job seekers: Candidates that are not deliberately in need of a change, but they are browsing the internet in their spare time. A well made and attractive job post can definitely catch their eye, so a new opportunity, even if not intentional, can always appear.

* *Administrator* (Optional): The administrator is an optional candidate here, as he only appears in the case of 3rd party software like commercial job boards. He owns a website that holds multiple offers from multiple companies, which need to pay a fee in order to advertise their vacancies. The administrator has the ability to remove both users and companies from his platform and to view several reports containing information from clients.

Diagram

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**Figure 2**: The components of e-recruitment (*Source*: [4])

* Employers (Companies/Firms): The final target of the job seeker where they can close the deal based on the job requirements and their experience and skill. On a website, companies have the ability to posts new job vacancies, modify the details and to process using their own policies, all the data received from applicants.
* Recruitment Market: The recruitment market is the mediator between all the components that is responsible for keeping everything together. It’s the main piece where e-recruitment revolves around. During time the online environment took different shapes like corporate websites, commercial job boards/portals, social-media sites, games, blogs and lately a lot of them have been upgraded to sustain a recommender engine that allows for more precise and efficient results fit for every user’s personal preferences.

As Figure 2 shows, all the information the recruitment market collects from jobseekers, companies and administrators, depending on the situation, is stored in a database so that it is safe, validated, current, organized and available at any time.

# **2.6 The Hiring Process**

The process of hiring is composed of multiple consecutive tasks. It usually begins with identifying applicants in a specific domain, making an interesting eye-catching job announcement and continued by assessing the incoming applications to communicating with the most suitable candidates in an interview.

* Identification: Identification requires the least amount of Internet usage, as seen in Table 1, because it mainly consists of creating the wanted candidate profiles with the appropriate qualifications. A suitable job description for the chosen segment of the working market should be created and then distributed is some type of online environment.(Newell 2009)

|  |  |
| --- | --- |
| Recruitment phase | E-recruitment techniques, tools and sources |
| Identification of candidates | None |
| Attracting applicants | E-recruitment system, Internet job boards and career portals, corporate career website, social networking sites, various (third-party) websites, industry-specific web resources, electronic mail and electronic mailing lists |
| Processing and pre-screening applications | E-recruitment system |
| Communicating with candidates | E-recruitment system, corporate career website, electronic mail and electronic mailing lists |

**Table 1**: The use of e-recruitment sources, techniques and tools in the case companies at different recruitment phases (*Source*: [2])

* Attraction: Attraction is the most important and Internet dependent step towards the expansion and growth of a company. The brand and reputation of a firm tends to be a very relevant factor for driving jobseekers to their doors. Corporate website, social media sites and job boards are the most popular and efficient software tools to reach the target audience. The principal ways of submitting your information are through CV’s resumes and application forms. (IRS 2005). Lately, a lot of website are using verification engines to assure the authenticity of the incoming applications.
* Selection: Selection implies reducing the large amount of received applications by eliminating the unsuitable candidates for each vacancy. This can be achieved in the form of technical tests, evaluations, quizzes or simply by removing candidates whose qualifications or studies/degrees are not matching the given requirements. Because of issues of security, confidentiality and not knowing if the right individual is taking the assessment, a lot of companies are hesitant to use online testing tools and prefer the more physical/in-person way.(IRS 2005). Having an automated engine to perform the processing of candidates is essential in ensuring an organized and valid system for storing data for further refinement.
* Communication: Communication is considered a critical part of the hiring process because it determines whether you get dropped off or proceed further towards an interview. There is risk of receiving negative feedback from candidates whose resumes were rejected too early and it can appear as if the process was rushed without enough consideration and this can eventually lead to damaging the firm’s reputation. However, it can be easily avoided by giving quick and on point feedback to the applicants, explaining what they got wrong and how can it be improved for future job interactions. Communication can be achieved by email, phone calls or even face-to-face, where the distance is not a problem.

# **2.7 Traditional recruitment vs E-Recruitment**

Traditional or paper-based recruitment revolves around the exact same concept as e-recruitment: finding the right person to fill an available vacancy. The main difference between the two comes at how the hiring process takes place. As Figure 3 shows, the steps of both concepts are almost the same. However, online recruitment comes with an advantage at selection and communication with the applicants, as it allows these processes to happen concurrently (at the same time). Technology made it possible, by allowing access to candidates information at all times, for HR department and the employees to keep the users in touch with their progress during the whole recruiting process. Running an online environment comes with the responsibility of upkeeping and constantly improving it, so it can provide a pleasant and different experience to the user compared to the classical method.

Diagram

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**Figure 3**: The design and sequence of tasks in traditional paper-based recruitment process vs. the (new) recruitment process using e-recruitment. (*Source*: [2])

The traditional method involved publicity by newspapers, placement agencies, job fairs, employee referrals, educational institutes, so its geographical spread was greatly reduced compared to the online method, implying a smaller number of candidates and a higher cost for the administration and processing required by the human resources departments.

As a conclusion, paper-based recruitment should never be replaced, it should be supplemented. The flaws of online recruitment can be patched by traditional methods and the volume, speed will be greater, costs lower, due to modern technologies.

# **2.8 E-Recruitment in the context of the application**

# **Chapter III**

# **Artificial Intelligence in E-Recruitment**

# **3.1 Artificial Intelligence and Machine Learning**

Artificial Intelligence or A.I. is a domain of computer science that aims at providing machines the ability to mimic human behaviour and perform complex tasks like learning, decision-making, problem-solving and planning. Even though A.I. is centered around simulating human intelligence, it is also used widely in areas that involve more computation than people can handle.[8]

John McCarthy stated that “It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.”

There are countless real-word applications nowadays that are benefiting from A.I., the most common being:

* Computer Vision: Is a technology that enable machines to obtain and process information from digital photos, videos and various visual data. Applications can vary from image recognition to radiology imaging in healthcare to self-driving cars that are aware of the surrounding environment.[14]
* Speech Recognition: Also referred as speech-to-text, is a technology that uses natural language processing (NLP) to transform human speech into a written format understood by a computer. It is particularly used in systems revolving voice search, as Siri, Alexa, Google, and to provide more accessibility for texting.[14]
* Customer Service: Customer services provide 24/7 assistance by replacing human resources with virtual assistants, also known as chatbots. They are specifically trained to answer the FAQ (Frequently Asked Questions) and to provide suggestions and feedback for users around a specific media platform. [14]

As the ultimate goal of A.I. is to reach and possibly surpass the human intelligence in machines, this can only be achieved through learning algorithms that know how the human brain behaves. Thus, a very popular and widely used branch of A.I. emerged, called Machine Learning (ML). Machine learning relies on working with datasets by examining and comparing the data to find common patterns and to improve over time, without being explicitly programmed to do so.[9]

Tom M. Mitchell said that “Machine learning is the study of computer algorithms that allow computer programs to automatically improve through experience.”. A more formal definition, also by him, affirmed that “a computer program is said to learn from experience (E) with respect to some task (T) and some performance measure (P), if its performance on T, as measured by P, improves with experience E then the program is called a machine learning program.”.[9]

Machine learning requires the human intervention for providing starting data and gives a response about what is most likely to happen when some new data is introduced. This process can be done in several ways, as shown in Figure :

A picture containing text, businesscard, screenshot

Description automatically generated

**Figure 4**: The three types of machine learning (*Source*: [12])

* Supervised learning: Supervised learning is the most commonly used technique of learning as it requires labeled data, meaning that each input data has an answer or result already given, usually by humans. This can help the machine to reduce the number of expected output results and thus to improve the overall correctness of the program. In order to achieve the best prediction, this technique compares the computed result with the available labels and learns by adjusting an error to get as close to the expected output as possible. Depending of what you want to predict, supervised learning can be used to solve regression or classification problems. Classification problems have a limited number of label values, usually only two, meaning that it responds to a random question like “Is this an animal” with either a yes or a no. Regression problems are used with continuous label values that have no specific value limits and they can be used for example to predict the height of a man or the price of a house.[9][12]
* Unsupervised learning: Unsupervised learning uses unlabeled data and relies on the machines learning on their own to detect patterns and group them. Depending on what you are trying to group, there are mainly to ways to achieve this: clustering or association. Clustering is looking for similarities in the data and grouping the together accordingly. Association tries to find the connections between the formed groups and to understand the rules and meaning behind why they were grouped in that particular way.[9][12]
* Reinforcement learning: Reinforcement learning is usually a long-term process that continuously learns based on a reward/penalty system, meaning that the machine is rewarded when it gives a correct output and is penalized when it gives an erroneous one.[9][12]

# **3.2 Uses of Artificial Intelligence in E-Recruitment**

# **3.3 Artificial Intelligence in the context of the application**

# **Chapter IV**

# **Application Description**

# **4.1 Requirements**

The application represents an online environment that allows jobseekers to easily browse through various offers to find a suitable job and companies to recruit in an organized and efficient manner. It also incorporates an intelligent system to further enhance the user experience by providing similar job opportunities to his preferences. Thus, there are mainly two types of users, clients/jobseekers and organizations/companies. In addition, there is a third type of user, the administrator whom has full privileges over the entire software.

As a client you can benefit from the following functionalities:

* Visualize/browse available job offers
* Search/Filter jobs on various criteria
* Like/Dislike an offer
* Apply to jobs
* Visualize/browse similar jobs to a specific one
* Login / Change profile settings
* Get recommendations based on your personal background and the ratings you give
* Visualize the distance in kilometers between you and the headquarters of the organization the current job opening belongs to (if both you and the company have marked their locations on the map)

As a company you are able to:

* Login / Change profile settings
* Enlist your organization / Modify organization data
* Post job openings / Manage the details of your own offers / Remove applications
* Visualize candidates and their information that applied to your openings

As an administrator you have the power to:

* Remove any applications / organizations / accounts

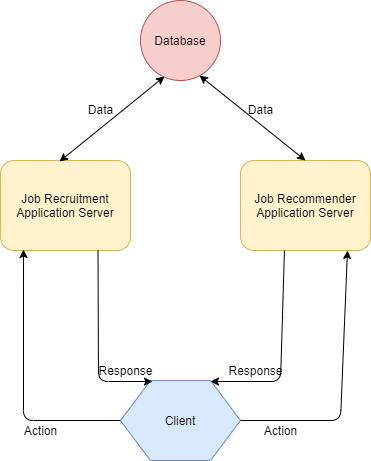
As an unregistered user (no account) you are capable of doing the following:

* Visualize/browse available job offers
* Visualize/browse similar jobs to a specific one
* Register account
* Search/Filter jobs on various criteria
* Visualize various charts/graphs with statistics

# **4.2 Specification**

# **4.3 Design**

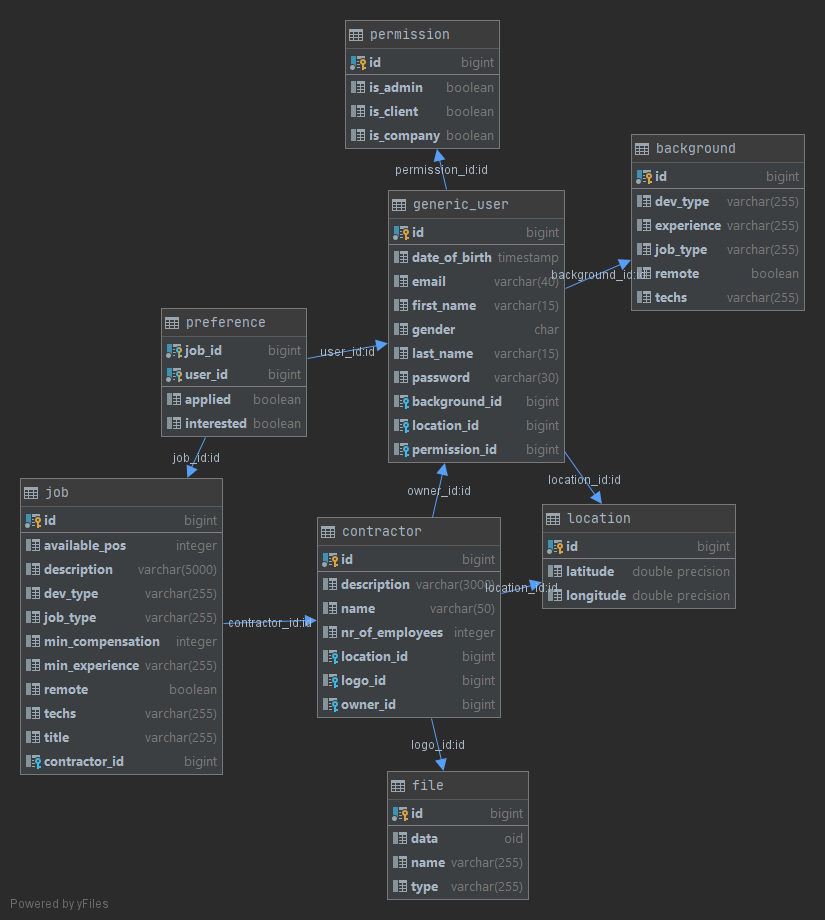
## **4.3.1 Application Flow Diagram**



**Figure 4:** Application flow schematic

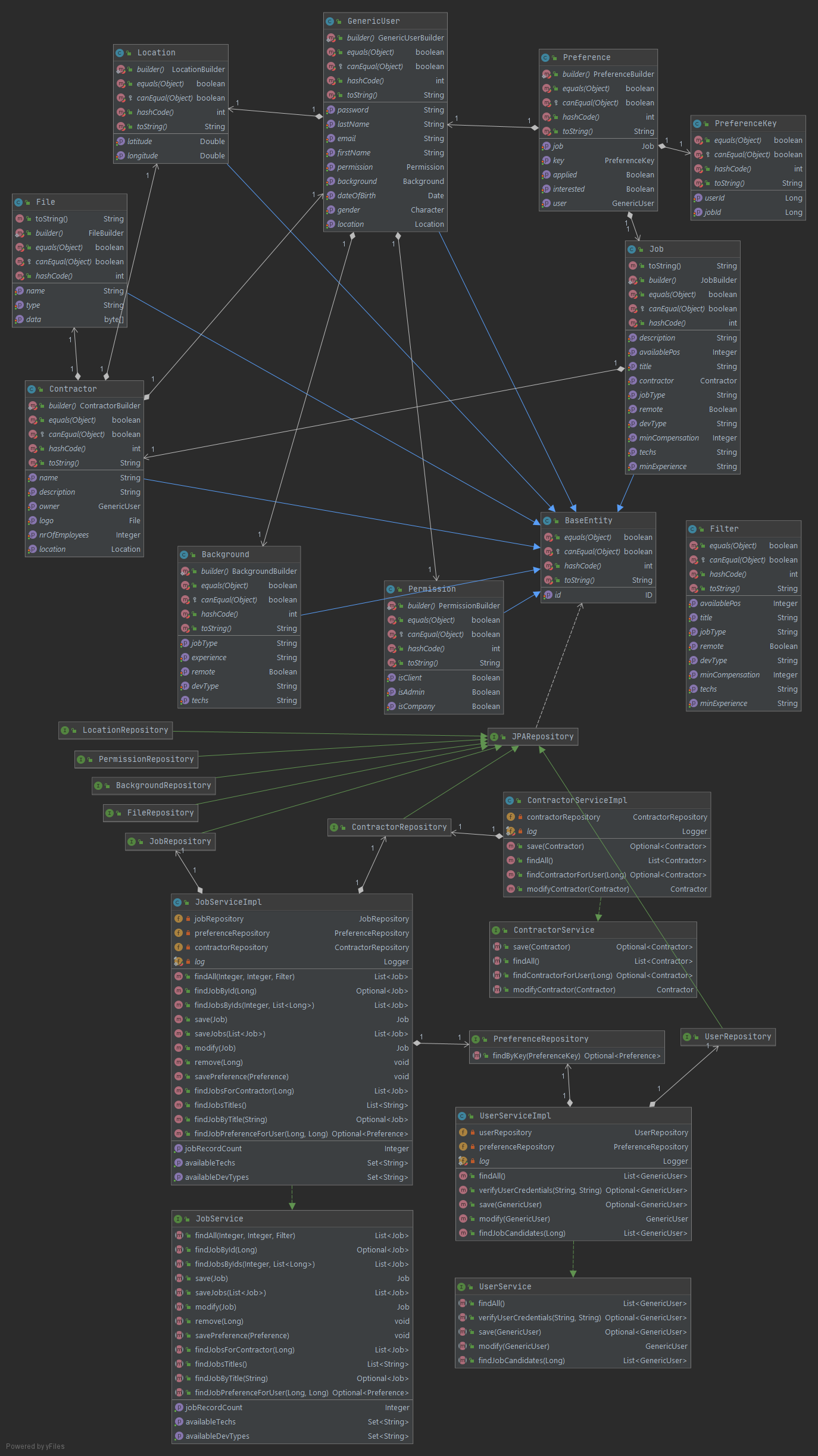
As Figure 4 shows, the application is structured in four main components. All the actions that are performed on the website are sent to one of the two servers, depending on the context and all the received data is persisted in a shared database amongst the two.

## **4.3.2 Database Diagram**



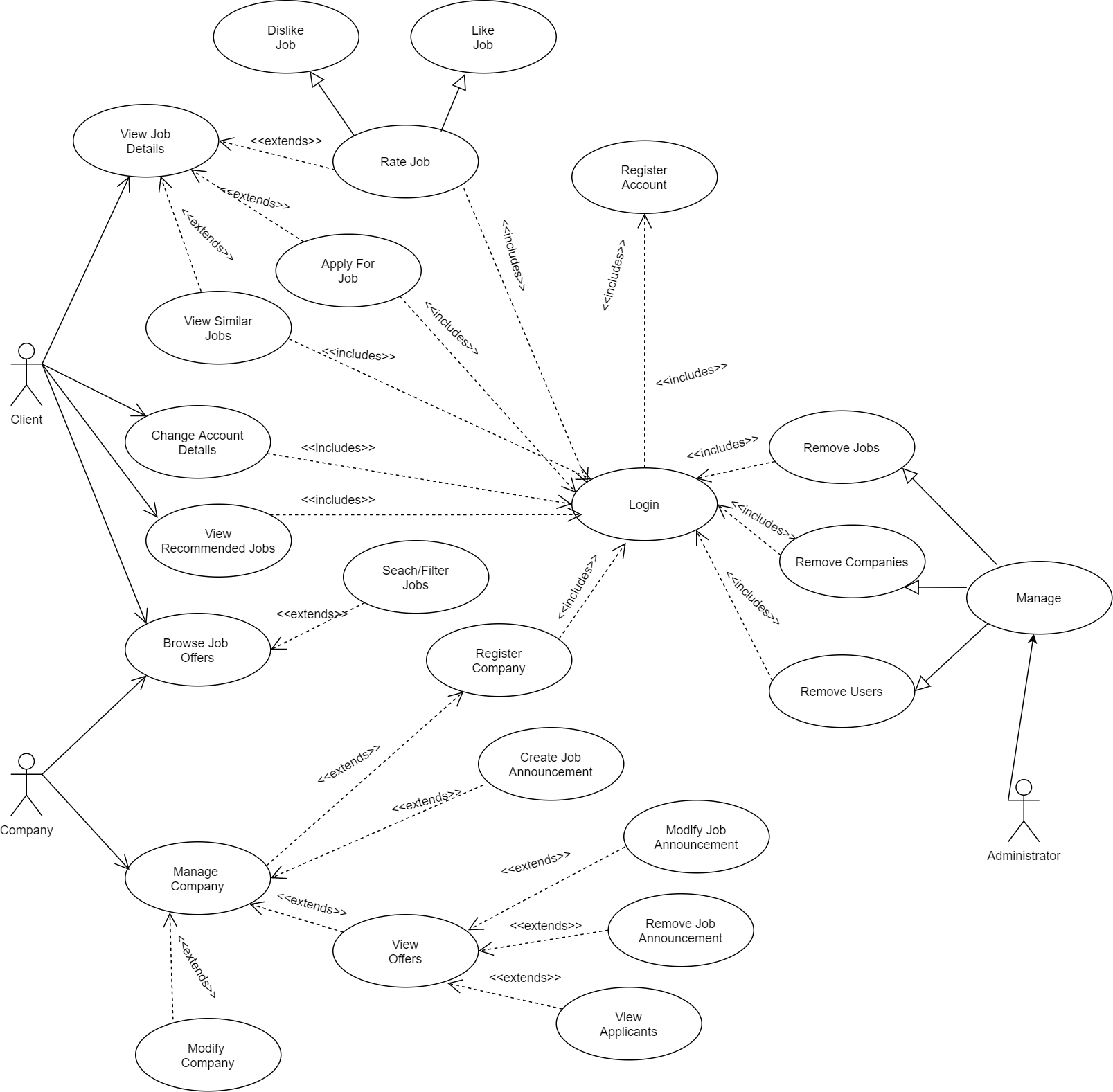
**Figure 5**: Database schematic/diagram

## **4.3.3 Class Diagram**



**Figure 6**: Spring server class diagram

## **4.3.4 Use Case Diagram**



**Figure 7**: Use Case Diagram

# **4.4 Technologies & Implementation**

# **4.5 Testing & Validation**

# **4.6 Execution**

# **Chapter V**

# **Conclusions**

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