

# Computing for mathematics handout 8 - 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  $x(t) = \dots$  and  $y(t) = \dots$ .

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.