

## Calculus III

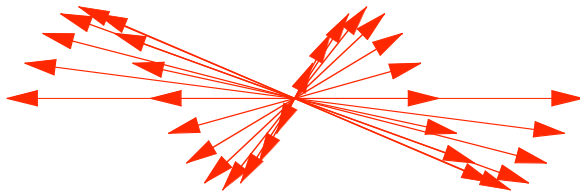
### Lab #2: Vector-valued functions

- For this lab we will need the package `Arrow` in order to represent vectors.

```
Needs["Graphics`Arrow`"]
```

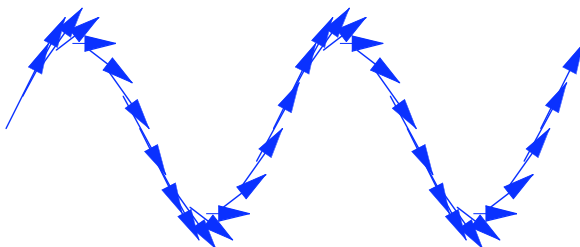
- This package will load the `Graphics` package needed to draw arrow vectors. Note that the single quotes around `Arrow` are under the tilde (`~`) key. This package should be run only once per session at the beginning of the session.
- Let's define a vector-valued function for the sine curve.

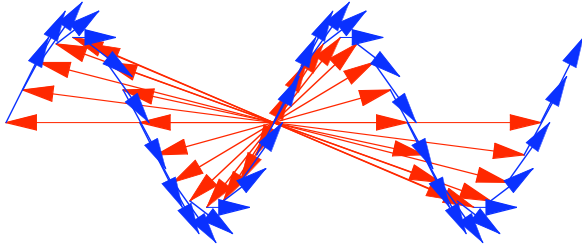
```
x[t_] := t;
y[t_] := 2 Sin[t]; (* graph looks better with 2 times sine *)
vectorvalue = Table[Arrow[{0, 0}, {x[t], y[t]}], {t, -2 π, 2 π, π/8}];
a1 = Show[Graphics[{RGBColor[1, 0, 0], vectorvalue}], AspectRatio → Automatic];
```



- We defined a table of arrows defined by our vector-valued function. We could double the number of arrows by using an increment of  $\frac{\pi}{16}$ . The show will then graph the table of arrows.
- Next we will define a table of velocity vectors.

```
velvector = Table[Arrow[{x[t], y[t]}, {x[t] + x'[t], y[t] + y'[t]}], {t, -2 π, 2 π, π/8}];
a2 = Show[Graphics[{RGBColor[0, 0, 1], velvector}], AspectRatio → Automatic];
Show[a1, a2];
```





- The above statements will cause the velocity vectors to be printed in blue. Rather than start at the origin, the velocity vectors will have their initial points at the point  $(x(t), y(t))$ . In addition, both sets of vectors will be printed.
  
- Exercises Lab #2
  
- 1. Define the vector-valued function  $\vec{r}(t) = \langle 4\cos(t), 2\sin(t) \rangle$ . Graph the velocity and acceleration vectors on the same graph as above.
  
- 2. Use the above function and find its unit tangent vector,  $\hat{T}(t)$ , and principal unit normal vector,  $\hat{N}(t)$ . Plot these with  $\vec{r}(t)$  on the same graph.
  
- 3. Define your own vector-valued function  $\vec{r}(t)$ . Graph it and its velocity and acceleration vectors on the same graph.