STUDENT PROJECTS USING ASTRONOMICAL DATA BANK

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1. INTRODUCTION

There are several ways to use a computer with students for teaching Astronomy. Among many others we can list the following : to emulate and to explain the phenomena as with a planetarium, to visualise some astronomical properties such as the motions in a binary-stars system, or to simulate some observations with a telescope. We shall present here a different approach : the use of a computer to compute and to analyse the content of an astronomical data bank.

The projects developed with the students, in this context, allow them to have access to real astronomical data obtained by professional astronomers and then to make an analysis of the data based on their own knowledge.

2. STUDENT POPULATION

Such projects are developed with two different groups of students : Population A and Population B.

2.1) The Population A concerns undergraduate students in Physics or in Mathematics. They are in the 2nd year or their university cursus which lasts normally 4 years. This course spans over 14 weeks, 3 hours every week. During the 5 first weeks there are academic lectures on astrophysics as well as on programming language, but all the students involved in these courses are already familiar with one programming language (fortran, pascal or other). During the following 9 weeks, the students are working on computer using the data bank.

The astronomical courses concern mainly stellar astrophysics; the stellar properties developed are linked with the data contained into the data bank that they

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will use. For all of them, this will be their first contact with Astronomy, but they have some knowledge on the radiation mechanism (line-formation among others) as well as in the field of spectroscopy.

2.2) The Population B concerns students which are nearly graduated : they are in their 4th year of university cursus. This project lasts in total 22 hours and is part of their yearly astronomical course in astrophysics.

3. THE DATA BANKS AND ITS QUERY

Two different data banks are used according to student Population to be considered. The students of Population A are using a data base created with the content of the Bright Star Catalogue, so they have access only to a limited amount of data concerning about 10×10^3 stars. The second group of students, Population B, has access to the content of the data bank SIMBAD at the CDS ("Centre de Données Stellaires") at Strasbourg (France), that is about 6×10^5 stars.

In both cases, the students must develop a project based on data selected from the data bank. The projects developed by the students can be either free-scope projects, either set-piece one; free choice can be limited only by availability of data and the astrophysical knowledge of the students. However a list of possible projects is predetermined by the supervisor and the students are given any choice within the menu. These projects must, of course, be assessed : the assessment is done through the evaluation of a written report which has two components : one concerning the programme itself and the other referring to the astrophysical analysis of the data selected.

3.1) The data used by the youngest students, the Bright Star Catalogue, has been implemented directly in the computer of the Université de Paris-Sud. We have bought at the CDS the machine – readable version of the Bright Star Catalogue. A specific software to query this data bank has been written by G. Debève, informatician engineer at the Institut d'Astrophysique.

The interrogation of this data bank is done through specific criteria defined by the students, according to the Project they have chosen. The output of data is written in standard formats, which are more or less the ones existing in the printed version of this catalogue. During the test-phase of their project, the students can also obtain their data selection, on screen only, but always formatted. An example of such a query is the following :

REU (MAG, 4.8, 6.0 ; POS 2000, 0:0:15, 0:5:32 ; 30:0:0, +45:12:1)
(HD ; MAG ; U–B ; Vsin i) (file name)

The selection of the stars will be made through the union of the two conditions written inside the first parenthesis : stars with a V magnitude between 4.8 and 6.0

and with the following coordinates : 0 h 0 mn 15 s $\leq$ $\alpha(2000)$ $\leq$ 0 h 5 mn 32 s and 30° 0' 0" $\leq$ $\delta(2000$ $\leq$ 45° 12' 01".

In the output file the following data will be stored for all the stars selected : their HD number, (U–B) and Vsin i values.

It is in fact the first time that the students have access to a real data bank, except the electronic diary via the Minitel, which is of common use in France. Some students do not realise very easily that the query of a data bank is done through a software that must have been written previously by someone, and it is a real experience for them.

3.2) The nearly-graduated students (Population B) have access to the whole data bank SIMBAD.

We shall not present SIMBAD here, neither describe its query, the interested reader can refer to SIMBAD user's guide edited by the CDS. The connection with SIMBAD is very easily established through the telephone network. It can be even done, at home, with a Minitel. Nevertheless, the ultimate query of the data bank is done only by the supervisor in order to protect the access to this data bank and to limitate to a reasonable amount the cost of such a query, but the parameters of this query is defined by the student and not adjusted by the supervisor.

4. THE COMPUTER AND THE PROJECTS

The computer used with these projects depends on the student Population to be considered.

4.1) The Population A students work with a computer CDC990 via a terminal. From his own query each student creates his own sub-file. The content of this file is determined by the query done by the student which results of the project chosen. So, the first step to be done by the student is an analysis of the project selected, in term of data to be extracted from the data bank. Then, these data are analysed by fortran programs written by the students.

Due to the kind of data included into the BS Catalogue, the analysis is mainly oriented towards the fundamental parameters of the stars.

We shall just mention an example of such a project developed by the students : the analysis of the distribution of stars having a measured parallax, in terms of luminosity and spectral type.

For these youngest students, the goal of these courses is :
- to initiate them to work with a large computer
- to initiate them with the concept of a data bank and its query
- to analyse, from astrophysical basis, the data selected in the data bank.

4.2) The Population B students have access to the context of a much more wider data base because they are already familiar with much more astrophysical concepts.

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For this group of students, the emphasize is put only on the astrophysical analysis of the data and not on the programming aspect. For that purpose the student work with the microcomputer Macintosh SE and the software EXCEL. The great avantage of that microcomputer and software is that we can feed directly the PC with the data extracted from SIMBAD and then any computing of these data can be performed very quickly without any knowledge of a advanced programming language.

One example of a Project realized by these students is the following :

– query of SIMBAD data bank to find all the objects present in a small circle around the given coordinates. The coordinates and the radius of the circle are chosen in such a way that inside it there is an open stellar cluster. Then, for this sampling all the data are extracted.

These data are analysed by the students in term of membership of the cluster. Such a project allows the students to explore a very large set of stellar properties including the reddening in this area. The software EXCEL is also convenient to draw quickly relationship between variables, which reinforce their analysis.

6. CONCLUSION

The first objective of these projects, at any level they are considered, is to remove the student from the lecture and textbook situation.

For the first time, the student is on contact with real data, obtained and used by researchers. The aim of these projects is not that the students may mimick some post-graduated work but the objective is to bring the student to work, with his own possibilities, with real astronomy data.

This situation is different of what we are doing generally with the so-called "laboratory exercises".

Using such data, the students learn about real data : for example they learn that error bars are as important as the measured values, they learn to appreciate how data must be handled.

During the realisation of these projects we let the student to work at their own pace and to handle by themselves their acquired knowledge as well in programmation than in the astrophysical domain, so it is obvious that some students are much more supervised than others. But, nevertheless, all the students can produce a final work which can be assessed through the following criteria : how the problem has been tackled, the presentation of the scientific context, the logistical approach and the conclusion to be drawn.

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