Computing for mathematics handout 9 - Extracting solutions from outputs of solvers

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What you have learnt this week:

Some basic Sage code to solve differential equations:

- ODEs;
- Systems of ODEs;
- Numerical solutions of ODEs (for when they can't be solved exactly).

Extracting parts of an equation

In handout 7 we saw how to extract solutions to equations from the list output:

```
sols = solve(x ^ 2 − x − 1 == 0, x, solution_dict=True)
[d[x] for d in sols]
```

Another way to do this is to use .rhs():

```
sols = solve(x ^ 2 − x − 1 == 0, x)
[eq.rhs() for eq in sols]  # We are getting the right hand side of the solutions which are given
```

This extends to the solutions of differential equations.

```
t = var('t')
y = function('y', t)
x = function('x', t)
sols = desolve_system([diff(x, t) == 1 − y, diff(y, t) == 1 − x], [y,x])
```

If we take a look at sols, the output of desolve_system is a list containing x(t) = ... and y(t) = ...

To extract the solutions we use the rhs() method:

```
x(t) = sols[0].rhs()
y(t) = sols[1].rhs()
```

Now plotting these is straightforward:

```
p = plot(x, t, 0, 10, legend_label="$x(t)$")
p += plot(y, t, 0, 10, color='red', legend_label="$y(t)$")
p
```

NOTE THAT THE ABOVE FAILS TO PLOT! We need to include initial conditions so that x(t) does not contain x(0).

Numerical analysis

Certain equations and differential equations can't be solved or are very difficult to solve. In this case numerical solutions can still be found. This is what desolve_rk4 is for.

This is all part of a subject called Numerical Analysis.

Some applications of this include the solution of equations that describe how many people would be in a queue throughout a day across different hours of the day.

LaTeX

LaTeX is a language for typesetting (writing) documents.

- Go through the videos on the corresponding lab sheet.
- Take a look at my coursework template.
- There are various other templates available at https://www.writelatex.com/templates.

What you should do next:
- Work through LaTeX lab sheets.
- **Finish the coursework**
- Contribute to the wiki.
- If anything is still unclear **please** come and see me during office hours.