DARC: A Visual Analytics System for Multivariate Applicant Data Aggregation, Reasoning and Comparison (Supplementary Materials)

Yihan. Hou, Yu. Liu, He. Wang, Zhichao. Zhang, Yue. Li, Hai-Ning. Liang, and Lingyun. Yu

Xi'an Jiaotong-Liverpool University, China

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Use Case - Goal

The main goals of the case study are: 1) assess how the glyph visualization helps users gain an overview of multivariate data, 2) observe how the system supports users in analyzing and comparing multivariate information, and 3) understand how DARC supports users make decisions.

Procedure

We invited a Programme Director from Computer Science to use our visual analytics system. The PD also joined in the interview at the design stage. Before the study, we had uploaded last year's recruitment data into the system, so that the PD can compare new applicants with the students from the previous year.

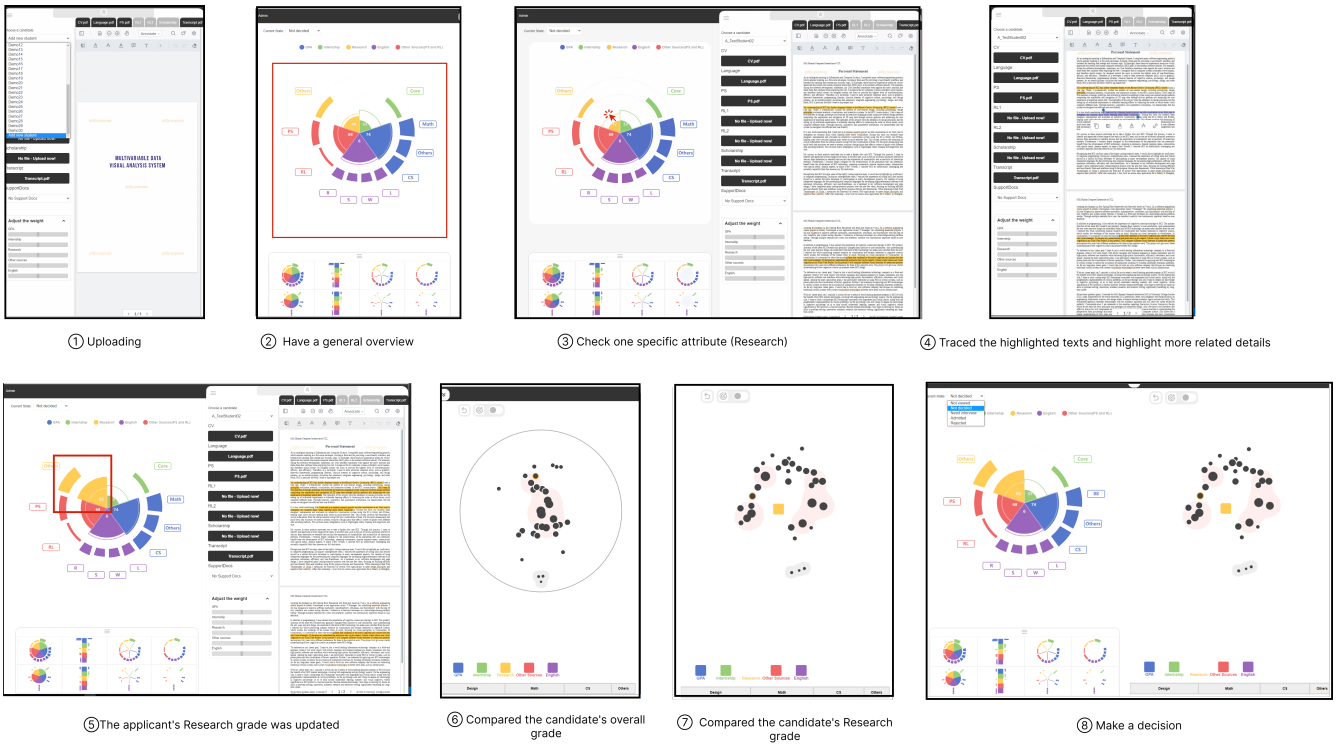

Figure 1. Step-by-step screen captures of the user decision

1. **Upload materials ①:** PD uploaded a new candidate's data in the system.

2. **Generate glyph visualization ②:** He noticed that the keywords in the documents got highlighted and the candidates' information (GPA, English, Internship, Research, Other sources) was presented in the glyph visualization in the Analysis view. After checking the visualization, PD noticed that the candidate's GPA was above the average but English grade was below.

3. **Check details ③:** He decided to check the grades of the four English skills from the exterior layer of the glyph, and found the English grade was low due to Writing and Speaking.

4. **Find reasons ④:** He also noticed the student did not be scored well in "Research". So, he clicked the "Research" in the glyph visualization and traced the highlighted texts about the research experience in the "Personal Statement" document shown in the Reasoning view. PD explained that he usually gives more credits to the project experience. Thus, he checked the details about the project experience mentioned in the text and highlighted more keywords.

5. **Re-compute grades ⑤:** Since more related details were highlighted, the applicant's Research grade was updated, directly reflected in the glyph visualization.

6. **Compare applications ⑥, ⑦:** However, PD still cannot decide if the candidate should be recruited. So, he compared the candidate's overall grade and "Research" grade with last year's accepted candidates in the Comparison view. He found that the candidate point was located close to the suitable candidates area. When he dragged the "Research" attribute block, the point followed quickly.

7. **Make a decision ⑧:** The above findings assisted PD in understanding the candidate's qualifications, the overall and specific ranking. Finally, he decided to accept the candidate and commented that our system offered a great support in making this decision.

Questions used in the Design Stage (Section 3. User Interview)

1. Could you please briefly introduce your process of recruiting graduate students? Such as what information needs to be reviewed and what feedback needs to be given?
2. How many students do you need to check when you recruit graduate students each admission?
3. Do you have different standards for students of different majors?
4. What information would you like to receive from the Graduate Sc staff about the applicant? (For Programme Directors)
5. Have you found difficulties in using the existing system?

Summary of interview

Application material: Typical application materials include academic transcripts, a curriculum vitae, a personal statement including study motivation and previous experience, proof of English language achievement (IELTS or TOEFL), and one or two recommendation letters.

Recruitment process: Students' application are received firstly by the Graduate School staff. They mainly check whether the student's application documents are complete and provide initial comments. The school staff have to check whether the applicant's grades meet the entry requirement, the ranking of the applicant's school, the GPA, the English scores, etc. Besides, they will give an initial recommendation (reject, borderline, accept) for the application. This will help the Programme Directors obtain a quick overview about the applicant. The Programme Director(PD) will consider the initial evaluation given by the graduate school, then carefully review the applicant's materials and make a decision after comprehensive consideration. In general, both school staff and programme directors consider the applications from the following aspects: 1) whether the applicant's studying background fits the Master programme's direction, 2) whether the applicant meets the entry requirements, and 3) whether the applicant shows interest in studying the applied research direction. Sometimes, when applicants' grades are at the borderline or if their study motivation is not reflected in the Personal Statement, PDs will arrange interviews. To remember the applicants' cases, Graduate School staff often makes notes in the application system. Besides, they often have a long list of applicants from different programmes.

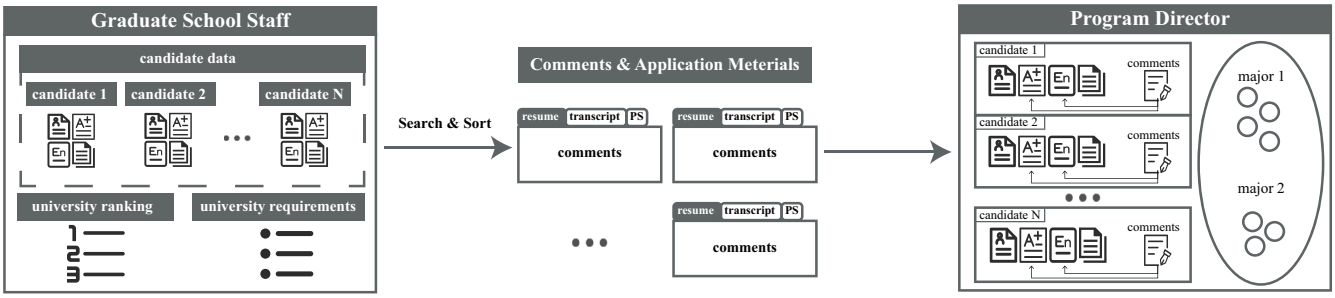

Figure 2. Master student recruitment process. The Graduate School first reviews applicant's materials and then provides an initial evaluation to Program Director for further reviewing before making a decision.

Difficulties encountered: The work of the Graduate School staff focuses more on information extraction rather than final decision making. Their main issues include: 1) repetitive manual work, and 2) they need to remind students to complete their applications. On the other hand, PDs mainly focus on making reasonable decisions based on the submitted materials. Each year, they receive applications from different majors and for each application, review many application documents. Comparing multiple applicants is not a trivial task for two reasons: 1) it is difficult to quantify some of the criteria (e.g. whether the study motivation is strong); and 2) it is difficult to compare applications across the board at any time. Usually, the PD can only compare a few applicants in a small range based on previous notes and retrieve the corresponding documents when needed. It is important to note that applications can be submitted throughout the year, however, usually the programmes have their enrollment targets. Thus, it is possible that late applications will face a relatively high rate of "competition" for admission. Therefore, it is important that PDs can keep a consistent enrollment criteria in the student recruitment. In addition to this, PDs also need to balance the offer numbers for different majors. In summary, in the student recruitment task, even with modern retrieval and analytics systems, extracting useful information from the multivariate data for making decisions can be time consuming.

Questions used in the Evaluation Stage (Section 6. Evaluation)

1. Would you like to use this system frequently to help admission work?
2. Do you find the system is unnecessarily complex?
3. Do you think the system was easy to use?
4. Do you think you would need the support of a technical person to be able to use this system?
5. Do you find the various functions in this system are well integrated?
6. Do you think there are too many colors which interrupts you?
7. Can you imagine that most people would learn to use this system very quickly.
8. Do you find the system is very cumbersome to use?
9. Are you very confident using the system?
10. Do you need to learn a lot of things before you could get going with this system?
11. Do you understand the three parts of the system? If not, which part is difficult to understand?
12. Does these glyphs help you grasp a student's information? (overall/advantage/disadvantage)
13. What's your favourite glyph? Why?
14. Can you understand a student's different attributes quickly from the glyph? (such as average line)
15. Can you compare the two students?
16. Can you understand why the student is locating here?
17. Are you able to understand the overview layout quickly of all glyphs? If not, why? (such as why the points move like this with changing the block)
18. Does it help you to trace students' original file when needed?
19. Are there any parts of the interface particularly useful or helpful?
20. How does this interface compare to your current tool?
21. What (if anything) would you like to change about this tool?
22. What other scenarios do you think this system can be applied for?

Summary of interview

We conducted semi-structured interviews with four domain experts in the local University: an expert in case studies (EC), a staff member working in the Graduate Office (EG), and two Programme Directors (PD1 and PD2). PD1 and PD2 also participated in the previous interview at design stage.

Procedure. The interviews started with a demonstration of the system using the student recruitment data of the previous years. After the experts get familiar with the system, they can explore the system by themselves. We encouraged them to tell their findings aloud and ask questions if they encountered any problems. We recorded the interview and took notes of the feedback and problems for later analysis. Finally, we asked a list of prepared questions about the visual and interaction design, learnability, interface features, scalability and some follow-up questions based on their comments. The expert interview was conducted individually.

Analysis. All recorded interviews were eventually transcribed into text and then independently coded by three of the co-authors to find the relevant responses to the questions listed. The answers to the questions were then discussed and confirmed one by one in conjunction with the notes and independent coding. The results and main findings are listed in Section 6.

Eight design alternatives

Due to page limitations, we have moved the figure showing the 8 design alternatives from the text to the supplementary material.

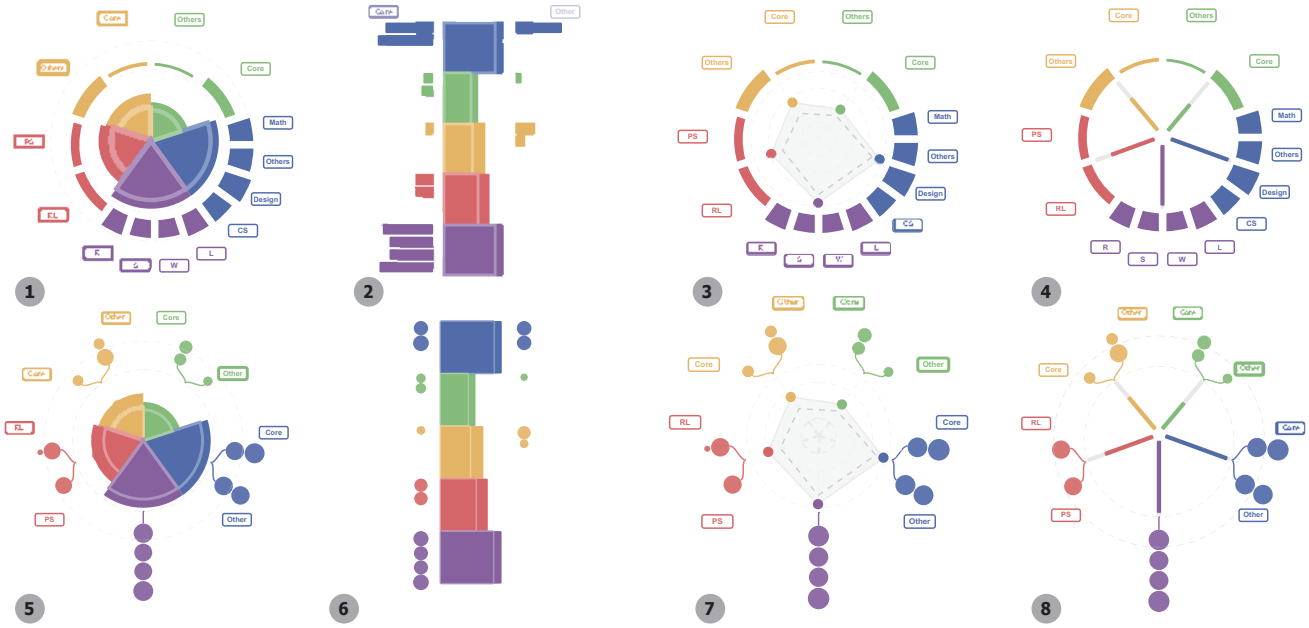

Figure 3. The eight glyph alternative choices.