HRVATSKI CENTAR KOMPETENCIJA ZA HPC

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(Digital Europe, EuroHPC JU)

The Croatian landscape of education in the fields of HPC, HPDA and AI

Osijek, April 2025

CONTENT

1. INTRODUCTION

The research on the Landscape of education in the fields of HPC, HPDA, and AI is conducted as part of the project National Competence Centres in the framework of EuroHPC Phase 2 (EuroCC 2) within the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 951732 and Digital Europe. One of the project activities is to identify competencies and the need for new educational content and training activities in the fields of High Performance Computing (HPC), High Performance Data Analysis (HPDA), and Artificial Intelligence (AI). For this purpose, and to create a more detailed landscape of needs and opportunities in these fields, a survey was conducted targeting companies and institutions.

2. SURVEY CONTENT

The survey was created using a tool based on the open-source software LimeSurvey, where the introduction section requires the entry of the entity's name and contact information of the responsible person. Participants were informed that the entered data would be used exclusively for the research purposes of the project in an aggregated form, without mentioning the names of the entities and personal information, and that the data would be deleted after the completion of the research. The main part of the survey consists of questions divided into three themes, or sections: High Performance Computing (HPC), High Performance Data Analysis (HPDA), and Artificial Intelligence (AI). At the beginning of each section, a question is provided to determine the relevance of the respective field to the entity's operations, as well as a question regarding educational activities on the same topic, where entities can offer educational activities or express a need for such activities. Subsequent questions within each section are similarly structured to assess the relevance of specific subtopics within the respective field to the entity's operations and to gauge the offer or demand for educational activities. A total of 53 such subtopics are covered, with 17 in the first section (High Performance Computing), 15 in the second section (High Performance Data Analysis), and 21 in the third section (Artificial Intelligence). At the end of each section, participants can independently propose additional topics within the respective field. Table 2.1 presents all the questions from the main part of the survey along with the provided response options.

Table 2.1. *Questions in the survey by fields and provided responses*

field / *subtopic*	question	provided responses
High Performance Computing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Croatian HPC infrastructure usage	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Supercomputing in natural sciences	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Introduction to MPI and OpenMP parallel programming models	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Embedded supercomputing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Parallel algorithms	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Parallel libraries	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Real-time supercomputing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Performance engineering and co-design	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
HPC in modeling and simulation	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Parallel programming models	Business critical	Yes / No

	Educational activity on the topic	I can offer / I need
Programming for heterogeneous parallel architectures	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
GPGPU and accelerators	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Green computing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Croatian HPC resources: Supek and Vrančić	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
EuroHPC	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Training machine learning models on supercomputers	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Energy efficiency of high-performance computing systems	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
High Performance Data Analysis	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Analysis of large datasets and data stream processing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Croatian Scientific and Educational Cloud HR-ZOO	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Computational fluid dynamics	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need

HPDA in fraud and anomaly detection	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
HPDA co-processors and accelerators	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
HPDA in biomedical sciences	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Introduction to Big data	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Cloud computing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Real-time stream data processing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Computational chemistry	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Solving large-scale problems on supercomputers	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Meteorological analytics and climate change simulations	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Quantum computer simulators	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Numerical modeling of rigid and solid bodies	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Quantum computing	Business critical	Yes / No

	Educational activity on the topic	I can offer / I need
Artificial Intelligence	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Frameworks for deep learning	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Feature extraction from multidimensional data	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Bias in machine learning models	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Learning from imbalanced data	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Multi-label classification	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Clustering of data with complex shapes	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Deep learning for image analysis	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Machine learning for autonomous vehicles	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Elements of artificial intelligence	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Modern programming languages as tools in data science and machine learning	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need

Data preparation and handling	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Large language models	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Natural language processing	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Traffic system analysis and management in near-real-time using machine learning	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Mission-critical AI-based services	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
AI-based monitoring, management, and maintenance of industrial facilities	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Artificial intelligence in augmented reality and access management	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Ethical issues and regulations in the application of artificial intelligence	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Security in AI-based systems	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Development of Retrieval-Augmented Generation (RAG) applications	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need
Co-pilots	Business critical	Yes / No
	Educational activity on the topic	I can offer / I need

3. RESULTS AND ANALYSIS OF THE SURVEY

In this chapter, the results of the survey research are described, including an overview of the participants, an assessment of the relevance of the three researched fields (High Performance Computing, High Performance Data Analysis, and Artificial Intelligence) in the operations of the surveyed entities, an overview of the offer and demand of educational activities by fields, and an analysis of the offer and demand of educational activities by specific subtopics within all three fields.

3.1. Survey participants

A total of 57 entities participated in filling out the survey. For the purposes of analysis, they were categorized into four groups: small and medium-sized industries, large industries, educational and research institutions, and public institutions. The largest number of participants, 21 (37% of the total) belong to the group of educational and research institutions. They are followed by 15 participants (26%) from the small and medium-sized industry group, 13 participants (23%) from the public institutions group, and the fewest participants, 8 (14%) are from the large industry group. Figure 3.1 graphically presents the composition of survey participants by these groups.

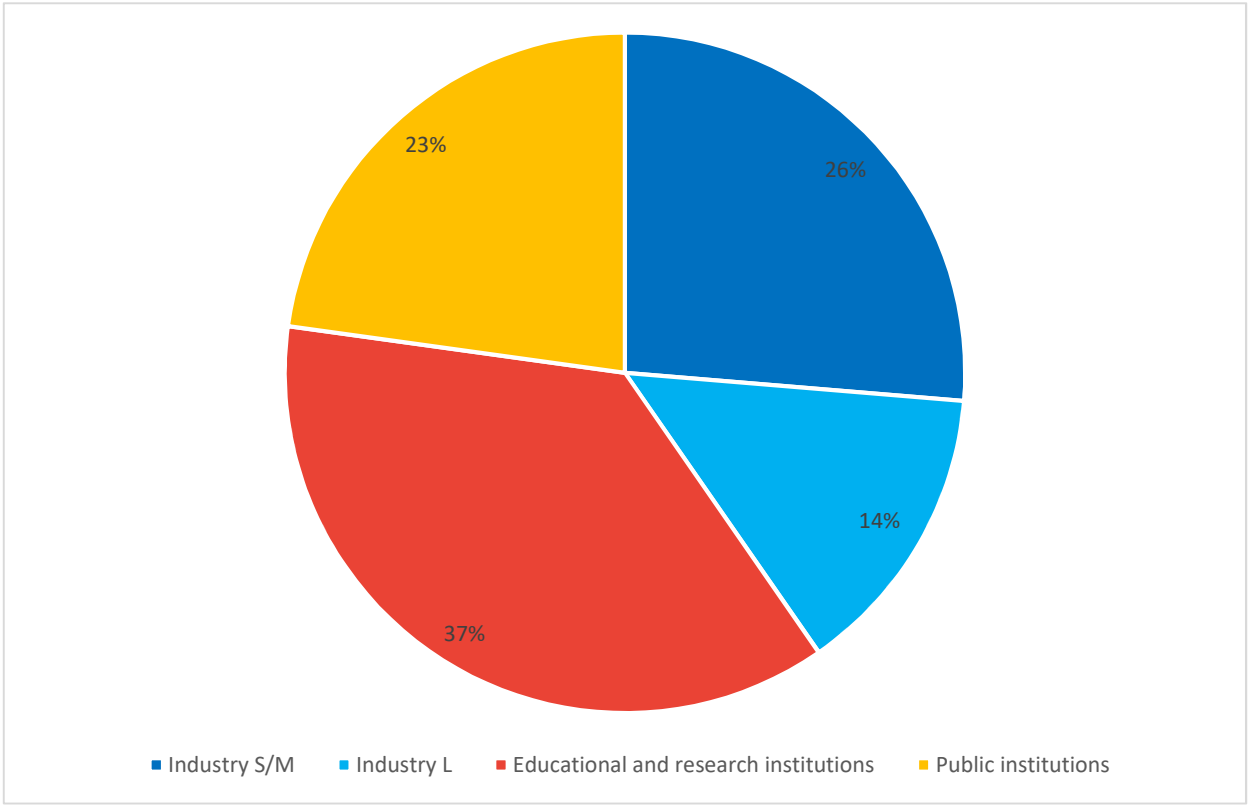

Figure 3.1. *Composition of survey participants by groups*

3.2. Overview of the relevance of researched fields in business

In the initial part of each section of the survey, which presented the three fields of knowledge covered by the survey, participants expressed the relevance of these fields in their entities' operations. Participants had the option to select any number of fields, including none. The first field, High Performance Computing (HPC), was considered relevant by 21 survey participants for their business operations. High Performance Data Analysis (HPDA) was deemed relevant by 30 entities. Artificial Intelligence (AI) emerged as the most critical field, with 48 participants identifying it as relevant to their business operations. Six surveyed entities indicated that none of the mentioned fields were relevant to their business operations. Table 3.1 provides an overview of these results categorized by groups of entities.

Table 3.1. *Overview of the relevance of researched fields by groups of surveyed entities*

	High Performance Computing	High Performance Data Analysis	Artificial Intelligence	None
Industry S/M	4	5	11	2
Industry L	2	4	6	2
Educational and research institutions	11	14	19	1
Public institutions	4	7	12	1
Σ	21	30	48	6

It is evident that in all three fields, entities from the educational and research institutions group prevail, considering these fields relevant to their business operations. Regarding the remaining three groups, in the fields of Artificial Intelligence and High-Performance Data Analytics, the second most numerous are entities from the public institutions group. This is primarily a result of the division of the formerly unified industry group into two new and more specific groups: small and medium-sized industry and large industry. Thus, in these two fields, the third most numerous are entities from the small and medium-sized industry group, while the fewest participants are

from the large industry group. Given the number of participants in the four surveyed groups, these results align with expectations. Among the entities that do not consider any of the three fields relevant in their business operations, there are two from the small and medium-sized industry group, two from the large industry group, and one each from the groups of educational and research institutions and public institutions. A graphical representation is provided in Figure 3.2.

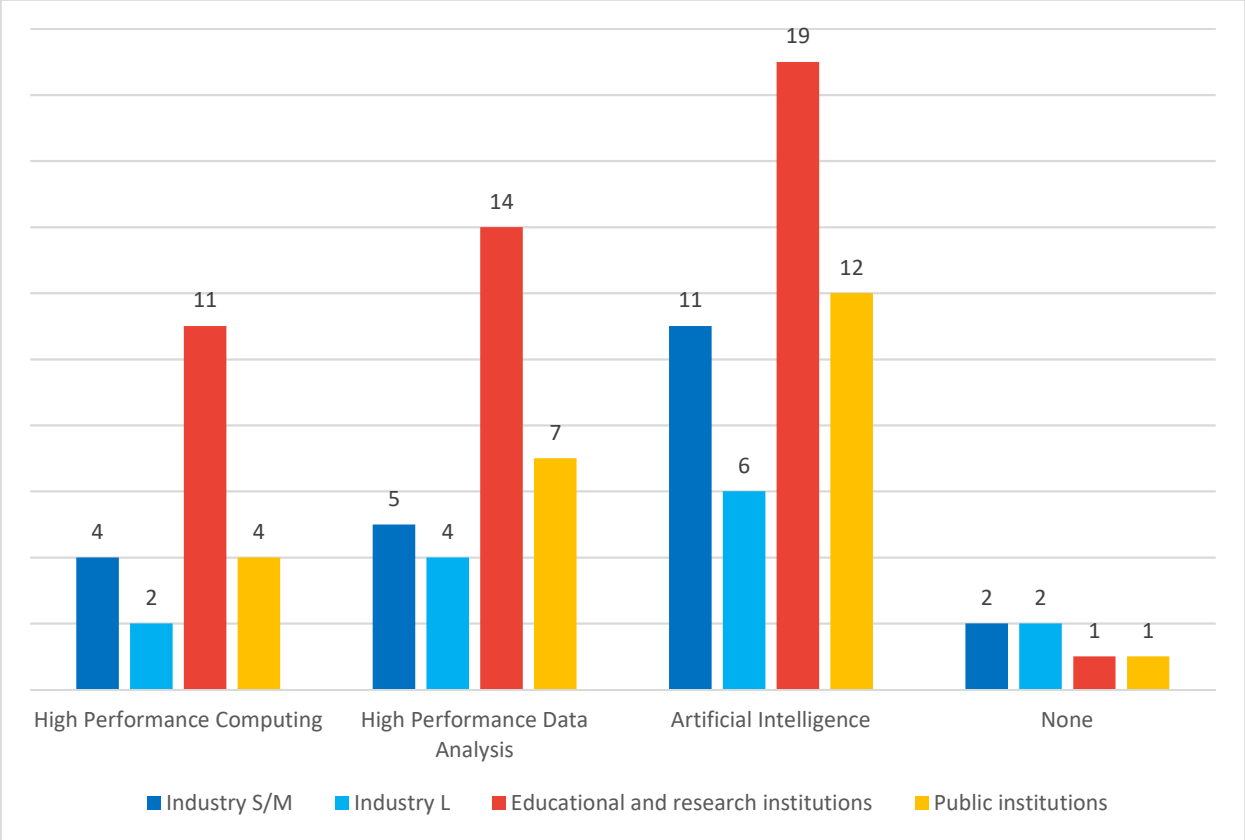

Figure 3.2. *Graphical representation of the relevance of researched fields by groups of surveyed entities*

3.3. Overview of offer and demand of educational activities by fields

When it comes to responses regarding educational activities for the three main research fields, the outcome is identical, but with certain differences in the number of subjects. These differences primarily stem from the fact that some participants who do not consider a certain field relevant to their business still expressed interest in attending educational activities in that field. On the other hand, there are also entities whose representatives did not offer or request educational activities, despite considering a specific field relevant to their business. The results by fields and groups of surveyed entities are presented in Table 3.2.

Table 3.2. *Overview of offer and demand of educational activities by fields and groups of surveyed entities*

	High Performance Computing		High Performance Dana Analysis		Artificial Intelligence	
	offer	demand	offer	demand	offer	demand
Industry S/M	1	4	0	3	2	5
Industry L	0	4	1	5	2	3
Educational and research institutions	6	8	8	8	11	9
Public institutions	0	5	0	5	1	9
Σ	7	21	9	21	16	26
Σ	28		30		42	

In all three fields, the demand for educational activities exceeds the offer overall, with the difference being slightly more observed in the field of High Performance Data Analysis, somewhat less in the field of High Performance Data Analytics, and the least in the field of Artificial Intelligence. When comparing across groups of entities, the pattern is generally the same, with a partial exception for entities from educational and research institutions group, who both offer and seek educational activities to a similar extent in the field of High Performance Data Analytics, while in the field of Artificial Intelligence, they offer more educational activities than they seek. It is also important to highlight that in the field of High Performance Computing, no entities from the groups of large industry and public institutions have offered any educational activities, and the same is observed in the field of High Performance Data Analytics for the small and medium-sized industry group as well as again for public institutions. The following chart in Figure 3.3 illustrates this relationship across individual groups of entities.

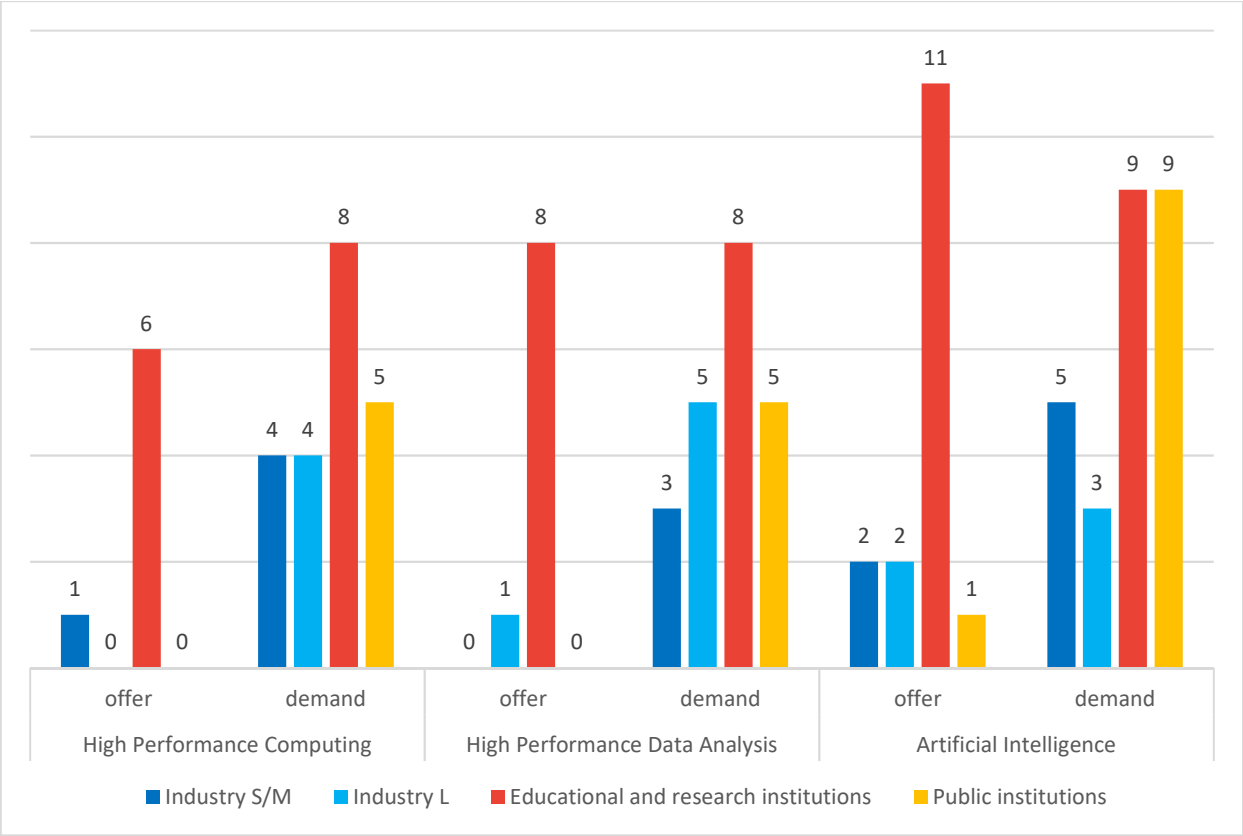

Figure 3.3. *Graphical representation of the offer and demand of educational activities by fields and groups of surveyed entities*

3.4. Overview of offer and demand of educational activities by specific topics in the field of High Performance Computing

By delving deeper into each of the three main fields, interest among entities can be identified for more specific corresponding topics. For the field of High Performance Computing, the results are provided in Table 3.3.

Table 3.3. *Overview of offer and demand of educational activities by specific topics in the field of High Performance Computing*

High Performance Computing	offer	demand	Σ
Croatian HPC infrastructure usage	7	14	21
Supercomputing in natural sciences	4	9	13
Introduction to MPI and OpenMP parallel programming models	6	9	15

Embedded supercomputing	4	10	14
Parallel algorithms	5	9	14
Parallel libraries	5	9	14
Real-time supercomputing	4	8	12
Performance engineering and co-design	5	9	14
HPC in modeling and simulation	6	8	14
Parallel programming models	4	8	12
Programming for heterogeneous parallel architectures	3	6	9
GPGPU and accelerators	4	7	11
Green computing	2	13	15
Croatian HPC resources: Supek and Vrančić	4	11	15
EuroHPC	4	12	16
Training machine learning models on supercomputers	6	9	15
Energy efficiency of high-performance computing systems	3	11	14

On the chart in Figure 3.4, it is noticeable that the topic “Croatian HPC infrastructure usage” is cumulatively the most interesting in terms of offer and demand for the surveyed entities. 21 participants from the survey have shown interest in this topic. It is followed by “EuroHPC” with 16 interested participants, and then “Introduction to MPI and OpenMP parallel programming models”, “Green computing”, “Croatian HPC resources: Supek and Vrančić”, and “Training machine learning models on supercomputers”, each with 15 interested participants. For the remaining topics in this field, the overall level of interest is generally not significantly lower.

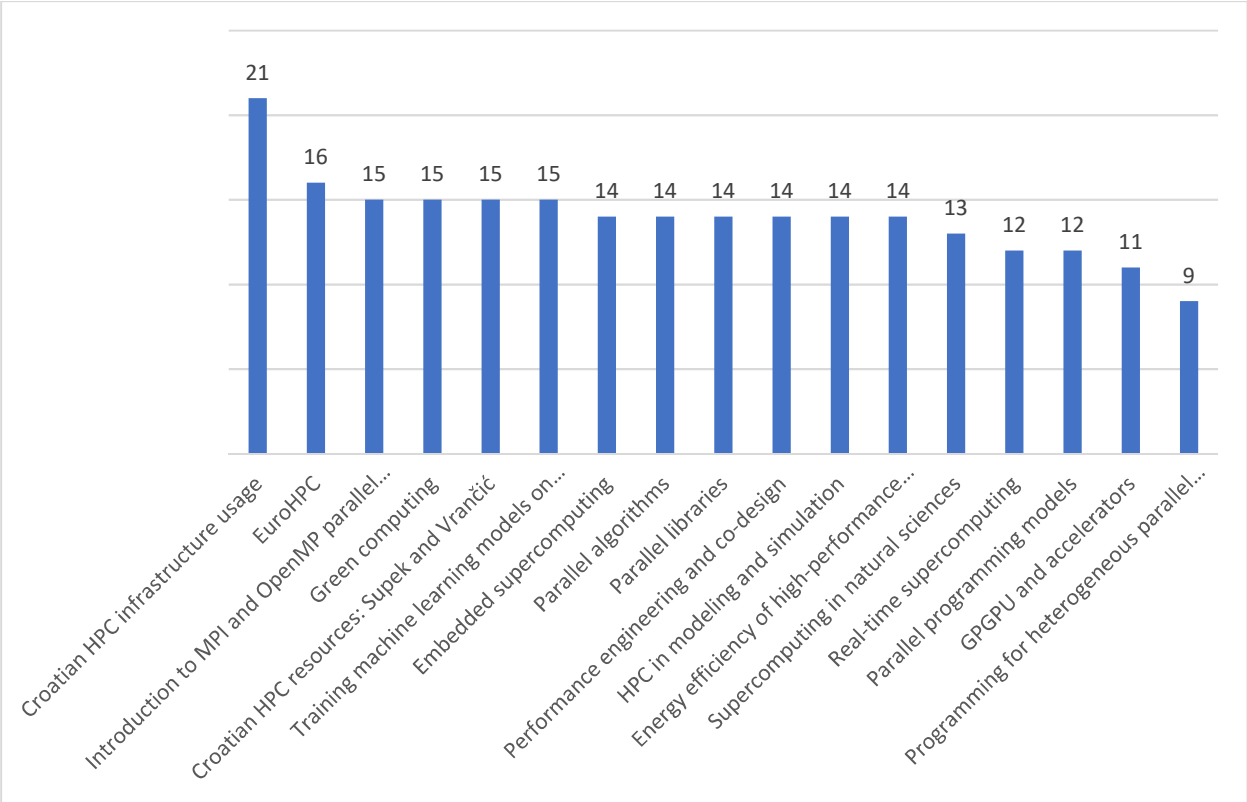

Figure 3.4. *Cumulative graphical representation of offer and demand of educational activities by specific topics in the field of High Performance Computing*

When looking individually at the offer and demand of educational activities by topics in the field of High Performance Computing, the chart in Figure 3.5 shows that the highest demand is for the topic "Using the Croatian HPC infrastructure", which interests 14 participants, followed by "Green computing" with 13 interested participants, and "EuroHPC" with 12. On the offer side, the results differ somewhat. Although the greatest interest was again expressed for "Using the Croatian HPC infrastructure", with 7 participants indicating willingness to offer it, only slightly less interest was shown for the topics "Introduction to MPI and OpenMP parallel programming models", "Training machine learning models on supercomputers", and "HPC in modelling and simulation", each with 6 interested participants. Additionally, the topics "Parallel algorithms", "Parallel libraries", and "Performance engineering and co-design" each attracted 5 interested participants.

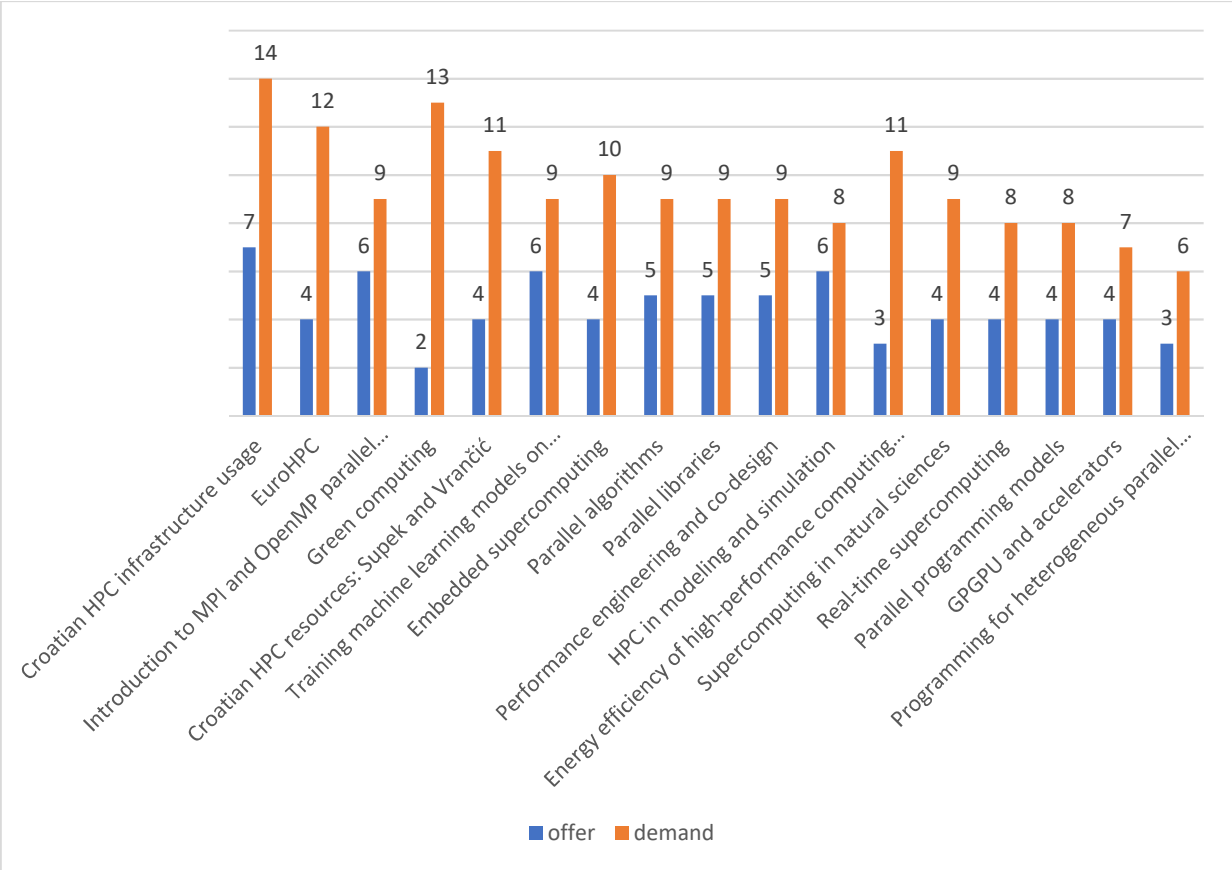

Figure 3.5. *Graphical representation of offer and demand of educational activities by specific topics in the field of High Performance Computing*

In the section intended for independently proposing more specific topics within this field that were not covered in the previous questions, no new suggestions were submitted.

3.5. Overview of offer and demand of educational activities by specific topics in the field of High Performance Data Analysis

The data on offer and demand for topics in the field of High Performance Data Analysis are presented in Table 3.4.

Table 3.4. *Overview of offer and demand of educational activities by specific topics in the field of High Performance Data Analysis*

High Performance Data Analysis	offer	demand	Σ
Big data analysis and data stream processing	8	14	22
Croatian Scientific and Educational Cloud HR-ZOO	3	13	16
Computational fluid dynamics	4	9	13
HPDA for fraud and anomaly detection	4	15	19
HPDA co-processors and accelerators	1	10	11
HPDA in biomedical sciences	1	7	8
Introduction to Big data	6	15	21
Cloud computing	6	14	20
Real-time data stream processing	4	13	17
Computational chemistry	2	6	8
Solving large-scale problems on supercomputers	4	9	13
Meteorological analytics and climate change simulations	1	6	7
Quantum computer simulators	0	13	13
Numerical modeling of rigid and solid bodies	2	7	9
Quantum computing	1	10	11

According to the chart in Figure 3.6, cumulatively, the most interesting topics are “Big data analysis and stream processing” with 22 interested participants, “Introduction to Big data” with 21 interested participants, and “Cloud computing” with 20 interested participants.

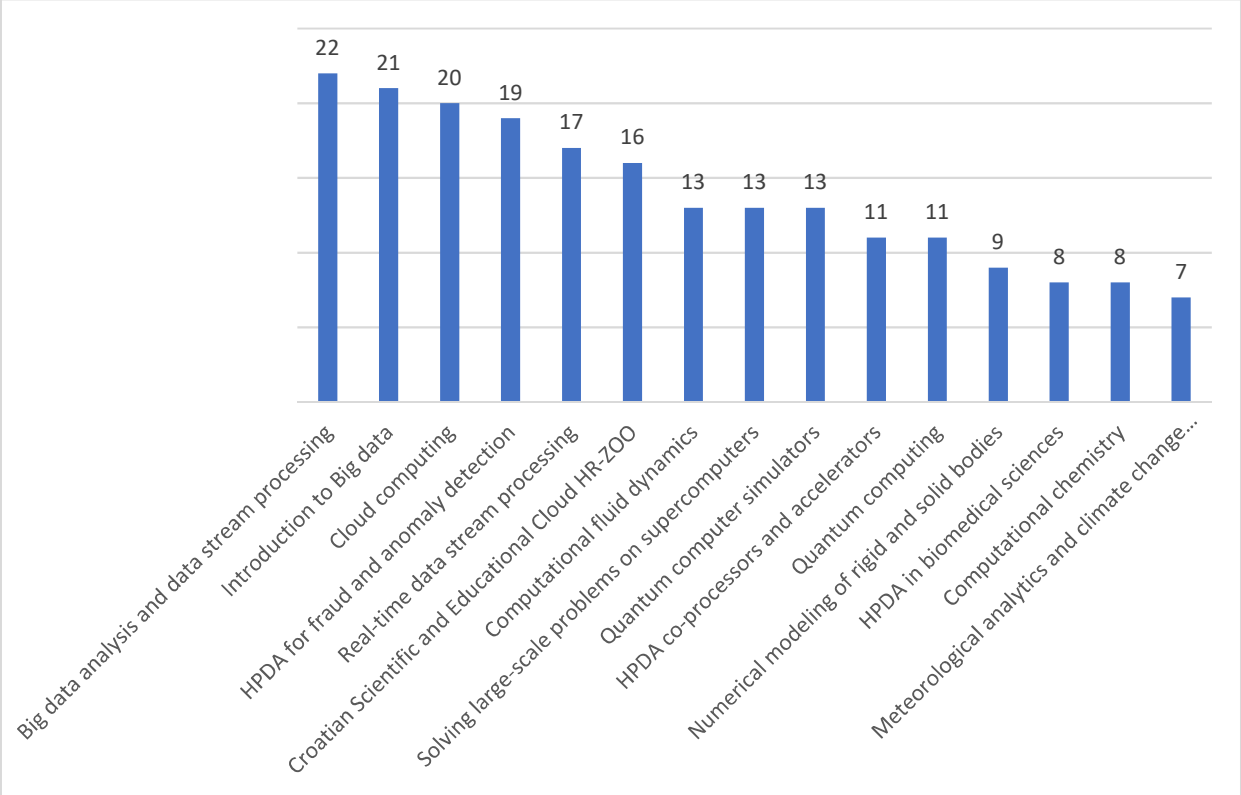

Figure 3.6. *Cumulative graphical representation of offer and demand of educational activities by specific topics in the field of High Performance Data Analysis*

The chart in Figure 3.7 illustrates individual topics by offer and demand. It is evident that the highest demand is for topics “Introduction to Big data” and “HPDA for fraud and anomaly detection”, each with 15 interested participants; followed by “Big data analysis and data stream processing” and “Cloud computing”, each with 14 participants; and then “Real-time data stream processing”, “Croatian Scientific and Educational Cloud HR-ZOO”, and “Quantum computer simulators”, each with 13 participants. This generally aligns with the cumulative results, as was also the case for the High Performance Computing field. Unlike that field, however, this one shows a greater alignment in the offer of educational activities as well: “Big data analysis and data stream processing” (8 participants), “Introduction to Big data” and “Cloud computing” (6 participants each), and “HPDA for fraud and anomaly detection”, “Real-time data stream processing”, “Computational fluid dynamics”, and “Solving large-scale problems on supercomputers” (4 participants each).

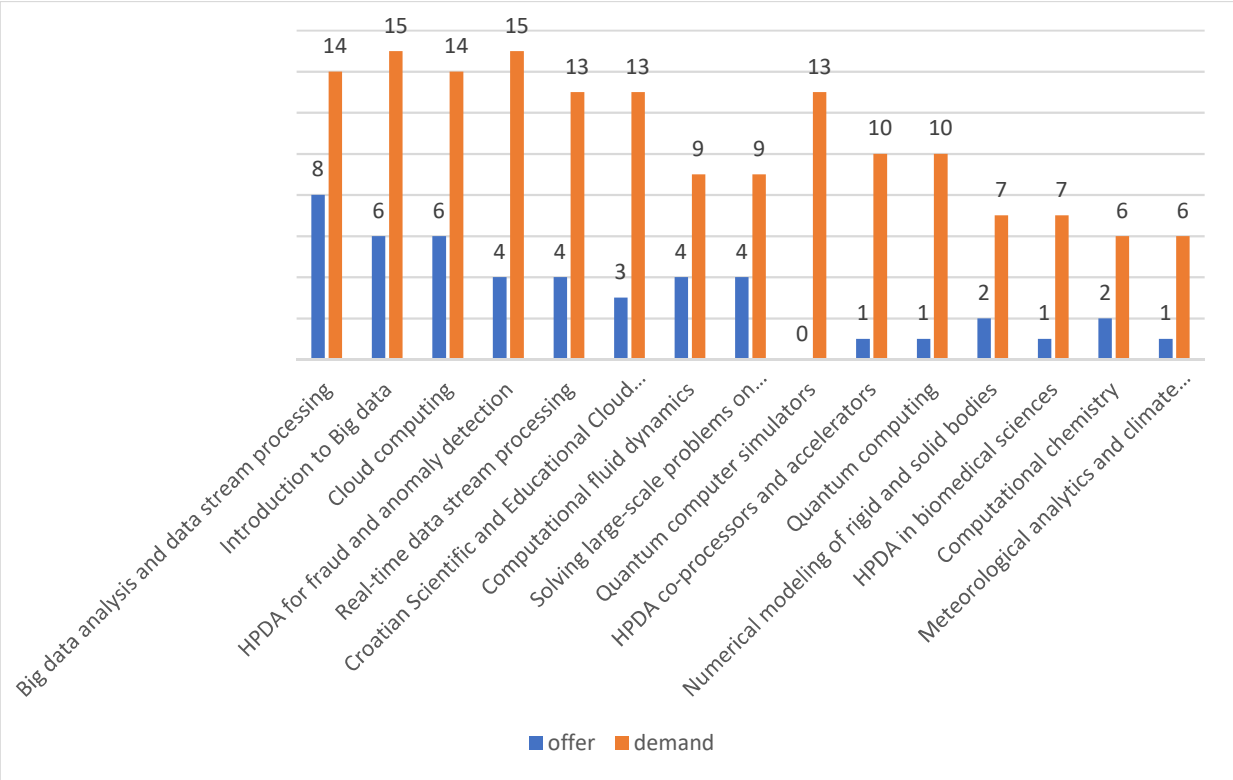

Figure 3.7. *Graphical representation of offer and demand of educational activities by specific topics in the field of High Performance Data Analysis*

In the section intended for independently proposing more specific topics within this field that were not covered in the previous questions, no new suggestions were submitted.

3.6. Overview of offer and demand of educational activities by specific topics in the field of Artificial Intelligence

The data on offer and demand for topics in the field of Artificial Intelligence are presented in Table 3.5.

Table 3.5. *Overview of offer and demand of educational activities by specific topics in the field of Artificial Intelligence*

Artificial Intelligence	offer	demand	Σ
Deep learning frameworks	14	22	36
Feature extraction from multidimensional data	12	17	29
Bias in machine learning models	8	17	25
Learning from imbalanced data	8	18	26
Multi-label classification	9	17	26
Data clustering with complex patterns	8	16	24
Deep learning for image analysis	8	17	25
Machine learning for autonomous vehicles	2	15	17
Elements of artificial intelligence	11	23	34
Modern programming languages as tools in data science and machine learning	8	20	28
Data preparation and handling	12	23	35
Large language models	9	22	31
Natural language processing	7	15	22
Traffic system analysis and management in near-real-time using machine learning	3	15	18
Mission-critical AI-based services	2	16	18
AI-based monitoring, management, and maintenance of industrial facilities	3	19	22
Artificial intelligence in augmented reality and access management	3	13	16

Ethical issues and regulations in the application of artificial intelligence	6	22	28
Security in AI-based systems	9	21	30
Development of Retrieval-Augmented Generation (RAG) applications	5	12	17
Co-pilots	3	22	25

From the chart in Figure 3.8, it is evident that cumulatively, participants in the survey are most interested in the topic of "Deep learning frameworks" (36 participants), followed by "Data preparation and handling" (35 participants), and "Elements of artificial intelligence" (34 participants).

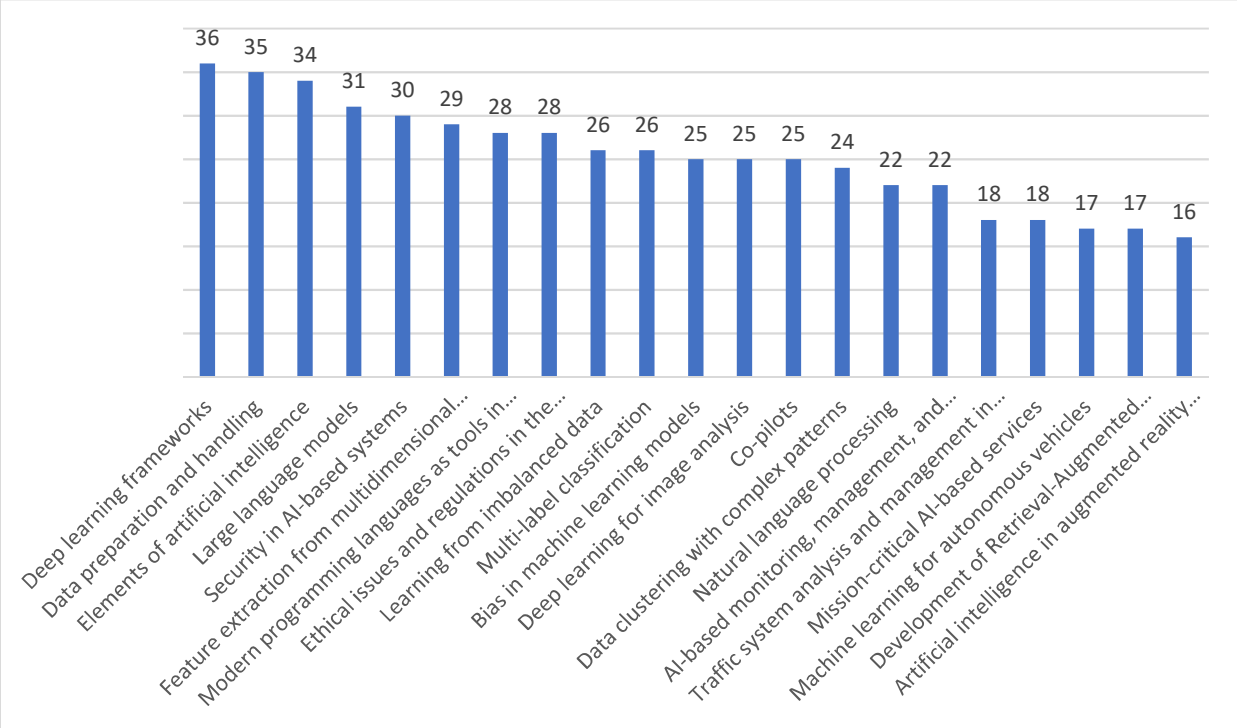

Figure 3.8. *Cumulative graphical representation of offer and demand of educational activities by specific topics in the field of Artificial Intelligence*

When it comes to the offer and demand of educational activities, from the chart in Figure 3.9, it is evident that the highest number of participants are seeking educational activities on the topics "Data preparation and handling" and "Elements of artificial intelligence" (23 participants each), followed by "Deep learning frameworks", "Large language models", "Ethical issues and regulations in the application of artificial intelligence", and "Copilots" (22 participants each), and the topic "Security in AI-based systems" (21 participants). On the other hand, the highest offer is

for the topic “Deep learning frameworks” (14 participants), followed by “Data preparation and handling” and “Feature extraction from multidimensional data” (12 participants each), as well as “Elements of artificial intelligence” (11 participants).

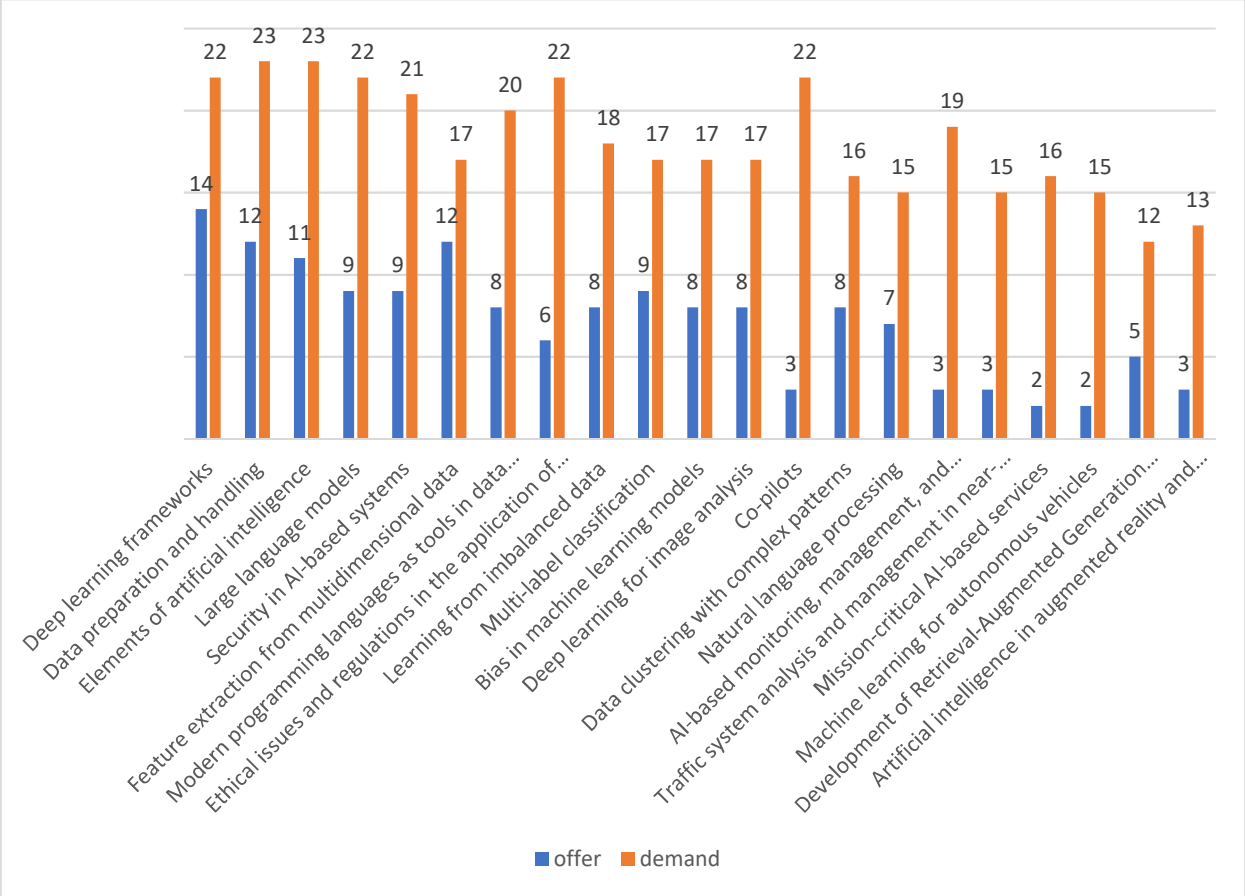

Figure 3.9. *Graphical representation of offer and demand of educational activities by specific topics in the field of Artificial Intelligence*

As additional topics in this area that would interest them, some participants suggested Deepfake, the process of selecting the best machine learning model for a given task and dataset, and deploying artificial intelligence models into production, in the sense of writing backend code that enables access to the AI model via an API, including the basics of containerization using Docker and deploying Docker containers to the cloud.

3.7. Summary overview of offer and demand of educational activities by specific topics

In Table 3.6, cumulative data on the offer and demand of educational activities for all three researched fields are presented, sorted by cumulative offer and demand.

Table 3.6. *Cumulative overview of offer and demand of educational activities by specific topics*

	offer	demand	Σ	field
Deep learning frameworks	14	22	36	Artificial Intelligence
Data preparation and handling	12	23	35	Artificial Intelligence
Elements of artificial intelligence	11	23	34	Artificial Intelligence
Large language models	9	22	31	Artificial Intelligence
Security in AI-based systems	9	21	30	Artificial Intelligence
Feature extraction from multidimensional data	12	17	29	Artificial Intelligence
Ethical issues and regulations in the application of artificial intelligence	6	22	28	Artificial Intelligence
Modern programming languages as tools in data science and machine learning	8	20	28	Artificial Intelligence
Learning from imbalanced data	8	18	26	Artificial Intelligence
Multi-label classification	9	17	26	Artificial Intelligence
Co-pilots	3	22	25	Artificial Intelligence
Bias in machine learning models	8	17	25	Artificial Intelligence
Deep learning for image analysis	8	17	25	Artificial Intelligence
Data clustering with complex patterns	8	16	24	Artificial Intelligence
AI-based monitoring, management, and maintenance of industrial facilities	3	19	22	Artificial Intelligence
Natural language processing	7	15	22	Artificial Intelligence
Big data analysis and data stream processing	8	14	22	High Performance Data Analysis

Introduction to Big data	6	15	21	High Performance Data Analysis
Croatian HPC infrastructure usage	7	14	21	High Performance Computing
Cloud computing	6	14	20	High Performance Data Analysis
HPDA for fraud and anomaly detection	4	15	19	High Performance Data Analysis
Mission-critical AI-based services	2	16	18	Artificial Intelligence
Traffic system analysis and management in near-real-time using machine learning	3	15	18	Artificial Intelligence
Machine learning for autonomous vehicles	2	15	17	Artificial Intelligence
Real-time data stream processing	4	13	17	High Performance Data Analysis
Development of Retrieval-Augmented Generation (RAG) applications	5	12	17	Artificial Intelligence
Croatian Scientific and Educational Cloud HR-ZOO	3	13	16	High Performance Data Analysis
Artificial intelligence in augmented reality and access management	3	13	16	Artificial Intelligence
EuroHPC	4	12	16	High Performance Computing
Green computing	2	13	15	High Performance Computing
Croatian HPC resources: Supek and Vrančić	4	11	15	High Performance Computing
Introduction to MPI and OpenMP parallel programming models	6	9	15	High Performance Computing
Training machine learning models on supercomputers	6	9	15	High Performance Computing
Energy efficiency of high-performance computing systems	3	11	14	High Performance Computing
Embedded supercomputing	4	10	14	High Performance Computing
Parallel algorithms	5	9	14	High Performance Computing
Parallel libraries	5	9	14	High Performance Computing
Performance engineering and co-design	5	9	14	High Performance Computing
HPC in modeling and simulation	6	8	14	High Performance Computing
Quantum computer simulators	0	13	13	High Performance Data Analysis

Supercomputing in natural sciences	4	9	13	High Performance Computing
Computational fluid dynamics	4	9	13	High Performance Data Analysis
Solving large-scale problems on supercomputers	4	9	13	High Performance Data Analysis
Real-time supercomputing	4	8	12	High Performance Computing
Parallel programming models	4	8	12	High Performance Computing
HPDA co-processors and accelerators	1	10	11	High Performance Data Analysis
Quantum computing	1	10	11	High Performance Data Analysis
GPGPU and accelerators	4	7	11	High Performance Computing
Numerical modeling of rigid and solid bodies	2	7	9	High Performance Data Analysis
Programming for heterogeneous parallel architectures	3	6	9	High Performance Computing
HPDA in biomedical sciences	1	7	8	High Performance Data Analysis
Computational chemistry	2	6	8	High Performance Data Analysis
Meteorological analytics and climate change simulations	1	6	7	High Performance Data Analysis

On the chart in Figure 3.10, which visualizes individual offer and demand, it is evident that the most in-demand topics are “Elements of artificial intelligence” and “Data preparation and handling” (23 participants each), followed by “Copilots”, “Ethical issues and regulations in the application of artificial intelligence”, “Large language models”, and “Deep learning frameworks” (22 participants each), as well as “Security in AI-based systems” (21 participants). On the other hand, the highest offer is for the topics “Deep learning frameworks” (14 participants), “Data preparation and handling” and “Feature extraction from multidimensional data” (12 participants each), and “Elements of artificial intelligence” (11 participants).

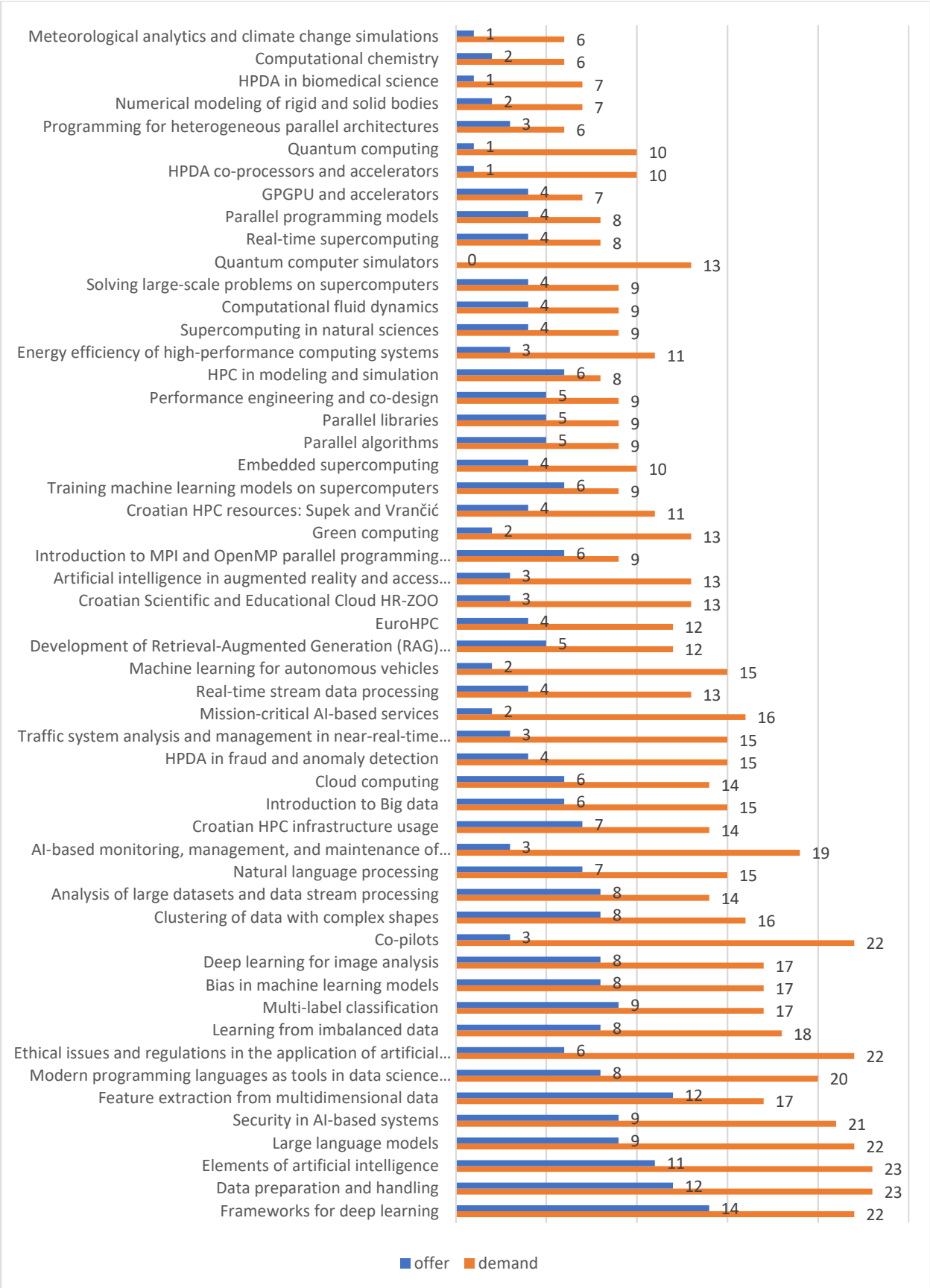

Figure 3.10. *Graphical representation of offer and demand of educational activities by specific topics*

4. CONCLUSION

The survey was conducted with the aim of identifying the need and opportunities for training and education in the fields of High Performance Computing (HPC), High Performance Data Analytics, and Artificial Intelligence (AI), based on previously identified competencies and needs in these fields among small and medium-sized industry, large industry, educational and research institutions, and public institutions. The largest share of participants, 37%, came from educational and research institutions, followed by 26% from small and medium-sized industry, 23% from public institutions, and 14% from large industry. Survey results generally show a greater demand for educational activities than offered, highlighting the importance and significance of the Croatian Center of Competence for HPC in organizing training activities, primarily for the needs of educational and research institutions and industry. While industry can offer training in some fields, its entities predominantly seek educational opportunities. Public institutions, on the other hand, generally do not offer such activities, but have shown significant demand relative to their participation in the survey. Overall, the greatest interest is in the field of Artificial Intelligence, where the most in-demand topics are “Data preparation and handling”, “Elements of artificial intelligence”, “Deep learning frameworks”, “Large language models”, “Ethical issues and regulations in the application of artificial intelligence”, “Copilots”, and “Security in AI-based systems”. In addition to the high level of interest in all other topics within this field, participants also proposed additional topics not included in the survey questions, such as Deepfake and the process of selecting the best machine learning model. In the field of High Performance Data Analytics, the most in-demand topics are “Introduction to Big data”, “HPDA for fraud and anomaly detection”, “Big data analysis and data stream processing”, and “Cloud computing”. The third most in-demand field is High Performance Computing, where participants are primarily interested in education on Croatian and European HPC infrastructures and resources (e.g. “Croatian HPC infrastructure usage”, “Croatian HPC resources: Supek and Vrančić”, “EuroHPC”), as well as “Green computing” and “Energy efficiency of high-performance computing systems”. Across all fields, there are topics of interest where educational activities are not adequately offered. These include, for example, “Quantum computer simulators”, “Quantum computing”, “Copilots”, and similar. For most topics, educational and training activities can be carried out at educational and research institutions in collaboration with industry, while for others, such as “Quantum computing”, these activities these activities may need to be conducted in collaboration with national centers of competence and centers of excellence outside Croatia. In

accordance with the expressed interest, particular attention will also be given to activities related to the development and application of “Large language models”.