Bachelor Thesis Review

Faculty of Mathematics and Physics, Charles University

Thesis author	Penda Smajljaj
Thesis title	Analysing data from two-layer Timepix3 detector
Year submitted	2024
Study program	Computer Science
Specialization	Artificial intelligence
Review author	RNDr. František Mráz, CSc. Advisor
Department	Department of Software and Computer Science Education

Overall

	good	OK	poor	insufficient
Assignment difficulty		X		
Assignment fulfilled	X	X		
Total size *... text and code, overall workload*		X		

A Timepix3 detector is a detector of charged elementary particles that can trace particles flying through a matrix of pixels. Two-layer detectors use a pair of such detectors separated by four quadrants covered with different materials. This setting enables the detection of particles that fly through both layers and increases space resolution in detecting a particle's trajectory. Additionally, it enables the detection of particles without charge when they hit atoms in the separating layer and produce secondary (charged) particles.

The main goal of the thesis was to design a tool for interactive inspection and analysis of data captured from two-layered Timepix3 detectors. Currently, there are no tools for interactive analysis of data captured by two-layer Timepix3 detectors, and such analysis was made using the CERN ROOT framework, which is a big, complicated library with a C++ interpreter. The thesis implements a set of tools for interactive analysis of traces of individual particles (denoted as local analysis) and analysis of the whole stream of particles (denoted as global analysis).

The thesis goal was achieved. The implemented set of tools efficiently simplifies the analysis of data from two-layer detectors. Efficiency is extremely important as the size of usual datasets from Timepix3 detectors is several gigabytes. A user can use the tool without knowledge of the ROOT framework.

Thesis Text

	good	OK	poor	insufficient
Form *... language, typography, references*		X		
Structure *... context, goals, analysis, design, evaluation, level of detail*		X		
Problem analysis		X		
Developer documentation		X		
User Documentation	X	X		

The text is well structured and written in a readable way in good English. It gives enough details for understanding problems and their solution. The author proposed and later implemented functions to improve the information obtained from the source data. This resulted in a better association of clusters (particle traces, called coincidence groups) between the two layers and a better estimation of the angle of the traces. Additionally, the author showed how using simple machine learning algorithms (linear and quadratic regression) can improve the precision of the analysis. She also implemented a simple regression tool that can be used by the user to estimate arbitrary parameters.

Thesis Code

	good	OK	poor	insufficient
Design *... architecture, algorithms, data structures, used technologies*		X		
Implementation *... naming conventions, formatting, comments, testing*		X		
Stability	X			

The implemented tools are fully usable. As the ROOT format is widely used in high-energy physics, the program is based on the huge ROOT library. This choice simplified some tasks, like reading and writing ROOT datasets. On the other hand, it required the student to learn ROOT design and usage.

The implementation in C++ resulted in stable and efficient code. The tool can process large datasets in a reasonable time, and it was evaluated on several ROOT files of different sizes and tasks.

The program's usability is improved by the possibility of running most of the functions from the command line, which is an advantage for many time-consuming tasks.

Overall grade Excellent

Award level thesis No

June 21, 2024 Signature