

Chapter 7.2 - 2D and 3D Plotting

10 MIN · YOUTUBE · [HTTPS://WWW.YOUTUBE.COM/WATCH?V=H0L3-TSBGKM](https://www.youtube.com/watch?v=H0L3-TSBGKM)

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SUMMARY

The lecture focuses on advanced techniques for 2D and 3D plotting, emphasizing improved visualization methods for complex data representations. It highlights the importance of combining surface and contour plots, adjusting transparency, and using iso-surfaces to convey richer information in visualizations.

- *Advanced visualization techniques enhance data representation beyond basic plotting.*
- *Combining surface and contour plots provides a clearer understanding of data structures.*
- *Lifting plots in the Z-axis allows for better visibility of underlying data.*
- *Adjusting transparency (alpha) can reveal more information without overwhelming the viewer.*
- *Iso-surfaces are effective for visualizing functions in three dimensions, especially for complex data like fluid flows.*
- *MATLAB offers better tools for 3D plotting compared to standard Python libraries, which may require additional packages for advanced visualizations.*
- *Slicing techniques can be used to visualize 4D data by examining cross-sections of iso-surfaces.*

We're now going to talk about a little bit more advanced 2D and 3D plotting schemes. I showed you some of the basics in the last lecture, just how to set up some basic structure, set up the the way to label X and Y axes, height, put legends on, annotate, so forth. But I want to also show you some more advanced tricks that you can do to improve your visualization capabilities. So one of the ones I examples I gave last time was for instance a little spiral wave and I gave lots of different ways to visualize it. So what I want to show here is a little bit more advanced techniques for doing a much better job of visualization. So let's start off here with a visualization I constructed which is that same spiral wave which has a combination of a surface and underneath it the contour. So you gain a lot of information. So if I look at this from 3D, I can kind of see this basic structure. But the nice thing about the contour is the contour also shows me the ampl where the constant amplitude solutions are or what their structure looks like. So you can clearly see the spiral wave here. But of course, if I didn't show you this, if I only showed you the contour, it also misses a lot of information here. So here, what I've done is combine them. But notice what I've also done in order for me to combine them because I actually showed this previously in the last lecture.

This thing was sitting right on top of the contour. So you couldn't really see the contour. So what I did is I lifted this entire plot up by two ZV values. But then I had to reabel the axis here. So now this is not really negative one, but it is negative one in my new coordinate system that I've lifted to. So you see what I've done here is I've completely redone in some sense this plot with only one goal which is to make it a little bit easier to represent the data with both combination contour and surface plot. And so that's kind of the idea behind this. The second one here is the same figure but now it's not quite clear you can see it on here but if you clone the repo you will see this. This is slightly transparent on top. So you can start to see through the spiral, underneath the spiral. And

what that gives you is just a richer representation of what that spiral looks like in visualizing this thing. And I've noticed here I've also overwritten all the X and Y labels, put some latte on here. so I've done a something that you might actually use to publish in a paper or a report. something a very nice graphical representation of this data completely fixed up in sort of a more professional way.

So how would I do this? Well, the way you would start doing this is you could start doing for instance the basic plotting here. So first of all I bring in here the the different plots. Here's the first plot 221 which is two rows two columns first plot going to be a rep a projection 3D and I just do a surface on a contour together. So that's what I'm doing here. And that's actually what I did previously from what I did. But notice what I did here with the surface, I lifted it by two. So in other words, instead of plotting the function, the function here being u , I plotted $u + 2$.

So it takes the entire function and adds two to it. So it's going to lift it upwards off of the bottom. The contour is always at the zero level set. In other words, at the value z equals the height being zero. And so the problem with it is this thing here would sit right on top of it. So by doing this, I've lifted everything up and I've created this artificial separation. But now since I've lifted it up by two, these axis labels are wrong. So I have to overwrite them. So notice what I'm doing here. I'm overwriting all the X, Y, and Z axis labels. So I go to each axis label. Notice what I did here. I have the axes and I override them with negative L or or put in what I would like here which is from negative L to L and and that that's kind of what I'm doing here and put in zero as well.

And then on the X ticks, notice that X ticks are 0 1 2 3, but I'm going to overwrite them to call to be the zero and the one or the zero is going to be have no axis. And then the negative I'm going to label it negative 1 01, which I do right here on this next line. And I even pick the font size to make it look good. And I even pick the view angle.

So all these are the things that I can do to make a figure much nicer than if you just simply use `con`, you know, surface. You're going to get a plot, but it's never going to be as nice as something like this. And so a lot of these techniques are just taking you to another level of being able to represent the solutions that you might have. So again, I encourage you to start thinking about these things because nice plots are make a great first impression and they also convey information much better than if you don't make nice plots.

Okay. Now in the second one, the only difference between these is this command right here. Alpha is 7. Alpha is a value between zero and one that can make it completely transparent or completely non-transparent. So between 0 and one is the level of transparency you might have. Here I picked it to be 7. So it's somewhat transparent but not fully transparent. If you make it fully transparent, it's too much information. You kind of want it to be sort of semi-transparent. And that's you can but you can always change this with this alpha parameter. So that's the only difference between these two is that this is solid. So I can't see inside that spiral wave. But up here I can see the rest of the spiral wave through this. And again, it's not clear it would show up unless you have a high quality YouTube video stream. But again, if you clone the repo and plot this, you'll see it pretty clearly. And as you change this alpha parameter, you can start playing around with that information.

Again, part of what you're doing here is just trying to make it easier for people to see what you're trying to show them. Give them the richest representation of the data possible. Okay? And this gives you options. How do we do this in 3D? 3D is even harder. So now in 3D we might have an XYZ direction. We're plotting a function XYZ. So there's that fourth dimension. What is the value of the function f in XYZ? And so one of the ways we can do this is through iso surfaces. And so these are surfaces of constant amplitude. So this is sort of an egg carton. So it's a bunch of essentially sinusoidal and x and y and z . And this is what it looked like in that ISO surface. Now in fairness, I actually did these plots in mat lab. The 3D iso surface capabilities of Python are actually still quite poor. There are some extra software you can download that is not in the standard matplotlib lib library to allow you to do these but because what's in mplot liib does not work very well for 3D iso surfaces. So I'm just showing you the kind of possibilities of things you could do.

But I'm showing at least the next set of plots are in mat lab and apologies for that. I wish Python had better pack packages out of the box for this. again you can find some on the internet where people have built some of these visualization tools. Some of them are free. some are not. but I'm just showing you then what I can do in mat lab. So you at least have an idea of how you would plot essentially a 4D function. Right? So it's a and that's how you would do it here with isoace.

You can do the same and this is this is sort of what this is the function that we're applying here. It's a cosine sorry in x y and z . So it's like egg carton type structure. It's on this domain here from -3 to 3. Okay. here it is with multiple iso surfaces. So in this one here it's the it's essentially the same same here. I'm just now in fact that's multiple but now I'm not color inverting. And I'm showing you what this would actually look like for instance out of mat lab directly. So you can see these different shells are ISO surfaces and you can kind of get a pretty good idea of what that surface is going to look like with this with this kind of command architecture or surface architectures of constant amplitude and isoaces are probably one of the best way to visual visualize this. So when you do for instance highdimensional fluid flows a lot of times people will visualize highdimensional fluid flows with isosurfaces of you know the constant value of velocities or something like this. So this is sort of a standard way to visualize in 3D.

You can also take that same iso surfaces and visualize it by cutting planes across it. So instead of visualizing the surfaces you just take certain planes that you would put across it. This is with a grid on it. This is without a grid on it. Again, this is done in mat lab using a sliver command. It's a way of visualizing different slices or actually I think it's a slices command. Slices will allow you to go through and plot different slices of of the of the of this essentially 4D object. Okay. so that is what you might want to do. And again once you get into visualization of truly 3D domains and so it's XYZ and a value in that domain you may want to move out of at least Python. There are different possibilities available to you that you can find ex extras on on the internet on but certainly if you do just do it with standard mat lab matplotlib lib you're you don't have a whole lot of good options there for yourself but this is always very important and package like parave view for instance is a professional package which allows you to do beautiful visualizations of 3D flows and so forth so but this again it's another package outside of the path Python framework, but there's not a whole lot of great 3D plotting package built into Matplotlib Lib. And so you're going to have to look elsewhere. You can find them, but you'll have to do some homework to find out what's best for your for your application.