

Empowering Underrepresented Communities Through Julia

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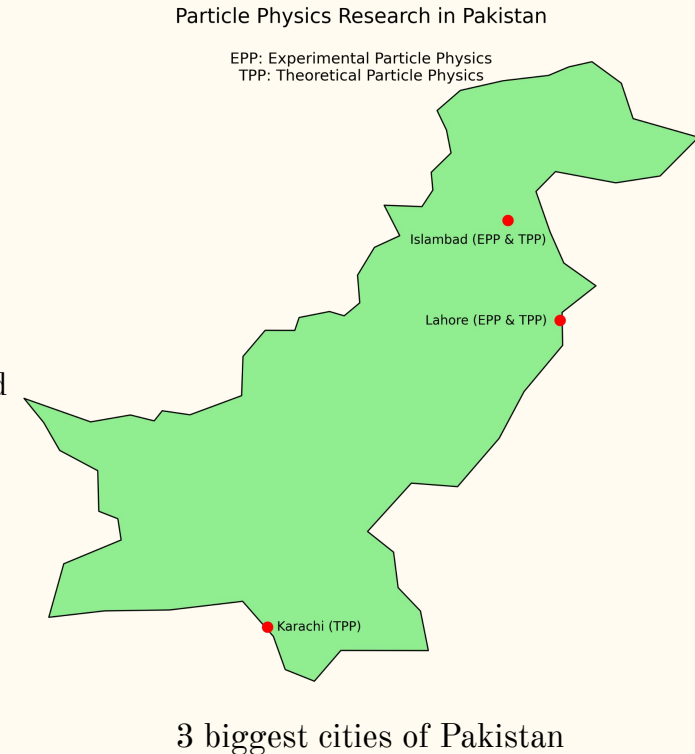
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JuliaHep 2024 Workshop, CERN

1st October 2024

Experimental Particle Physics in Karachi

- **Karachi: One of Pakistan's Largest Cities**
 - Significant urban population and academic institutions.
- **Lack of EPP Research in Karachi Universities**
 - No active Experimental Particle Physics (EPP) research in local institutions.
- **Knowledge Gap Among Students**
 - Students in Karachi are less aware of ongoing EPP research compared to students in Lahore and Islamabad.
 - Possible contributing factors: Lack of strong research linkages among intra-cities, Long distances between universities and research centers from Karachi to Islamabad and Lahore
- **Research Focus in Karachi**
 - Current research in Karachi predominantly focuses on Nanophysics, Molecular Physics, Medical Physics, TPP



Workshop

A workshop arranged to give a flavour of Experimental Particle Physics at the LHC and Julia language

- Arranged at NED University, Karachi (Pakistan)
- No of Participants: 15
- Study year of Participants: 2nd-4th Year of BS Physics

It's the first-ever workshop on Julia programming in Pakistan

Zeta Science Forum | **julia**

HANDS-ON JULIA HEP WORKSHOP

DATE: 27TH SEP FRIDAY

REGISTER HERE

E-PARTICIPATION CERTIFICATES WILL BE AWARDED TO ALL ATTENDEES (LIMITED SEATS AVAILABLE)

TALKS

SESSION 1 **HIGGS BOSON AND THE FATE OF OUR UNIVERSE**
SPEAKER: **DR SHABBAR RAZA** at 9:30AM - 10:00AM
Associate Professor, FUUST, Karachi
Post Doctoral Fellow, Kavli Institute of Theoretical Physics, China

SESSION 2 **INTRODUCTION TO CMS EXPERIMENT**
SPEAKER: **M. ANSAR IOBAL** at 10:00AM - 10:40AM
Post Doctoral Fellow, University of California Los Angeles (UCLA), US

WORKSHOP

SESSION 3 **INTRO TO JULIA PROGRAMMING** at 11:00AM - 11:20AM

SESSION 4 **JULIA PROGRAMMING (HANDS-ON WORKSHOP)** at 11:20AM - 12:20PM

SESSION 5 **JULIA PROGRAMMING IN HEP (HANDS-ON WORKSHOP)** at 12:20PM - 01:00PM

INSTRUCTORS:

SHAFIQ UR REHMAN
MS Physics (On-going), NED University

ALI ASGHAR
MSc-Physics (On-going), University of Karachi

SHAHZAIB ABBAS
MSc-Physics (On-going), University of Karachi

VISIT: [HTTPS://INDICO.CERN.CH/EVENT/1459588/OVERVIEW](https://indico.cern.ch/event/1459588/overview) OR SCAN QR CODE

FOR MORE INFORMATION: shahzaibabbas2001@gmail.com **LOCATION:** PHYSICS DEPARTMENT, NED UNIVERSITY, KARACHI

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Workshop - Selection of students

We selected 15 students, with a focus on underrepresented communities (such as women, racialized groups, and other minorities), with the following goals:

- To encourage them to pursue higher education, ultimately empowering their communities in the future.
- To introduce them to Physics at the Large Hadron Collider (LHC) to spark interest in further studies and/or a career in Experimental Particle Physics (EPP).
- To provide insight into how various physics analyses are conducted at CERN and highlight the critical role of programming in these processes.
- To familiarize them with Julia programming and its high performance, enabling them to use it in their current or future research for maximum efficiency.

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Workshop

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- **Three talks:**
 - **Introduction to Particle Physics** - Dr. Shabbar Raza (Associate Professor at FUUAST, Pakistan)
 - **Introduction to CMS Experiment** - Dr. Muhammad Ansar Iqbal (Postdoctoral fellow at UCLA, USA)
 - **Introduction to Julia** - Shafiq Ur Rehman (Instructor at Aligarh Institute of Technology)
- **Two Tutorials**
 - Basics of Julia Programming
 - Short tutorial of Julia Programming in High Energy Physics



The poster is for the 'Julia HEP Workshop' held on September 27th, Friday. It features a dark blue background with particle physics imagery like particle tracks and detectors. Logos for Zeta Science Forum, Julia, and the University of California are present. A QR code is provided for registration. The workshop is divided into three sessions: Session 1 (Higgs boson), Session 2 (CMS experiment), and Session 3 (Julia programming). Sessions 4 and 5 are hands-on workshops for Julia programming. Instructors listed are Shafiq Ur Rehman, Ali Asghar, and Shahzaib Abbas. Contact information and location (Physics Department, NED University, Karachi) are provided at the bottom.

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Workshop - Tutorials

The tutorials on Julia Programming and its applications in High Energy Physics (HEP) were presented by Ali and me, both master's students at the University of Karachi with a strong passion for HEP.

- We are self-taught in Julia Programming and, through various tutorials (referenced in the following slides),
- We explored how to use Julia as a tool for HEP research.

The tutorials were conducted using Google Colab

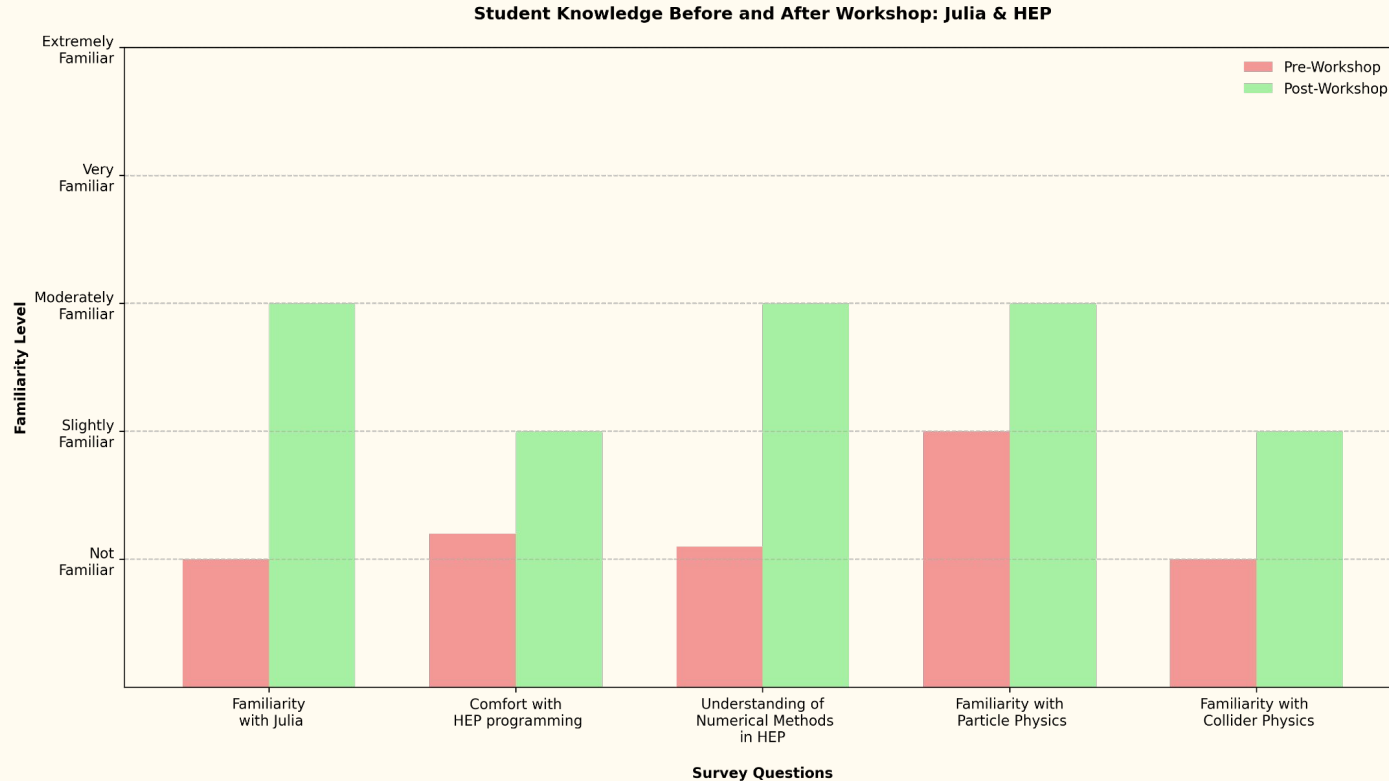
- We utilized a [template](#) to run Julia.
- We provided participants with self-guided Jupyter notebooks that covered the basic syntax of Julia and the simulation of Higgs boson decay channels.

```
1 using Random
2
3 # Define the decay channels and their probabilities
4 decay_channels = Dict{
5   "bb" => 0.60,
6   "cc" => 0.03,
7   "tt" => 0.06,
8   "Wb" => 0.19,
9   "ZZ" => 0.12
10 }
11
12 # Ensure the probabilities sum to 1 with a tolerance
13 total_probability = sum(values(decay_channels))
14 tolerance = 1e-10 # Define a small tolerance
15
16 # Missing line(s): Complete the probability validation check
17 if abs(total_probability - 1.0) > tolerance
18   # Complete this line to handle the error
19 end
20
21 # Function to simulate a Higgs boson decay
22 function decay_higgs()
23   rand_value = rand()
24   cumulative_probability = 0.0
25
26   for (channel, probability) in decay_channels
27     cumulative_probability += probability
28     if rand_value < cumulative_probability
29       return channel
30     end
31   end
32
33   return "Invalid Decay" # This should never be reached
34 end
35
36 # Simulate multiple Higgs boson decays
37 num_decays = 100000
38 results = Dict{channel => 0 for channel in keys(decay_channels)}
39
40 for _ in 1:num_decays
41   decay_channel = decay_higgs()
42   results[decay_channel] += 1
43 end
44
45 # Print the results
46 println("Decay Channel Results after $num_decays decays:")
47 for (channel, count) in results
48   percentage = count / num_decays * 100
49   println("$channel: $count ($round{percentage, digits=2})%")
50 end
```

Reference Material used for the tutorials

- [UnROOT Tutorial · HSF Julia Tutorial](#)
- [Julia Documentation · The Julia Language](#)
- [Potential of the Julia Programming Language for High Energy Physics Computing - INSPIRE \(inspirehep.net\)](#)
- [Performance of Julia for High Energy Physics Analyses - INSPIRE \(inspirehep.net\)](#)

Survey from the students



Some Images of Workshop



Conclusion

- Julia programming boosts STEM access for underrepresented communities.
- Integrating Julia with CMS Open Data engages students in particle physics and STEM.
- Diverse expert speakers enhance learning and networking.
- The workshop fosters community, inspiring collaboration in particle physics and coding.



Seeking short
research opportunities

Here's my [CV](#)

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Acknowledgement

We extend our gratitude to the Department of Physics, NED University, for giving us the opportunity to organize this workshop. We are also thankful to the contributors who made Julia-related resources easily accessible online, and to the speakers who enriched the event with their knowledge. Lastly, we would like to thank Hamza Hanif (PhD Candidate , Simon Fraser University) for his mentorship and guidance.