Math 174
Calculus II

Dr. Constant J. Goutziers
Department of Mathematics, Computer Science and Statistics
goutzicj@oneonta.edu

Lesson 2
Symbolic Computation

Initializations

```
> restart;
```

2.1 General Symbolic Computation

The real power of Maple lies in its symbolic capabilities. A computer algebra system allows the user to perform mathematical computations on the computer screen much like they used to be performed with pencil and paper. We now explore some of these symbolic features.

Examples

Example 2.1.1

Differentiation of Expressions.
Define the expression $e^{2x} \sin 7x$ and compute its first and second derivatives.

```
> expr:=exp(2*x)*sin(7*x);
```

$$expr := e^{2x} \sin(7x) \tag{2.1.1.1}$$

```
> der1:=diff(expr, x);
```

$$der1 := 2\, e^{2x} \sin(7x) + 7\, e^{2x} \cos(7x) \tag{2.1.1.2}$$

```
> der2:=diff(expr, x$2);
```

$$der2 := -45\, e^{2x} \sin(7x) + 28\, e^{2x} \cos(7x) \tag{2.1.1.3}$$

```
>
```

Example 2.1.2

Equation Solving.
We consider three very familiar problems.

Problem 1.
The quadratic equation.

```
> eq1:=a*x^2+b*x+c=0;
```

$$eq1 := a x^2 + b x + c = 0 \tag{2.1.2.1}$$

```
> sol1:=solve(eq1, x);
```

$$sol1 := -\frac{1}{2}\,\frac{b - \sqrt{b^2 - 4ac}}{a}, -\frac{1}{2}\,\frac{b + \sqrt{b^2 - 4ac}}{a} \tag{2.1.2.2}$$

```
>
```

Problem 2.
Simultaneous linear equations.

```
> eq2:={3*x-4*y=1, 5+x+7*y=-3};
```

$$eq2 := \{3x - 4y = 1, 5 + x + 7y = -3\} \quad (2.1.2.3)$$

```
> sol2:=solve(eq2, {x, y});
```

$$sol2 := \{y = -1, x = -1\} \quad (2.1.2.4)$$

```
>
```

Problem 3.
Numeric Solutions.

Most real life equations cannot be solved in closed form, but require numerical routines in stead. Maple's numeric equation solver is called **fsolve**. In this example we compute the points of intersection of the curves

$$y = \frac{x}{5} \quad \text{and} \quad y = \sin x$$

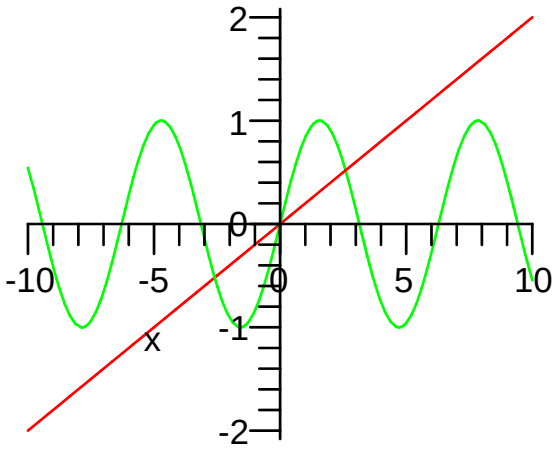
First we define the curves and make a sketch.

```
> c1:=x/5;
  c2:=sin(x);
```

$$c1 := \frac{1}{5}x$$

$$c2 := \sin(x) \quad (2.1.2.5)$$

```
> plot({c1, c2}, x=-10..10);
```



Clearly, $(0, 0)$ is a point of intersection and there are points of intersection on the intervals $(-4,-2)$ and $(2, 4)$.

```
> x1:=fsolve(c1=c2, x=-4..-2);
```

$$x1 := -2.595739080 \quad (2.1.2.6)$$

```
> x2:=fsolve(c1=c2, x=2..4);
```

$$x2 := 2.595739080 \quad (2.1.2.7)$$

```
>
```

We use the **subs** command to obtain the corresponding points of intersection in (x, y) format..

```
> P1:=subs(x=x1, [x, c1]);
```

$$P1 := [-2.595739080, -.5191478160] \tag{2.1.2.8}$$

```
> P2:=subs(x=x2, [x, c1]);
```

$$P2 := [2.595739080, 0.5191478160] \tag{2.1.2.9}$$

```
>
```