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Experience of conducting the first Russian cardiology hackathon Cardio data hack

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This article is about the experience in organizing and conducting the first Russian cardiology hackathon Cardio data hack UFA 2022 which took place in Ufa in November 2022. It describes the preparation stages and organizational conditions of the hackathon conducting, the ways of interacting between the event organizer and participants, and the methods of evaluating the tasks. The first hackathon case was the recognition of ventricular bigeminy in patients with 24-hour ECG recording; the second case was performing a meta-analysis of the studies which assessed efficacy and safety of oral anticoagulants in atrial fibrillation and chronic renal failure stages IV and V. The hackathon attracted 179 registered participants who formed 42 teams, but further only 37 of them confirmed their participation and formed 8 teams. 7 teams gave the final solution of the tasks, and 5 of them presented their results with 3 of them giving solutions for both cases. Eventually, there were obtained the prototypes of solution for bigeminy recognition during Holter monitoring and high-quality meta-analyses evaluating the efficacy and safety of oral anticoagulants.

Keywords: hackathon, cardiology, Holter monitoring, meta-analysis.

Relationships and Activities: none.

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In the last decade hackathon has gained wide popularity as a way of collaborative solution of a certain problem using modern information technologies (IT) over a limited period of time. Usually, within the framework the hackathon, participants received a task based on an existing problem, often formulated by a quite certain customer interested in solving it. Despite the fact that sometimes hackathon allows the specialists of various economic sectors to get an informational solution of their problem, basically it is a pedagogical practice [1], designed, among other things, to practically consolidate the formation of professional skills in students [2]. Also, many authors who study the hackathon practices refer to its ability to form competencies related to soft-skills, for example, ability to work in a team or project management skills [3]. Despite the popularity of hackathons in Russia and support for their conduction at the state level, in particular, a series of hackathons "Digital Breakthrough" within the framework of the national project "Digital Economy", their use for solving medical problems is rare.

The practice of conducting hackathons specifically on medical topics, on the contrary, is quite popular abroad. This is largely due to the fact that within the framework of the hackathon, you can

present your own idea of an innovative startup in the field of public health [4]. Many researchers of the practice of conducting hackathons on medical topics note that, firstly, this is a great opportunity to participate in interdisciplinary projects that combine the competencies of IT specialists and medical professionals, that contributes to interprofessional training (for example, [5]), secondly, the opportunity to grow a generation of innovators capable of using innovative and entrepreneurial approaches to solve the complex problems of the modern healthcare system [6], thirdly, the possibility of introducing new methods of active training in the field of medicine, contributing to the development of skills in setting and solving problems in the field of digitalization of the healthcare system [7]. Moreover, the hackathon topics in the field of medicine can be various: from epidemiological studies and virology, to genomics and bioinformatics [8]. However, conducting medical hackathons is associated with a number of emerging problems for the organizers. One of the problems is the formation of teams of specialists in various fields, for example, clinicians, scientific researchers, IT specialists, medical statisticians, etc. In this regard, the organizers are required to provide extensive coverage of the hackathon not only in specialized professional "publics" but in the media, and the use of an electronic platform capable of bringing together the specialists from different regions as well as maintaining operational communication between them. Another problem is a keeping the participants motivated to perform the tasks of the hackathon. To solve this problem, it is required to form the prize fund or find alternative non-material ways to encourage participants. The third problem is the formation of a competent jury including the experts from various fields of knowledge (medicine, IT, statistics, pharmacoeconomics, etc.) and the development of methods for coordinating expert opinions to obtain transparent and reliable results of the evaluation of competition participants. Thus, the problem of the development of the methods for organizing and conducting medical hackathons is relevant.

As you know, cardiology/cardiosurgery is a fairly high-tech healthcare industry and is associated with a large number of modern technical and IT solutions. Despite numerous hackathons in the field of healthcare, according to our data, a hackathon in the field of cardiology has not yet been held.

In this article we present the experience of organizing and conducting the first Russian cardiology hackathon Cardio data hack UFA 2022 in Ufa in November 2022.

It should be noted that almost all hackathons have similar principles of organization, and the key point in hackathon conducting is the use of the modern electronic platform that provides the online support for all the event stages: from the team registration and expert consultations to downloading completed solutions and broadcasting participants' speeches. In our case, for conduction of the first hackathon on cardiovascular issues Cardio data hack UFA 2022 within the frameworks of III Eurasian (Russian-Chinese) Congress on the Treatment of Cardiovascular Diseases, the platform codenrock was used. This platform was chosen in particular due to the possibility of chat-communication of both the organizers with participants and participants between each other as well as the support for video broadcasting of all intermediate procedures and the final presentation of works to the jury through its own service.

The first stage in the hackathon organization is the development of the rules of its conducting regarding to general regulations (requirements for participants, requirements for teams), requirements for the final result of completing tasks, the order and timing of the event, the order of registration for the hackathon, requirements for the protection of personal data and the security of the event. The developed rules for the hackathon conduction were posted on the platform which was the main platform for its online holding.

The second stage of the hackathon is the selection of companies which will become the task "providers". It should be noted that the tasks should meet the following requirements: to be modern and interesting for participants, to correspond to the hackathon topic, i.e. to be from the field of cardiology, implying the creation of a prototype in the form of a software product. "The providers" themselves should decide about the valuable prizes that will be presented to hackathon participants as well as the criteria for evaluating tasks.

The third stage of the hackathon organization concerns the creation of organizational conditions for its conduction: expert consultations, determining the format for presenting results, developing a methodology for coordinating expert opinions.

Formally, the hackathon was held in two stages: the first stage was correspondence, when the registered teams of participants do the tasks proposed by the organizers (15 days), and the full-time stage (online), where the participants defended their solution of the proposed cases. It should be noted that participants downloaded the complete task solutions in the form of reports for the tasks, scripts with codes and presentation on the platform in the last day of the correspondence stage, and while performing face-to-face (online), the authors could no longer change the downloaded solutions. The correspondence stage included 2 online consultations with

the experts and case developers (checkpoints), and the participants could also ask questions to both the hackathon organizers and task developers in the chat on the competition platform.

The first task was a practical arrhythmia recognition case — ventricular bigeminy on a test set (dataset) in patients with 24-hour electrocardiogram recording (ECG). The participants received the sets of labeled ECG data where the corresponding type of arrhythmia was marked by the specialists, and also a set of "raw" (unmarked) ECG data on which it was recommended to check the correctness of the resulting solution. The ECG data represented the 7 lead-ECG parameters written to a line (I, II, V5, III, aVL, aVR, aVF). The participants also received the information on the time of the recorded complex in milliseconds from the beginning of the day, on the time of the recorded complex in milliseconds from the beginning of recording, "type of complex" — S-supraventricular, V#-ventricular, X and Z — artifacts, "code of arrhythmia" — a brief designation of the recorded arrhythmia and "arrhythmia" — name of arrhythmia. The participants were required to develop a software solution, download it on the platform, and also to make a presentation in the form of a report on the results obtained and methods used. The case was proposed by the manufacturer of the daily ECG monitoring complex Normocard (Kemerovo).

The second task required the participants to conduct the meta-analysis of the data sources where the efficacy and safety of oral anticoagulants in atrial fibrillation and chronic renal failure stages IV-V were assessed. And it was explained that the participants are not limited either by the choice of the studies or by the source of their search, or by the number of studies, or by the statistical meta-analysis tool used, or by the modeling environment. Along with that, the participants had to make a decision on the inclusion/exclusion of the studies into the meta-analysis independently. The participants were required to present the results of the meta-analysis in the form of an expanded report and provide a script in the form of a code for its performance.

The main difficulty faced by the organizers is that in fact the jury had only one day to check the results obtained by the teams of the hackathon participants. This was complicated by the position of the experts in 4 different time zones of Russia (Moscow, Samara (+1), Ufa (+2), Novosibirsk (+4)). In this regard, the experts filled out the expert evaluation sheet in accordance with the established evaluation criteria developed in advance.

The evaluation criteria of the first task were: the presence of correctly performed preprocessing of the original information (20 points), the presence of the calculated values of classification quality metrics (balanced accuracy not <75% on the test dataset) (25 points), the presence of a ready-made prototype for automatic recognition of bigeminy on an ECG in the form of a software solution (50 points), correctly designed program script with comments (5 points).

The evaluation criteria of the second task were: the presence of a statistically competently well-founded assessment of the heterogeneity of the results of the drug effect in the selected studies (10 points), the presence of correctly well-founded choice of the model with fixed or random effects, all corresponding statistical tests were conducted (10 points), the presence of a correct choice of statistical approach to the meta-analysis performance depending on the criteria of inclusion/exclusion of the studies and their number with justification for such a conclusion (10 points), correct justification for the criteria of inclusion/exclusion (5 points), the conduction of the analysis the stability of the obtained generalized evaluation of the magnitude of the effect (5 points), the presence of correctly and statistically competently conducted analysis of the completeness of the studies included in the meta-analysis (10 points), the presence of graphical support of meta-analysis results (10 points), the presence of correctly designed meta-analysis script with comments and report on the meta-analysis (20 points), the presence of a well-written article on meta-analysis (20 points).

Each expert assigned points to each participating team in accordance with the evaluation criteria, then the points assigned by all the experts were summed up, and based on the ratings received, the teams were ranked. It should be noted that to assess the consistency of expert opinions, the Kendall concordance coefficient was used, the significance of which was checked on the basis of the Friedman criterion at the level of $p<0,05$.

One of the advantages of the hackathon Cardio data hack UFA 2022 was the absence of limitations in the application of the development environment, which is quite rare for Russian events. As prizes for the first task, it was planned to give a Holter for the prize-winner's medical organization, an annual subscription to the Holter software, Yandex station, souvenirs and merch events. For the second task, the best meta-analysis was published in the journal "Russian Journal of Cardiology. Education".

Finally, the hackathon attracted 179 registered participants who formed 42 teams, but further only 37 of them confirmed their participation and formed 8 teams. 7 teams gave the final solution of the tasks, and 5 of them presented their results with 3 of them giving solutions for both cases.

The jury of the hackathon consisted of experts from Saint-Petersburg (professor Villevalde S. V.),

Samara (professor Duplyakov D. V.), Kemerovo (Gribov A.) and Ufa (professor Zagidullin N. Sh. and associate professor, c.t.s., Lakman I. A.).

The three prize — winners were the following teams: 1st place — team Delta (Saint-Petersburg, Moscow, Astrakhan, Tomsk), 2nd place — team No. 3 (Saint-Petersburg, Ulyanovsk, Kemerovo, Moscow), 3rd place — team Samara cardiology (Samara).

When solving the first task, all 5 teams conducted high-quality data preprocessing, exactly, they conducted an analysis of time series, which in fact are the results of the recorded ECG. To solve the task of bigeminy classification, 4 teams of these 5 used artificial neural networks, one team used machine learning algorithms (random forest, boosting). As a metric to assess the quality of classification, all teams chose the area under the ROC curve (AUC). In result, the AUC of all teams when recognizing bigeminy was not less than 60%.

When solving the second task, all 3 teams used the PRISMA methodology in conducting systematic review and meta-analysis. As an inclusion criterion, all 3 teams used for the studies a condition of comparing the results of the efficacy and safety of any oral anticoagulant at any dose (dabigatran, rivaroxaban or apixaban) compared with warfarin for patients with chronic kidney disease stage 4-5, and one of the teams additionally considered only the results of randomized clinical trials.

Finally, one team selected 6 studies, another — 4 and the third — 3, and 2 studies were considered by all the teams. All 3 teams used and analyzed the forest-plots for endpoints (stroke, infarction, death), and 2 teams also built funnel plots to estimate the sufficiency of the studies for the meta-analysis. To assess the quality of the selected studies, one team used the "traffic light" chart, and the other two teams calculated the indicators I^2 and Q to assess the heterogeneity and homogeneity of the studies. All 3 teams used R for the meta-analysis conduction; moreover, one of the teams wrote its own software.

After the hackathon conduction, on the basis of the collected data from the expert evaluation sheets, the consistency of expert opinions was checked: for the second task, the concordance coefficient of expert opinions was 0,66 ($p<0,001$), for the first task, such an analysis was not performed. This indicates the consistency of expert opinions that is a marker of their competence in the field of conducting expertise.

The choice of online hackathon conduction technology made it possible to significantly expand the geography of participants and attract specialists from various fields of knowledge necessary to solve practical tasks (cardiologists, doctors of functional diagnostics, developers of software applications and specialists in the field of data analysis and statistics). As a result, the teams turned out to be not only interdisciplinary but also interregional. For example, the team that won in the hackathon included participants from Saint-Petersburg, Moscow, Astrakhan and Tomsk, the second-place team — participants from Saint-Petersburg, Moscow, Ulyanovsk and Kemerovo. Interestingly, many hackathon organizers set the possibility of international and interregional cooperation as one of the goals of its holding. For example, in the hackathon SIIM 2021 (USA), where it was required to develop an experimental concept of a radiology training module with gamification elements, participants contacted specialists from five different countries, which allowed them to complete an operational check of the developed concept [9]. Another advantage of the hackathon, especially within the framework of major scientific events, is the opportunity to combine the efforts of both experienced participants and novices to find creative solutions to complex problems. For example, the work [10] says that the hackathon held within the framework of the International Research Congress of Nurses in Calgary (Canada) has become an excellent method of bringing together novices and experts with different experiences to develop technological solutions to healthcare system problems. We hope that the experience gained in the first cardiology hackathon in the Russian Federation will be in demand in the future and will lead to greater integration of cardiologists and IT specialists.

Relationships and Activities: none.

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