Experiences at an PhD interview at IISc Bangalore

by Neeraj Singh Bhauryal - Friday, July 25, 2014

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This is the record of my interview at IISc Bangalore for Integrated PhD program in Mathematics which took place on 28th May. So I was called at 2pm there and since I was 10th on the list my turn came at 6pm , I was little nervous and excited too. So the panel comprised of 5 Professors Prof Gautam Bharali , Prof Basudeb Datta, Prof E.K Narayan, Prof Dilip Patil, Prof Pooja Singla

Prof N- Welcome Neeraj , how do you pronounce your last name?

I- Sir it's Bhawwr-yaal.

Prof G.B- So Neeraj you completed your BSc last year and we don't have any record of yours from last year of what you've been doing, so would you please tell about that?

I- Sir currently I'm enrolled in Int-PhD program at IISER Mohali and I've just finished 1st year of M.S there.

Prof B-So why do you want to leave there?

I- Sir I'm interested in Analysis and I think that IISc Bangalore is the best option for me.

Prof G.B - So what courses have you done there?

I- Sir I'm not comfortable with the courses I've done.

Prof G.B- I think I just asked you a simple question?

I-(named all the courses from 1st year)

Prof G.B- So what are you really interested in?

I- Analysis.

(Profs started discussing amongst themselves on which topic to start, and finally decided to start Analysis itself)

Prof G.B - I think you must have seen it before but still can you tell whether the series $ sum frac{1}{nln n}$ converges or not?

I- (I knew the general result that for $ p>1$ the series $ sum frac{1}{n(ln n)^p}$ converges) Sir it will diverge using integral test (Then I showed that it satisfies all hypothesis required and thus divergent)

Prof G.B- Can you prove the Integral test? Just give me the idea how it's done.

I- (Luckily I had done its proof while preparing for TIFR's interview, drew the diagram and explained the details roughly)

Prof G.B- very good.

(This made me more confident)

(Then they were discussing amongst themselves on which topic shall they ask next, then they decided to come back on Analysis after sometime and started Group Theory)

Prof P- Can you write some groups?

I- (I got careful not to write any group which can get me in trouble as I knew next they are going to make out problems from them, wrote $ (mathbb{R},+), (mathbb{Q}setminus{0}, .), (mathbb{Z},+))$

Prof P- You wrote all abelian groups , write some non-abelian groups!

I-(For 10 secs I couldn't remember any non-abelian group, thoughts were coming in my mind like paani main doob mar beta IISc ka interview hai aur non-abelian groups ni pata!), then wrote $ S_n,D_n$.

Prof P- Okay so is $ (mathbb{Q}setminus{0}, .)$ cyclic?

I-(thought for a while) It won't be cyclic since it has exactly two elements $ 1,-1$ of finite order while $ (mathbb{Z},+)$ have only one element of finite order so that they both can't be isomorphic.

Prof B- Okay then is $ (mathbb{Q}^{+}, .)$(group of positive rationals wrt multiplication) cyclic?

I- (thought for a while) it can't have generator of the type $ frac{1}{q}$ for any $ q in mathbb{Q}$ since then it won't generate elements of the type $ frac{p}{q}$.

Prof B- So you mean $ (mathbb{Q}^{+}, .)$is not generated by $ frac{1}{q}$ but it may have generator of the type $ frac{p}{q}$.

I- Then it won't be able to generate elements of the type $ frac{1}{q}$

Prof P- Okay, can you give finite proper subgroup of $ (mathbb{Q}^{+}, .)$?

I- There won't be any since any non identity element in the group will have infinite order and so cyclic group generated by that element won't fit inside the finite subgroup.

Prof G.B- (smiles) But isn't there always a finite subgroup for any group?

I- Yes sir the identity group!

Prof P- And what about $ (mathbb{R}^{+}, .)$?

I- Mam, same reason as above , it won't have any finite subgroups except the identity group.

Prof P- Is $ (mathbb{R}^{+}, .)$ and $ (mathbb{R}, +)$ isomorphic?

I- Yes , the exponential map will work.

Prop B-Let's come back to Analysis now, can you give a continuous onto map between $ (0,1)$ and $ (-1,1)$?

I- yes, $ f(x)= sin 2pi x$ will work.

(They agreed with that and were discussing that the thing they wanted to ask next will not work now!)

(Suddenly)

Prop N- What's the value of $ f(frac{1}{4})$

I- 1

Prof N- So this example wont's work since 1 is not in the co-domain.

I-(then I just drew the line joining the points $ (0,-1)$ and $ (1,1)$).

Prof B- Write down the function.

I- $ f(x)=2x-1$

Prof B- So you're first stretching the interval and then pushing it back.

I- yes sir (this idea came in my mind initially but I was not getting the function and then wrote $ f(x)=sin 2pi x$)

Prof B- Now can you give an example of continuous onto function from $ [0,1)$ to $ (-1,1)$

I- (I tried to find some function explicitly for few minutes but failed) Sir can I draw?

Prof B- yes you can , otherwise it is tough to write down the formula.

(I was drawing something inside the rectangle $ x=0,x=1,y=-1,y=1$, but was not able to draw the required one)

Prof B-At least start somewhere at $ x=0$.

I- So finally I drew a function starting from $ (0,0)$ and monotone function like $ sin x$ which is increasing its magnitude steadily as x increases and tending to touch both +1,-1 but actually not touching them.

(Post interview my friend Soutrik gave an example $ f(x)= x^2sin frac{1}{1-x}$ which really works , the similar graph I had drawn)

Prof B- So now can you prove that this type of function cannot be one-one?

I-(After thinking for sometime) Sir if this function is one-one then since it is continuous it will be strictly monotone and thus wherever we start at $ x=0, f(x)$ won't able to take values below $ f(0)$ and so it cannot be onto,but this is a contradiction since $ f$ is given onto!

Prof B- Okay but for that you need to prove that one-one continuous function must be strictly monotone.

I-(I did this theorem day before interview, but I was not much confident whether I remember that one!) yes sir I can prove that.

Prof B- Okay the same idea in that prove works here also so try to use that idea.

(After some time he gave me a hint that use 'Intermediate Value Property')

I-(I was getting closer but not to the point)

Prof B- what if $ f(0)=0$?

I- (then I realised how it has to be done) okay so since it is onto it will take both positive and negative values and so $ exists cneq 0$ st $ f(c)=0$, so that $ f$ is not one-one and similar it can be done for any value of $ f(0)$.

Prof B - Yes!

Prof N- Let $ f(x):S^{1}to mathbb{R}$ be continuous function ,prove that it can't be one-one or precisely prove that $ exists xin S^{1} $ such that $ f(x)=f(-x)$

I- (I had no idea for this one)

Prof N- I hope you've done some topology?

I- Yes sir.

(After a while)

Prof N- let me give you a hint, consider the function $ g(x)=f(x)-f(-x)$

I- (still not getting anything!) Sir , I think we'll have to make use of Intermediate value property.

Prof G.B- IVP is valid for intervals not for $ S^{1}$!

I- (Thought for a while but was not getting anything)

Prof G.B- Okay Neeraj , I think you can do this problem later on.

I - Thank you sir.

So my interview went for around 50 mins and I think questions were not quite tough. I got to know after few days that I've not qualified the interview, I think I was not quick at many places which made them doubt on me and the last one I couldn't do which made a bad impression before leaving. But it was fun to be at IISc where I stayed for 3 days thanks to Amar bhaiya , the campus is really beautiful and I really recommend IISc to everyone who's interest area is Analysis as it has the best faculty in the country.

[Neeraj is now an Integrated PhD student at the Centre for Applicable Mathematics, TIFR,

Bangalore.]

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