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Developing a graph-based, domain-specific social network

Master's Thesis

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Contents

Contents iii

Hallgatói nyilatkozat vii

Kivonat viii

Abstract ix

1 Introduction 1
1.1 Context . . . 1
1.2 Problem statement and requirements . . . 2
1.3 Objectives and contributions . . . 3
1.4 Structure of this thesis . . . 4

2 Preliminaries 5
2.1 The Model United Nations framework . . . 5
2.1.1 Introduction . . . 5
2.1.2 History . . . 6
2.1.3 MUN in numbers . . . 7
2.1.4 Networking within Model United Nations . . . 7
2.1.5 Administration of a Model United Nations conference . . . 8
2.1.6 Personal experience: Budapest International Model United Nations 13
2.2 Social networks . . . 13
2.2.1 Introduction . . . 13
2.2.2 Connection with graph theory . . . 13
2.2.3 Social networking services . . . 13
2.3 Graph database technologies . . . 15
2.3.1 The property graph data model . . . 15
2.3.2 Neo4j . . . 16
2.3.3 Cypher . . . 16

3 Related work **17**
3.1 Examples for domain-specific social networks . . . 17
3.2 MyMUN . . . 18
3.2.1 Introduction . . . 18
3.2.2 Organizational features . . . 18
3.2.3 Features for participants . . . 21
3.2.4 Business model . . . 23
3.3 MunPlanet . . . 24

4 Building and securing a company-level production infrastructure **25**
4.1 Naming . . . 25
4.2 Brand . . . 25
4.3 Domain names . . . 25
4.4 Certificates . . . 25
4.5 Emails . . . 25
4.6 Source code management . . . 25
4.7 CI infrastructure . . . 26
4.8 Neo4j startup program . . . 26
4.9 Serving the application on the internet . . . 26
4.9.1 Choosing the platform . . . 26
4.9.2 Active Directory . . . 26
4.9.3 Naming conventions . . . 26
4.9.4 Subscription and support subscription . . . 26
4.9.5 KeyVault . . . 26
4.9.6 Networking . . . 26
4.9.7 DB VM . . . 26
4.10 Infrastructure security . . . 26
4.10.1 Identity management . . . 26
4.10.2 Resource management . . . 26
4.10.3 Network security . . . 26
4.10.4 Configuration security . . . 26

5 Overview and development of supportive libraries **27**
5.1 project-config . . . 27
5.2 crypto-random . . . 27
5.2.1 CI . . . 27
5.3 convertibles . . . 27
5.3.1 CI . . . 27
5.4 resily . . . 27
5.4.1 CI . . . 27
5.5 eslint-config-tslib . . . 27

5.6 eslint-config-angular 27

6 Overview and development of the Diplomatiq application 29
6.1 Platform objectives, target audience 29
6.2 Features 29
6.3 Chosen technologies 29
6.3.1 On the front end layer 29
6.3.2 On the back end layer 29
6.3.3 On the database layer 29
6.3.4 Client-server communication 29
6.3.5 API documentation 29
6.4 Developing the front end 30
6.5 Developing the back end 30

7 Security of the Diplomatiq application 31

8 Monetization and business model 33

9 Conclusion and future work 35

Acknowledgements 37

References 39

Appendix 43

Hallgatói nyilatkozat

Alulírott **Lucz Tamás Soma** szigorló hallgató kijelentem, hogy ezt a diplomatervet meg nem engedett segítség nélkül, saját magam készítettem, csak a megadott forrásokat (szakirodalom, eszközök stb.) használtam fel. Minden olyan részt, melyet szó szerint, vagy azonos értelemben, de átfogalmazva más forrásból átvettem, egyértelműen, a forrás megadásával megjelöltem.

Hozzájárulok, hogy a jelen munkám alapadatait (szerző(k), cím, angol és magyar nyelvű tartalmi kivonat, készítés éve, konzulens(ek) neve) a BME VIK nyilvánosan hozzáférhető elektronikus formában, a munka teljes szövegét pedig az egyetem belső hálózatán keresztül (vagy hitelesített felhasználók számára) közzétegye. Kijelentem, hogy a benyújtott munka és annak elektronikus verziója megegyezik. Dékáni engedéllyel titkosított diplomatervek esetén a dolgozat szövege csak 3 év eltelte után válik hozzáférhetővé.

Kelt: Budapest, 2020. május 31.

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Lucz Tamás Soma
s.k.

Kivonat Napjaink globalizált világának működésében kulcsfontosságú szerepet tölt be a diplomácia. Diplomatává válni hosszú folyamat, mely korai elhivatottságot kíván – gyakran középiskolás vagy egyetemista korban, világszervezetek munkájának tanulmányi célú szimulációjában való részvétellel kezdődik egy karrier. *Egy* leendő diplomata karrierjét támogatva nemcsak betekintést nyújthatunk az általa is formált közös jövőnkbe, de hosszú távon annak alakításában is részt vehetünk. *Az összes* leendő diplomata karrierjét tekintve a lehetőségek tárháza határtalan, az ezzel járó felelősség pedig hatalmas.

A *Model United Nations (MUN)* keretrendszerben világszerte évente többszázas nagyságrendben megrendezett konferenciákon résztvevő középiskolás és egyetemista diákok az Egyesült Nemzetek Szervezete (ENSZ) mindennapi munkájának formális szimulációján keresztül tanulhatnak diplomáciáról, nemzetközi kapcsolatokról, világpolitikáról – kockázatmentes, tényekre és információkra alapozott vitakultúrát kultiváló környezetben, gyakran tapasztalt karrierdiplomaták támogatásával.

A világ MUN-közösségének összefogására több szoftveres kísérlet is született. Ezek többnyire egy-egy problémára igyekeznek elszigetelt megoldást adni, így kapcsolatépítésre, konferenciák szakmai szervezésére, illetve rendezvények általános adminisztrációjára eltérő – gyakran házon belüli – szoftverek használatosak. Ezen alkalmazások nem kötik össze a közösség egészét, és nem adnak teljes megoldást az adminisztratív problémákra sem.

Dolgozatomban kifejtem, ahogyan megtervezem, lefejlesztem, és webalkalmazásként publikusan elérhetővé teszem a *Diplomatiq* nevű, MUN-konferenciák szervezésére alkalmas közösségi hálózat funkcionalitásban kezdetleges változatát. A *Diplomatiq* hosszú távú célkitűzése az, hogy a diplomaták elsődleges közösségi platformjaként nyújtson integrált megoldást az MUN-világban felmerülő adminisztratív problémákra.

A tervezés és fejlesztés teljes folyamata alatt fókuszban tartottam két alapvető szempontot. Az első szempont, hogy a rendszer „használatra kész” minőségben készüljön el, és később igény szerint bővíthető legyen további közösségi, adminisztratív, illetve valós idejű adatelemzési funkcionalitással. Ennek célja, hogy a szoftver a jövőben az MUN-szcénán kívül valódi diplomáciai alkalmazásokban is helyt tudjon állni. A második szempont – a tárolt személyes adatok érzékenysége, illetve a szoftver leendő alkalmazási lehetőségeinek figyelembevételével – az, hogy a rendszer már a kezdetektől modern, réteges, kriptográfiai biztosítékokat nyújtó biztonsági architektúrára alapozva készüljön el.

A rendszer tervezése és fejlesztése során a mérnöki szempontokon felül arra is figyelmet fordítottam, hogy a *Diplomatiq*, mint majdani vállalkozás az elvégzett munkámra egyszerűen ráépíthető legyen. A szoftver lefejlesztéséhez és publikációjához szükséges előfizetéseket, szolgáltatásokat és rendszereket mind olyan megfontoltsággal választottam ki és integráltam, mintha egy vállalkozást indítanék el. Dolgozatomban az ezzel kapcsolatban felmerülő adminisztratív és pénzügyi teendők mellett a rendszer egy kezdetleges üzleti modelljéről is beszámolok – kisebb terjedelemben, mérnöki diplomatervről lévén szó.

Abstract Diplomacy plays a key role in the operation of today's globalized world. Turning into a diplomat is a long process and involves early dedication — careers often start in high schools or universities, by students taking part in academic simulations of various intergovernmental organizations' work. Supporting *a* prospective diplomat's career not only enables us to peek into the future through them, but in the long run, we can also take part in jointly shaping tomorrow's world. Considering *all* prospective diplomats' careers, the possibilities are endless, and the associated responsibility is immense.

The world of junior diplomats mostly consists of conferences — annually hundreds of them, worldwide — held within the framework called *Model United Nations (MUN)*. During these events, high school and university students formally simulate the everyday work of the United Nations (UN), which enables them to learn about diplomacy, international relations and world politics — in a risk-free environment, cultivating debates based solely on facts and information. These conferences are often attended by experienced senior diplomats as well, with the goal of supporting and educating the future generation.

There has been several software attempts for bringing the MUN community together. Most of these attempts solve one isolated problem of the collective at a time: social networking, organizing the professional part of conferences, and administering the actual events usually involves several different — often primitive, in-house — software. These applications neither link the community together, nor do they offer a complete solution to administrative problems of MUN events.

In this thesis I design, implement and publish an initial version of *Diplomatiq*, a social network software system for diplomats, suitable for organizing MUN conferences. The long-term goal of *Diplomatiq* is to provide an integrated administrative solution to the MUN world, while being the sole professional networking platform for its diplomat users.

During the whole process of the design and implementation, I focused on two key points. The first point is that the system should be implemented in production-grade quality, and it should be extensible with further social, administrative, and real-time data analytics features as needed. The goal of this is to eventually cover the needs of real-world diplomatic applications as well, outside the MUN scene. The second point — considering the sensitivity of stored personal information, and also potential future applications — is that the system should be implemented upon a modern, layered security architecture, which provides cryptographic assurances in terms of application and data security.

Besides engineering aspects, I also paid attention to being able to build *Diplomatiq* as a prospective company upon my work. Subscriptions, services and systems needed for the implementation, publication and production operation were chosen and integrated with the same amount of consideration as I was starting company. In this thesis I present the related administrative and financial aspects of this too, as well as a primitive business model — briefly only, this being an engineering thesis.

Chapter 1

Introduction

1.1 Context

Diplomacy is the art and practice of conducting negotiations between nations and nationwide entities [1]. It is a complex system, where involved parties like governments and NGOs[1] engage in formal discussions, aspiring to *peacefully* influence the status quo of international relations along their interests. Parties are represented by selected, often professionally trained career diplomats, forming a diplomatic delegation.

Besides diplomacy, there are other tools for leveraging international relations. This set of tools, tactics and strategies is collectively known as foreign policy, and is usually directed by political leaders [2]. Foreign policy is often collated with diplomacy as a synonym, but the two are not identical. Diplomacy is a key instrument of foreign policy, and foreign policy is a superset of diplomacy. In order to achieve the objectives of a nation, tools of foreign policy can include espionage, threats, sabotages, wars, and other means of violence, as well as diplomacy.

Throughout this thesis, I consider diplomacy as the nonviolent elements of foreign policy: the system, methods and infrastructure of governments and NGOs peacefully interacting with each other, in order to influence international relations along their own objectives. Although most diplomacy materializes in confidence between parties, this thesis exists in the context of publicly conducted diplomacy, more narrowly in the context of the United Nations (UN), which — having 193 sovereign member states — is the largest intergovernmental organization in the world [3].

Being a powerful diplomat requires experience in various fields. Diplomats need strong organizational and leadership skills, as well as proficiency in written and oral communication for efficient negotiations. They must be able to stay rational and decisive in stressful

[1] non-governmental organizations

situations, besides the capacity to quickly process and integrate information into their decisions [4]. These skills can be developed in specialized educational institutes, usually offering graduate programs [5].

Apart from professional programs designed to train already graduated career diplomats, there are other ways to gain diplomatic experience. One of these is taking part in academic simulations of the United Nations' everyday work. For high school and university students, the Model United Nations (MUN) framework[2] offers hundreds of independent conferences annually, worldwide [6]. On these few-day-long events, participants become diplomatic delegates. They are placed in UN-like committees and assigned countries to represent. Assignments are published in advance, along with the topics the committees will discuss. This enables delegates to perform research and develop their positions before the conference, usually staying true to the actual position of their represented country. During the conference, delegates discuss their positions in the committees, conforming to the formalities of the real-world United Nations, like western business attire and the method of moderated formal debate. By the end of the conference, each committee produces a formal, UN-like *resolution*: a document summarizing the results of the debate and formulating measures for resolving the international issues presented to the committee.

1.2 Problem statement and requirements

Since even a medium-sized conference welcomes hundreds of international students, who need housing, meals, personalized conference accessories like badges and placards, topics to debate, merchandise, and afterwork entertainment, an MUN conference is a heavy organizational burden, requiring months of preparation. Most conferences are driven, prepared, implemented, and executed by voluntary, unpaid students of an educational institution — a high school or a university —, as an extracurricular activity, with additional help of their teachers. Professional event planners, IT and data administrators or other experts are usually not involved. Also, the staff rotates relatively fast as organizing students graduate and leave the institution, making it harder to reuse last year's experience.

Although in general conferences are self-sustaining by making use of participation fees, the execution quality of the event depends on the creativity, enthusiasm, and personal experience of the students at the top of the managerial hierarchy, rather than a solid financial basis. This results in the lack of ability to build modern, automated organizational tools, which ultimately causes data management to be cumbersome and insecure — even though the major part of the organizational work is indeed data management and batch processing. A customizable software system offered as a rationally priced service, tailored to the administrative needs of MUN conferences could greatly reduce this organizational burden by providing easy-to-use data management and other administrative features.

[2] The concept of Model United Nations is detailed in Section 2.1.

Aside from the organizational concerns, MUN conferences provide outstanding networking opportunities to both the participants and the organizers. Participants working themselves towards a diplomatic career can substantially benefit from building global acquaintances among their future colleagues. Experienced career diplomats attending MUN conferences as guests can open doors for prospective diplomats which no education can. Professional networking among future and current diplomats can be supported and facilitated well by a suitable software system.

Inspecting current solutions, there is no software system on the internet, which solves the administrative problems of MUN conferences, while making use of the great networking potential of the MUN framework. Implementing such a system would appreciably further global diplomacy in the long run.

The complexity of an envisioned software system capable of solving all problems and exploiting all opportunities of the MUN framework is immense. Besides social networking, such an application would need built-in features for event planning, project management, flexible data handling, batch processing, and dealing with a hierarchy of roles and responsibilities, as well as further MUN-specific features for administering the diplomatic role-playing aspects of a conference. Therefore the formulated feature requirements to be implemented in the scope of this thesis was minimal. As I focused on the engineering aspects, my goal was to set up a solid, secure, and production-grade architectural and infrastructural foundation for my envisioned application — and for a prospective company that will maintain my application. My other goal was to build a highly secure, production-ready application upon that foundation, providing an extensible but basic feature set for organizing MUN conferences, while facilitating networking among participants.

1.3 Objectives and contributions

In this thesis I present an elementary version of the *Diplomatiq* social network software system, suitable for organizing MUN conferences. On the one hand, I will refer as *Diplomatiq* to the software system itself, and on the other hand, to the prospective company conducting the maintenance, marketing and sales operations of the software system. Outside the context of this thesis, the social network is the first step of a long-term plan involving global consumption of public data, for producing real-time diplomatic prognoses and analyses.

My first objective was to design and implement Diplomatiq on a solid, production-grade foundation, with a minimal feature set, which can be extended with further social networking, administrative, and real-time data analytics capabilities as needed. Considering the sensitive personal information stored in the system, the prospective applications of Diplomatiq, and my deep interest in cryptography and computer security, my second objective was to build the system upon a modern, layered security architecture, which provides cryptographic assurances in terms of application and data security.

My contributions include the following:

- I designed, built, secured and paid a company-level production infrastructure for the development, testing, production operation and maintenance of Diplomatiq, including several kinds of supportive infrastructure.
- I designed an application security framework addressing authentication, authorization, and data protection, which provides cryptographic assurances regarding access control and the confidentiality and integrity of sensitive data.
- I designed, implemented and published an elementary version of the Diplomatiq social network software system as a client-server application, using graph database technologies and the aforementioned security framework.
- I developed several supportive libraries outside the Diplomatiq software along the way. I published the built artefacts of these libraries with detailed documentation, for free use in the open-source community.
- I published the source code of all my contributions as separate open-source projects, centralized under one project organization, called Diplomatiq.

1.4 Structure of this thesis

The thesis is structured as follows.

- *Chapter 2* summarizes the preliminary knowledge needed for a high-level understanding of this thesis. It details the concept of Model United Nations and my personal experience with MUN. It also defines the idea of a social network. Then it introduces graph database technologies, focusing on the property graph data model and the Neo4j graph database.
- *Chapter 3* gives examples for domain-specific social networks, and presents existing software solutions for the MUN community.
- *Chapter 4* describes my approach of building and securing a production-grade infrastructure supporting the development, testing, and public operation of Diplomatiq, the social network.
- *Chapter 5* gives an overview about the produced supportive libraries. It unfolds the reasons of their existence, as well as their features and implementation details.
- *Chapter 6* demonstrates the Diplomatiq social network application. It discloses the chosen technologies, client-server architecture, features and development methods, and implementation details.
- *Chapter 7* reveals the applied cryptographic and other security measures I built into Diplomatiq, in order to protect the system and user data from unauthorized access, from the API to the database level.
- *Chapter 8* gives a brief insight into the business considerations of Diplomatiq.
- *Chapter 9* concludes the thesis and presents possible future directions.

Chapter 2

Preliminaries

This chapter summarizes the preliminary knowledge needed for a high-level understanding of this thesis. It details the concept of Model United Nations and my personal experience with MUN. It also defines the idea of a social network. Then it introduces graph database technologies, focusing on the property graph data model and the Neo4j graph database.

2.1 The Model United Nations framework

2.1.1 Introduction

The Model United Nations (MUN) framework is an academic simulation of the everyday operation of the United Nations (UN). It is typically an extra-curricular activity materializing as annual, few-day-long conferences organized by students of high schools or universities. Participants welcomed from all over the world take on the roles of assigned nations' UN delegates, forming diplomatic delegations with their peers. There are hundreds of such conferences taking place every year [6]. While a medium-size conference has a few hundreds of participants and another few hundreds of organizers, the current largest Model UN conference — The Hague International Model United Nations (THIMUN) — attracts over 3,200 students from around 200 schools, from more than 100 different countries [7].

Delegates are placed in UN-like committees, where they discuss topics related to international issues and conflicts by the methods of moderated formal debate. The conduct of the debates and the conference is specified in the *Rules of Procedure*, a conference-specific, formal regulation derived from a similar document of the United Nations [8]. The result of the debate is a UN-like *resolution*: a formal document expressing the opinion or will of a committee. Resolutions are generally recommendations, but in some cases — like in case of a resolution adopted by the Security Council: the UN body with "primary responsibility for the maintenance of international peace and security" [9] — the adopted resolution is legally binding for all member states. Although MUN resolutions are of course never

legally binding, larger MUN conferences like THIMUN forward their adopted resolutions to the UN. These forwarded MUN resolutions are occasionally formulated into real-world UN resolutions after further debate and amendments.

The country and committee assignments are known in advance, which enables delegates to perform research and develop their positions before the conference. Students usually build their stances upon the actual standpoints of the countries they represent, but this is not a requirement. Since usually all positions of a given country's diplomatic delegation is assigned to students arriving from the same school, delegates representing the same country can construct complex nationwide strategies across different committees by cooperating with each other in advance.

The larger a conference is, the more possibilities it has regarding the simulation of the actual workings of the UN, or — as the community reinvents itself — even other intergovernmental bodies, like subsidiaries of the European Union. Even though the UN has only 193 member states [3], simultaneously simulating the whole operation of the six main organs[1], and the Secretariat of the UN requires much more participants.

2.1.2 History

The history of Model United Nations dates back to the early 20th century. The first similar event is believed to be held in November 1921 by the Oxford International Assembly [12]. It was based on the operation of the League of Nations, the first worldwide intergovernmental organization founded by the Allied powers after the First World War to maintain world peace. Although the League of Nations was formally disbanded in 1946 and its powers were transferred to the United Nations established in 1945, the organization marks an important milestone of intergovernmental cooperation [13].

The first well-documented Model League of Nations conference was organized by the Harvard International Assembly in 1923. It featured the same basic characteristics that modern MUN conferences have: organized by an academic institution, moderated formal debate about international conflicts in committees, and resolutions adopted as the result of the work conducted on the conference [12].

The era of Model United Nations started in the 1950s with the establishment of the first high school MUN, Berkeley Model United Nations in 1952, and two other MUNs founded by Harvard University: Harvard Model United Nations in 1953 and Harvard National Model United Nations in 1954. The founding of The Hague International Model United Nations in 1968 led to the global expansion of high school MUN conferences [14]. THIMUN was the first MUN in Europe, and is today's largest MUN conference [7]. In 1991, the Harvard

[1] The six main organs of the UN are: the General Assembly with several subsidiary boards, commissions, committees, councils, panels, working groups and others [10]; the Security Council; the Economic and Social Council; the Trusteeship Council; the International Court of Justice; and the Secretariat [11].

WorldMUN, a university level MUN rapidly accelerated the spread of university-level MUN. In 2007, the actuation of the BestDelegate.com portal significantly increased the online existence of MUN, providing research and preparatory resources for delegates attending MUN conferences. Founding of MyMUN, an MUN-specific registration and administration system, and MUNPlanet[2], an MUN-specific social and knowledge-sharing network furthered the presence of Model United Nations on the internet [14].

2.1.3 MUN in numbers

I have not found any databases, publications, or studies, which would yield satisfactory statistics about Model United Nations. However, according to several portals, websites and Facebook-pages, we can make assumptions about the worldwide spread of MUN.

Conferences

At the time of writing this thesis, MyMUN lists 2,457 conferences from December 2012 until today [6]. Calculating with roughly 8 years, and with the broad simplification that there were an equal number of conferences organized every year, there are annually more than 300 conferences worldwide, at least based on solely the data of MyMUN. Considering that MyMUN covers only a small fraction of all MUNs in the world, the number of annual MUN conferences likely goes well into the order of thousands.

Participants

MyMUN claims having over 100,000 registered members and over 900,000 yearly visitors [17]. The Facebook page of MUNPlanet [16] has over 150,000 followers. According to a 2007 calculation [18], there are 180,000 MUN participants in the United States only. The BestDelegate.com portal is used by over 750,000 people worldwide [19]. Considering the numbers above and MUN's increasing popularity, I would assume that millions of unique students attend Model United Nations conferences every year.

2.1.4 Networking within Model United Nations

MUN conferences offer a number of networking opportunities. First of all, delegates attend committee sessions, where they debate international issues, cooperate in producing resolutions, and leverage simulated international relations along their represented countries' best interests. Therefore the main contact point among them is work: they get to know fellow delegates by observing their leadership, public speaking, and negotiation skills in a competitive field. Committee and lunch breaks enable them to further their acquaintances during the day either professionally or personally.

[2] At the time of writing this thesis, the website of MUNPlanet [15] is not reachable, and its Facebook page [16] having more than 150,000 followers received its last update in June 2019.

Professional diplomats attending conferences as guests can also take part in committee sessions as observers, or as actual delegates or chairpersons, but they are more likely to attend the official ceremonies or soirées[3]. This way, delegates can interact with professional diplomats without unnecessary formalities of real-world diplomacy. Career diplomats are renowned to have appreciable social skills [4], which in this setting helps further loosing the mood, and leads to fruitful conversations between generations.

Besides professional programs like debate sessions and official ceremonies, conferences provide a number of other opportunities for delegates to get acquainted with each other. Events like organized sightseeings and afterwork parties allows building informal bounds alongside professional ones.

Aside from maintaining virtual friendships, members of the MUN community often harmonize their conference participations to meet with their foreign acquaintances. Since there is no suitable networking platform for this scenario, participants from different countries usually keep connected and communicate via general social networks, like Facebook. Due to the lack of Facebook's MUN-specific capabilities, a large part of the networking effect is lost, as delegates are not given automated suggestions on which conferences to attend based neither on their circle of friends, nor on their previous Model UN experience.

2.1.5 Administration of a Model United Nations conference

The general administration of a conference can be divided to two distinct parts. The *professional division* involves administrative tasks related to the Model United Nations framework itself: composing the discussed topics, assigning countries and committees to members of delegations, conducting the actual debates and formal ceremonies, and every other features associated with diplomacy. The professional division encompasses everything inside the simulation, where the participants are in their diplomatic roles. The *organizational division* covers the real-world event outside the simulation: travel and hotel arrangements, meals, conference accessories, merchandise, entertainment, among others. According to my personal organizational experience to be detailed in Section 2.1.6, the two divisions are separate responsibilities requiring completely different experience, and thus best to be kept as isolated as possible.

Similarly to the United Nations, the chief administrative officer of an MUN conference is usually the *Secretary-General*, responsible for organizing, administering and conducting the conference. In case of the aforementioned two-division administrative approach, the Secretary-General is responsible only for the professional division of the conference, and reports to the *Conference Manager* or *Project Manager*, who leads the organizational division, and is responsible for the entire conference. Henceforth I refer to the organizational and professional divisions together as management.

[3] elegant evening party, usually with snacks and drinks

In the following sections I detail the procedure of organizing a medium-size, high school-level MUN conference with the two-division administrative approach, broken down to distinct, preemptive phases. Most of the following is based on my personal experience, but it also contains parts I learned from event planners or other Model United Nations conference organizers.

Preliminary arrangements

Once the management of the previous year's session agreed upon their successors, the new management starts negotiations with the headmaster of the organizing school. They settle the dates for the conference, discuss necessary resources the school can provide, and start or continue securing external locations[4] for larger conference ceremonies involving all participants, which the school usually cannot host.

After the initial negotiations, the management announces the conference's subsequent session in the host school with its date and vacancies in the organizational structure, and starts coordinating interviews with eventual applicants wishing to take part in organizing the conference.

Participants' application to the conference

After the professional division agreed on the UN bodies to be simulated, they publish preliminary committee assignments with high-level topics on the conference's website or Facebook page. As the management opens the application for participants, delegations and individual delegates apply to the conference specifying their preferences of country and committee assignments. Since high school students rarely travel abroad alone, a delegation is usually accompanied by a couple of teachers of the applicants' school. The accompanying teachers are recorded into the registration system as well as the students.

The application procedure comes with significant paperwork. The management consisting of junior members usually lack the experience and resources for efficiently and securely processing sensitive personal information[5] of hundreds or thousands of applicants, and a school's IT division cannot be expected to be prepared for developing a suitable system either. Thus it is common that the registration is implemented with a simple online form populating insecure spreadsheets, or a primitive in-house application often making data management only more complex. Ready-to-use software like MyMUN are often not customizable enough to be useful for conferences generally requiring somewhat tailored solutions, which leads to the usage of multiple different applications. This can cause more pain than gain by requiring manual data maintenance in unintegrated systems.

[4] External locations are often needed to be secured years in advance.

[5] Registration data usually includes the applicant's name, birthdate, email address, phone number, and home address. It is also common to require the applicant's social security number or even the serial number of their passport for speeding up any immigration-related checks and administration.

Accepting or rejecting applications & finalizing country and committee assignments

Following the closure of the application procedure, the management decides about the acceptance or rejection of prospective participants. As applicants usually register as part of their school's delegation consisting of multiple delegates, it is common that the application of an entire delegation gets accepted or rejected together.

Whether to accept a delegation's application to the conference is decided by considering various factors: these can include the delegation's level of expertise — often with regards to the reputation of previously attended conferences —, the ability of fulfilling their preferences of represented countries provided at registration, and aspects of diversity, among others. In case of more mature conferences, committees are often classified by their members' expected level of MUN experience. A beginner delegate taking a seat in an expert-level committee is inexpedient, as it sets back the efficiency of the debate, or vice versa, it prevents the delegate from staying on their learning curve.

Accepting delegations happens in the interest of filling committee seats — predefined seats of countries represented in committees — in the best possible combination with regards to expertise, personal preference, diversity, and the prospective efficiency of the committee's work. Creating the final assignments of delegations and country-committee pairs can be challenging if done manually, considering the volume of input data, and the factors needed to be taken into account. Most conferences do the entire assignment process by hand, in spreadsheets, along a malleable set of priorities. This usually means playing with the synthesis of the committees until all delegations desired by the management can be offered a place to the conference close to their preferences.

This process can be automated, if the management composes a definitive set of priorities on how to assign already fixed committee seats — country-committee pairs — to the applied delegates as individuals. The problem of creating the assignments with the aforementioned conditions is a fundamental problem of combinatorial optimization: it is called *maximum weighted bipartite matching* or *assignment problem* [20]. Mathematically speaking, we are looking for the maximum-size matching in a weighted bipartite graph, where the sum of the edges' weight is maximal. One part of the graph is the set of applicants, and the other part is the set of committee seats. The edges between parts represent possible assignments, and their weights are "goodness" values based on assignment priorities composed by the management. Since this approach does not cover the possible requirement of all delegates from the same school needing to represent the same country, it is not always satisfactory.

If same-school students need to represent the same country, the process can still be automated with maximum weighted bipartite matching, but with an additional constraint: the management must restrict the application to fixed-size delegations. In this case, a participant school's fixed-size delegation applies to the conference as a whole, specifying their preferences from the set of same-size delegations of represented countries on the

conference. This way, the bipartite graph's two parts consist of school delegations applied and country delegations represented on the conference. An edge between the two parts means that the two kinds of delegation are of the same size, so they can be assigned to each other. The weight of an edge is the same "goodness" value based on assignment priorities composed by the management. This approach needs a second application step: after applied school delegations were assigned country delegations represented on the conference, the applicants of the delegations need to distribute the assigned committee seats among themselves.

Payment

The participation fees are collected after the registration, generally in multiple parts. International bank transfers executed by students and teachers usually renders the work of the conference's accounting department challenging, as it is often difficult to identify which delegation made which payment. Due to the general lack of integrated payment solutions in the MUN scene, conferences often face a heavy burden of financial paperwork.

A conference management system with integrated payment processing and accounting features could solve these organizational problems. It would also provide a cleaner experience to the participants: they could pay instantly and individually, without the troubles of needing to transfer the money in groups, as whole delegations.

Travel, hotel, meal and other arrangements for participants

With the closure of the acceptance and the assignments procedure, the final list of students and their accompanying teachers taking part on the conference becomes available, and the management can start working on participants' personalized experience. Though habits differ, most conferences offer various convenience services for additional fee, such as transport within the city, housing, meal arrangements, and tailored sightseeings or other entertainment programs. This causes lots of additional paperwork with regards to delegation's arrival and departure dates, hotel or other kinds of housing preferences, and several kinds of meal allergies and eating habits[6].

Similarly to the registration, most of the organizational paperwork in connection with convenience services is done manually. A capable software system possessing all information of a delegation's precise schedule, as well as their hotel, meal and entertainment preferences, could automate all this paperwork away. This would allow the management to focus on the quality of the provided services instead of administration. Also, it would open additional financial possibilities. Following preliminary arrangements between the conference management and hotels or other service providers, the applicants could purchase

[6]Since participants arrive from all around the world, conferences generally offer multiple types of menus respecting various cultures and allergies.

their necessities by selecting them from a list of integrated services during the application procedure. This would endorse further financial cooperation between parties — the conference, the company providing conference management software, and the service providers —, while providing a simple, one-step payment flow for the participants.

Personalized conference accessories

MUN conferences formally require participant students, teachers, and all other conference personnel to possess various personalized items. Every person — participants, guests, organizers, staff — should wear an official, conference-issued badge during all events of the conference. The badge usually describes the person's name and title — either a diplomatic one within the simulation in case of participants or guests, or an organizational one in case of organizers or members of staff. Participant delegates, chairpersons, teachers, guests and everyone else attending committee sessions should have official, conference-issued placards in front of them, describing their represented country or position within the committee. Placards are used for voting in larger committees, as well as for identifying delegates from the distance.

Producing hundreds or thousands of personalized items without experience and proper tools can be time-consuming. Management teams generally do not possess neither the experience nor the tools, which leads to hours or days of manual work of creating personalized elements, one by one. Besides being error-prone, this process consumes valuable organizational resources. A capable software possessing all necessary information about participants and organizers could automate away this manual work.

Conducting the conference

Following a half-year or longer period consisting of planning and preparation only, conducting the conference itself is usually not a real challenge. Administratively, the management needs to record whether arrived delegations signed in, and received their conference packages, but from the opening ceremony through the committee sessions and parties to the closing ceremony, the conference generally goes by itself, being already scheduled well.

Processing and storing resolutions and conference data

Few MUN conferences pay attention to the collection and storage of conference data. As management teams usually lack the resources and experience for keeping digital or paper-based documents, produced resolutions and other conference data is generally not preserved. A capable conference management system could offer solutions for this: with online resolution editing and automated video recording features, the management would not even need to collect conference data, because all of it would immediately be saved in the conference management software's permanent online database.

2.1.6 Personal experience: Budapest International Model United Nations

The previous section's points are mostly based on my personal organizational experience regarding Model United Nations. My former high school, Eötvös József Gimnázium, located in the 5th district of Budapest, first organized *Budapest International Model United Nations (BIMUN)* in 2011 April[7]. BIMUN was among the first large-scale international MUN conferences in Hungary [21]. Previously I had attended several foreign MUN conferences, and I was looking forward to take part in the organizational process of an international conference welcoming hundreds of students and diplomatic guests. Over the course of 6 years, I fulfilled several positions: I was a photographer, team lead, deputy Secretary-General, and part of the chief management as an executive advisor.

2.2 Social networks

2.2.1 Introduction

The term social network is used in social sciences, denoting a network of linked individuals or organizations, connected by social relations and interactions [22]. This thesis focuses on another aspect of social networks: online software providing networking, information sharing and messaging features for participating individuals or organizations. The two interpretations are related: users of a social network software form a social network in the scientific sense, and a social network can be loaded into a social network software for analysing patterns, or simply for facilitating interactions among social actors. Analysing social networks can be useful in various fields, including organizational studies and information sciences, and also in diplomacy [23].

2.2.2 Connection with graph theory

Since social networks essentially are connected entities, an obvious choice for modeling such networks is using graphs, where vertices are individuals or organizations, and edges are connections or interactions between them. This way networks are easier to visualize and understand [24], and graph algorithms are useful for various kinds of analyses [25]. By using different kinds of edges in the same graph, several kinds of connections can be represented within the same entity set, allowing to build a multi-dimensional model of the network. This can lead to deeper insight into network structure.

2.2.3 Social networking services

In this thesis I consider social networking services as social networks with associated features the network members can utilize, offered as mass-available services on the internet.

[7] The school has organized BIMUN conferences every year since then. Unfortunately, the tenth anniversary session of BIMUN, which would have been held this year, got cancelled due to the COVID-19 pandemic.

Besides the core networking activity of building relationships within the network itself, associated features can include messaging, information sharing, and collaborational functionality, among others. Usually the goal of a social network is to provide the possibility of interaction among participants, beyond actual in-person interactions. This enables individuals to connect with others regardless of physical distance.

Social networks can be categorized into four main types [26], but with regards to the focus this thesis, I divide the set of social networks into two parts.

- *Generic social networks* have no special characteristics or determined target audience: they offer a set of generic features for people to build and maintain virtual relationships with or without personal acquaintance.
- *Domain-specific social networks* have a determined target audience: they offer specialized features for members of the target audience in line with specific goals of usage in a given domain.

Real-world examples for generic social networks include Facebook [27], Twitter [28], and Instagram [29]. Facebook is the biggest social networking service in the world, having approximately 2.6 billion monthly active users [30]. It has several kinds of features for sharing ideas, photos, live or recorded videos, for connecting with friends, and for informing others in various ways. It also offers basic event-handling capabilities for facilitating in-person social interactions. Facebook's business model is based on targeted, personalized advertisement: it offers free features for users, who receive ads in their newsfeed and on other interfaces [31]. The platform has been continuously learning user preferences, and personalizes ads according to the user's assumed needs. Facebook's financial income is mostly based on the fees paid by businesses for publishing and targeting their advertisements in various applications of the social networking platform.

Twitter is a social network gained popularity by providing microblogging features. Users can publish short "tweets": posts with at most 280 characters[8]. It is asymmetric, meaning users can follow other users instead of needing to get virtually acquainted — although for private profiles, users need to be explicitly granted access. Twitter has approximately 166 million daily active users [33], and builds its revenue upon advertising and data licensing [34].

Instagram is a social network primarily used for sharing photographs capturing important moments. Despite the fact it is mainly used for image sharing, Instagram can still be regarded as a generic social network, because it is not to be interpreted within a specific domain, and has no determined target audience. Similarly to Twitter, it is asymmetric, but also has private profiles. Instagram was acquired by Facebook in 2012 [35], and shares the same basic characteristics regarding its business model: users receive sponsored posts and stories as personalized advertisements.

[8] Until 2017 November, the maximum length of a tweet was 140 characters [32].

Diplomatiq is a domain-specific social network. Its domain is diplomacy, its target audience is the set of junior and senior diplomats and other people working in diplomacy, and its specialized features — currently a very basic set of functionalities — include organizing MUN conferences. Broadening the capabilities of Diplomatiq will expectedly not alter its domain-specificity. Further domain-specific social networks are mentioned in Chapter 3.

2.3 Graph database technologies

Graphs are mathematically defined data structures being broadly used in several fields of computer science. Recent technologies and implementations made possible for developers to easily embed graph data models into their applications. There are numerous real-world scenarios which can be represented more efficiently as graphs (*nodes* connected to each other by *edges*), than with the traditional, relational approach.

Graph databases are NoSQL databases, which store data in graphs instead of the traditional, table-based approach[9]. In graph databases, a relationship represented as an edge in the graph is a "first-class" entity, and has the same basic storage characteristics as a node. Relationships are directly linked to entities, and therefore entities are directly linked to each other via relationships. This allows the querying of related entities to be fast, since the process does not involve lookups.

2.3.1 The property graph data model

It is common to define graphs as a set of objects, in which some object pairs are connected to each other. In this model, an object is called *vertex* or *node* or *point*, and a connection between two *vertices* is called *edge* or *relation*. Connections can be detailed further by specifying their directionality, also they can be *labeled* to define them even more. Similarly labeling vertices leads to the model of *typed graphs*. If we assign properties to the nodes or relations, we get the model of *property graphs*. Properties, as shown in Figure 2.1, are usually key-value pairs in the format of `key = 'value'`. Generally, keys are strings, and values represent common data types like string, integer, float, etc.

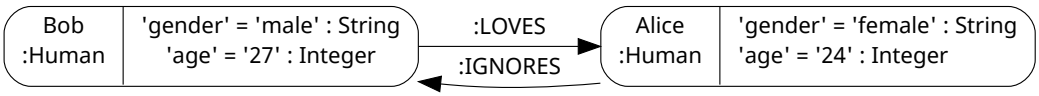

Figure 2.1 Two people's relationship modeled with a property graph

[9] The underlying data storage methods vary. There are graph databases which store graph data in relational tables, introducing another layer of abstraction between the stored physical data and the database.

2.3.2 Neo4j

Among a handful of graph database vendors [36], Neo Technology's Neo4j is the most popular one [37]. It features full ACID-compliance upon a pure graph data model, contrary to other vendors' multi-model approaches. Besides Neo Technology, Neo4j is backed by the open-source community as well [38]. There are two variants: *Community Edition* and *Enterprise Edition* with an extended feature set [39]. Neo4j also offers a program tailored to startup companies [40]. With the help of this startup program, companies can build their applications on the Enterprise Edition of the Neo4j platform, free of charge[10].

2.3.3 Cypher

Cypher is a query language developed especially for graph databases by Neo Technology [41]. Figure 2.2 shows that the language uses a sort of ASCII-art to represent nodes and relationships: nodes are in parentheses, relationships are in brackets surrounded by relationship direction information.

```
(Bob)-[:LOVES]->(Alice)
```

Figure 2.2 A basic Cypher example

Cypher syntax is elegant and expressive, thus very readable. Besides using it to represent nodes and relationships, we can utilize it to access the Neo4j's indexing capabilities and stored procedures as well. Even complex pattern-matching conditions can be expressed easily and intuitively in Cypher. Although today's modern application development frameworks — adopting increasingly capable data mapping solutions — make it less and less necessary to directly interact with databases, complex queries can still involve composing database commands manually. Therefore the expressiveness and ease of use of a database query language still remains essential.

[10] Certain limitations apply: the company must have at most 50 employees and at most $3 million annual revenue, among others [40].

Chapter 3

Related work

This chapter gives examples for domain-specific social networks, and presents existing software solutions for the MUN community.

3.1 Examples for domain-specific social networks

As previously described in Chapter 2, this thesis regards domain-specific social networks as networks having a determined target audience, offering specialized features for members of the target audience in line with specific goals of usage in a given domain. Real-world examples for domain-specific social networks include LinkedIn [42], DeviantArt [43], and Diplomatiq [44].

LinkedIn is an employment-oriented social network, facilitating professional networking: a connection between profiles usually represent real-world professional relationships. Having nearly 690 million registered members [42], it is the largest network of its kind. LinkedIn is a domain-specific network: its domain is human resources and employment, and its main target audience is job seekers and employers or recruiters. Besides general social network features like content sharing and messaging, job seekers can create professional profiles similar to a curriculum vitae, find jobs by specific criteria, and apply to job opportunities on the platform. Employers can list job opportunities on LinkedIn, while recruiters can interact with job applicants in the form of formalized or personalized messages. One interesting feature of LinkedIn's social network is *endorsements*: people can positively endorse each other's skills, allowing recruiters to select applicants based on community-approved claims, besides their education, previous work experience, and personally listed skills. LinkedIn's revenue is primarily based on a subscription model for its premium recruiting tool, which allows recruiters to access additional data about job seekers otherwise not available on the platform [45]. Apart from its recruiting tool, LinkedIn generates revenue from personalized advertisement as well.

DeviantArt is a domain-specific social network for sharing several kinds of artwork. Its domain is art and its target audience is artists and art lovers. Its features support sharing artwork of traditional and digital drawing and painting, photography, literature, filmmaking, among others. DeviantArt has over 45 million monthly unique visitors [43]. It generates its revenue by advertising, offering subscription-based memberships, brand partnerships, and producing prints for artwork published on the platform [46].

3.2 MyMUN

3.2.1 Introduction

MyMUN is a domain-specific social network, claiming to be "the ultimate MUN database, conference management tool, and social network" [17]. In the short run, it is a potential competitor of Diplomatiq[1]. Its domain is Model United Nations, its target audience is organizers and participants of MUN conferences, and it provides functionality both for organizing an MUN conference, and for preparing to one as a participant delegate.

MyMUN's website does not contain detailed company data, but according to other sources, the company was founded in 2014 [47] and seems to be an established startup, based on its 17 employees and $3 million of annual revenue [48]. From this point forward, every information disclosed in Section 3.2 originates from my personal experience of using MyMUN via its website [17], therefore I disregard references until the end of this section.

3.2.2 Organizational features

The platform offers a number of features for making the conference organization easier. However, having tried out the software in several different scenario, I experienced the application to frequently produce failures regarding even its basic functionality[2].

Registering an MUN society and a conference

In MyMUN, the first step of organizing an MUN conference is to register an organization, called "MUN society". The user registering the MUN society becomes the sole administrator of the organization, and the only administrator of all MUN conferences hosted by the organization. Even though further organizer members can be invited to administer a conference, but no access control is offered by the platform: invited organizers have the same permissions as an administrator. Since MUN organizational staff usually rotates

[1] Diplomatiq will outgrow the world of Model United Nations in the long run, which means it cannot be collated with MyMUN, as the two services will operate over different domains.

[2] As the website does not list any means of contact for feedbacks about the software, and I did not find any possibility of contributing to the closed-source MyMUN project, I have contacted the Chief Technology Officer via email, with a list of experienced failures and detailed reproduction steps.

quickly, and transferring the ownership of an MUN society or conference is not possible on MyMUN, this approach is not suitable for conferences hosting sessions over the course of multiple years.

An MUN society can host multiple *conferences*. For registering a conference in the system, the user needs to supply the conference's name (e.g. Budapest International Model United Nations) and codename (e.g. BIMUN), number of expected delegates on a session, contact information, and the start and end dates of the conference. Sadly, the platform does not allow the conference to have *sessions* as child entities, which means that a new conference entity needs to be registered for sessions of the same conference in different years. This excludes the possibility of e.g. tracking participants' performance on the same conference over different sessions, because there is no entity in the data model to connect the different sessions stored as separate conference instances. After submitting the necessary information, the conference gets immediately listed in the Discover section, allowing delegates and other participants to apply.

Conference application procedure

MyMUN offers various settings for the application procedure. Additional application data can be queried from applicants in the form of short text, long text, numeric, multiple choice, checkbox or file inputs. The organizers can manage the application of individual delegates, delegations, committee chairpersons, observers, and faculty advisors. The platform does not offer creating and managing custom roles beyond the previously listed ones, but each role's application deadlines and additional questions can be adjusted separately. Even though applications can be accepted or rejected, the system does not offer an automated way to accept or reject applications with regards to the best combination of applicants and country-committee assignments based on priorities. In MyMUN, a participant's application is either accepted or rejected, and the question of the applicant's country-committee assignment is addressed in a later organizational phase.

Committee and country assignments

The platform uses the term *Country Matrix* for denoting a matrix having committees on the X axis, and countries (committee seats) on the Y axis[3]. In the Country Matrix, organizers can assign accepted applicants to seats, or accepted applicant delegations to country delegations, if their sizes allow. The *Assignment Wizard* provides an automated way to assign committee seats to most of the delegates and delegations based on their preferences provided at the application, but the wizard cannot be configured to take into account additional priorities or restrictions. And even if it could, it still operates on the set of already applied participants, disallowing acceptance with regards to the best combination.

[3]The term *country matrix* is not specific to MyMUN, it is a common term in the MUN scene.

Handling finances

The financials of conference participation fees can be managed with MyMUN in various ways. Payment settings enable to adjust fees for different payment classes of different kinds of participants separately — delegates, head delegates, committee chairpersons, faculty advisors, and delegations —, but it is not possible to add custom payment classes. Participants can pay individually or in groups, with credit/debit cards, PayPal, or bank transfer, directly through MyMUN. The platform allows to issue refunds as well. Also, promotions and coupons can be offered to participants.

The organizational dashboard details a financial summary with all received and refunded payments broken down to payment classes. The cash flow view shows the financial reserves and the predicted income of the conference. Payment history can be exported with financial identifiers, so accountants of the conference can easily process payments.

Automated notifications and reminders

Relevant events of the application process are confirmed via automated email notifications. The confirmed events are the submission of an application, the acceptance or rejection of an application, and the assignment of a committee seat to an accepted applicant. MyMUN offers basic email notification templates for these events, which can be completed with additional HTML or text content in the settings.

Statistics

Organizers can create custom views of conference data stored in MyMUN. Custom views can include several metrics based on application type, application status, and other characteristics. Displaying such customized data can help organizers to decide if the conference met predefined numeric goals, e.g. diversity, distribution of genders in committees, etc.

Advertisement and marketing

Although most conferences usually have their already established audience[4], some need more than organic reach only. MyMUN provides a variety of promotional packages for boosting the visibility of an event. Packages include advertising on the platform itself by highlighting the conference on one of the promotional pages, on MyMUN's social media accounts, and through email campaigns. Packages can be optimized, and one can also compose a fully customized marketing campaign of the individual promotional items.

[4] With proper networking skills and some personal popularity, there is usually no need for significant marketing efforts. It is usual that organizers organically pre-promote their conferences in the MUN community, either in-person on other events, or on social media. On the very first session of BIMUN in 2011, the number of applicants was five times the conference capacity, as organizers put serious efforts into organic marketing among their friends and acquaintances.

3.2.3 Features for participants

Listing MUN conferences

Students can browse among conferences in the *Discover* section of MyMUN. This section consists of several views: the main view is a page highlighting upcoming and featured conferences. Events are categorized by continent, and featured conferences are displayed at the top of the page, and across categories. Besides the highlights view, other views display the conferences on a map, in a calendar, or with a regular list view providing filtering capabilities.

All views allow visitors to apply to displayed conferences. The most complete display of events stored in the system is in the regular list view, where also the most information is displayed of individual conferences at once. Conferences can be ordered by name, date, location, number of delegates, fee, and rating.

Applying to a conference

The application procedure starts with checking and modifying one's personal data as required. This step ensures that the application is performed with up-to-date information, in case any personal identifiers or characteristics — e.g. diet or allergies — stored in the system became obsolete. Data saved during this step is also updated globally.

In the second step, the applicant chooses their role on the conference. This can be delegate, member of a delegation, chairperson, faculty advisor or observer. Some of the roles cannot be selected if preliminary conditions are not met, e.g. users with the occupation student cannot apply as a faculty advisor. If the applicant chooses to be a member of a delegation, then they need to supply its name, and then the delegation's head delegate needs to confirm the membership in the system.

The third step lists the terms and conditions of a conference. Having contractual arrangement between conferences and participants is not ordinary, therefore this step is included only if the conference formulated and submitted such documents to MyMUN. If there are any, accepting the conditions is a requirement of the application.

The applicant needs to supply their committee seat preferences in the fourth step, first choosing the committee from the set of the committees offered by the conference, then the represented country within the committee with a search-assisted drop-down menu[5]. The minimum and maximum number of necessary assignment preferences is conference-specific. As described before, the software's *Assignment Wizard* feature claims to assign committee seats to applicants closest to their preferences overall.

[5] A search-assisted drop-down menu allows users to choose a value from a set, while providing search capabilities in the set.

Additional conference-specific questions need to be answered in the fifth step. Most conferences ask about applicants' personality, MUN society membership and previous MUN experience. Usually the goal of additional questions is to evaluate an applicant's attitude and commitment. Larger conferences implement sophisticated questionnaire often requiring serious professional background to fully answer.

The sixth step requires the applicant to formulate a motivational letter in which they introduce themselves and describe their personal and professional interest in the conference. The answer's input field supports long text formatting with optional images, links and other kinds of attachments. A separate document acting as the motivational letter itself cannot be uploaded, meaning that applicants need to prepare this document online, although it is automatically saved during editing.

In the seventh and final step applicants can review their application before submission. All steps' information can be separately edited, navigating the process back to the step to be amended. The application procedure can be either finished by submitting the application or aborted by withdrawing the application and deleting all saved data.

Offers during the application process

MyMUN offers several kinds of services already during the application process. In a continuously visible separate sidebar, hotel, flight and health insurance offers are shown. Hotels, motels and other housing opportunities are displayed on an interactive map covering the vicinity of the conference, indicating the event's exact location. Selecting a housing option reveals its price and community rating, and the offer can be reserved instantly, after the user was navigated to the housing service provider's website. Besides generic offers, conference-specific contractual housing offers can be displayed in a highlighted manner. Flights and other means of travel are also directly offered to applicants by integrating external service providers into MyMUN. Besides travel, the platform offers conference-specific health insurances as well.

Research and study guides

Model United Nations is an academic activity, and thus it involves conducting research before attending a conference. MyMUN offers a virtual library of study guides and position papers[6], which will be extended with a section for drafted resolutions as well. The platform's position paper database counts over 14,000 entries. MyMUN claims that it will also serve online courses on Model United Nations in general, and specifically on preparing to conferences as a delegate.

[6] An MUN position paper summarizes the position of the delegate's country regarding a given topic or issue. Its purpose is to prove the delegate's or delegation's level of preparation before the conference, and to serve as a topical fact sheet during the event.

Travel services

MyMUN promotes and cross-sells several kinds of travel services, some in cooperation with conferences. Services include flights, accomodation, health insurance, car rental, and adventure tours. A so-called *group service* offers a package of integrated services tailored to delegations: after receiving all data from the head delegate or a faculty advisor, MyMUN acts as a travel agency, and makes reservations for flights and accomodation, books required travel insurances, and sends a detailed travel offer to the delegation.

3.2.4 Business model

The financial basis of MyMUN lies on paid conference organization features, conference advertisement and marketing, the cross-sales of travel services, and on a three-level subscription-based membership in the *Delegates Club*, a closed circle of MUN participants offering exclusive content, savings and insurance benefits.

Paid conference organization features

MyMUN offers two plans for conference organizers. In the free *Trial* plan, basic features are available, like listing a conference on the platform, adding committees and organizers, and the management of chairpersons' application. The Trial plan is not sufficient for assisting in the organization of an MUN conference from the beginning to the end, encouraging organizers to subscribe to the *Professional* plan, which allows to utilize all features of the platform. The Professional plan costs the 4% the value of each financial transaction actuated through MyMUN's payment system, but minimally €4 per transaction. It is invoiced either directly to delegates, integrated to the online payment procedure of a conference application, or to the conference, if online payments are not available in a given area of operation.

Conference advertisement and marketing

As described previously, MyMUN allows organizers to promote their conferences in various ways. The offered packages containing several kinds of promotions are priced between €300 and €3,000. The fee of individual marketing elements — like featuring a conference on chosen landing pages or in email campaigns — vary between €100 and €1,500.

Cross-sales of travel services

Although directly not mentioned, fees of offered travel services probably contain dividends received by MyMUN. It is a common sales scheme, when a seller offers a service, and a second party offers a large audience in assumed need of the offered service, in exchange for dividend. MyMUN's offerings — flight tickets, accomodation, health insurance and group services — all provide ways for selling the services with considerable financial benefits.

Delegate's Club

The Delegate's Club is a subscription-based membership group within MyMUN, offering three levels of additional services for conference participants. Membership is not a requirement for using the platform for conference applications, but it comes with benefits. The smallest *Bronze* package costs €27 monthly for 6 months: it offers a flatrate for health insurances purchased through MyMUN, and full access to the position paper database. The *Silver* package costs €65 monthly for 1 year, includes all benefits of the Bronze package, and comes with a free ISIC Card[7] offering discounts for hotels, hostels, restaurants and museums. In addition to all benefits of the Silver package, the *Gold* package offers discounted subscription to diplomatic periodicals, and costs €90 per month for a fixed 1-year term.

3.3 MunPlanet

MUNPlanet was an online knowledge network where MUNers create, curate and share their knowledge and experiences about issues of global importance [16]. It is a potential competitor of Diplomatiq, being a global, domain-specific social network expanding along Model United Nations. Its domain is Model United Nations, its target audience is all participants of MUN conferences, and its specific features are to facilitate knowledge sharing within the domain.

No further information is available of MUNPlanet, since at the time of writing this thesis, its website [15] is not reachable, and its Facebook page [16] having more than 150,000 followers received its last update in June 2019.

[7] The ISIC Card is a student ID card, the only one of its kind which is internationally accepted.

Chapter 4

Building and securing a company-level production infrastructure

this is the foundation that we can build upon

security will be all over this chapter

4.1 Naming

4.2 Brand

4.3 Domain names

caa record, emails, security, 2fa, etc

4.4 Certificates

Sectigo, positiveSSL, password-protected, safely stored

4.5 Emails

DMARC + DKIM + SPF

4.6 Source code management

GitHub organization, 2FA, security settings, etc

continuous integration

4.7 CI infrastructure

4.8 Neo4j startup program

Enterprise Edition license

4.9 Serving the application on the internet

4.9.1 Choosing the platform

Azure

4.9.2 Active Directory

4.9.3 Naming conventions

4.9.4 Subscription and support subscription

4.9.5 KeyVault

4.9.6 Networking

4.9.7 DB VM

4.10 Infrastructure security

4.10.1 Identity management

4.10.2 Resource management

4.10.3 Network security

tűzfal, vnet rules, TLS mindenhol

4.10.4 Configuration security

everything from keyvault

Chapter 5

Overview and development of supportive libraries

5.1 project-config

5.2 crypto-random

5.2.1 CI

100SonarQube etc

5.3 convertibles

5.3.1 CI

100SonarQube etc

5.4 resily

5.4.1 CI

100SonarQube etc

5.5 eslint-config-tslib

5.6 eslint-config-angular

Chapter 6

Overview and development of the Diplomatiq application

6.1 Platform objectives, target audience

6.2 Features

6.3 Chosen technologies

6.3.1 On the front end layer

Angular

6.3.2 On the back end layer

Spring Boot

6.3.3 On the database layer

Neo4j

6.3.4 Client-server communication

HTTPS only ofc JSON-RPC API no resources, no REST at all

6.3.5 API documentation

OpenAPI v3

6.4 Developing the front end

components services CI platform with 3 slots

6.5 Developing the back end

CI platform with 3 slots filters controllers engines services repositories utils session handling error handling

Chapter 7

Security of the Diplomatiq application

security.txt

nem adunk ki a userről adatot (hogy létezik-e ilyen mailcímű user, stb)

encrypted db values, key versioning to avoid birthday problem

CORS

authentication why not oauth/openid/standard megoldások?

1. signed requests and authentication 2. session levels 3. SRP 4. cryptography

Chapter 8

Monetization and business model

Chapter 9

Conclusion and future work

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Appendix