

1 Projection matrix

Given two vectors u, v how to find the projection of u onto v

You can use trigonometry to solve it but we can use vector to solve it much more elegant.

Given vector $u = \begin{bmatrix} x \\ y \end{bmatrix}$ projects on $v = \begin{bmatrix} x' \\ y' \end{bmatrix}$

The project matrix is

$$p = \frac{uu^T}{u^T u} = \begin{bmatrix} x \\ y \end{bmatrix} \begin{bmatrix} x & y \end{bmatrix} = u^T u \begin{bmatrix} xx & xy \\ yx & yy \end{bmatrix}$$

Let's implement it in Haskell

```
u = [[x]
      [y]]
v = [[x', y']]
[ map(\vx -> (head u') ++ vx) v' | u' <- u, v' <- v]
```

We can use lambda function for string and integer operations:

```
outerStr::(a->a->a)->[[a]]->[[a]]->[[a]]
outerStr f v r = [ map(\vx -> f (head u') vx) v' | u' <- u, v' <- v]
```

```
-- String op
outerStr (++) u v
-- Integer op
outerStr (+) u v
```

1.1 Some properties about Project Matrix

$P^2 = P$ and $P^T = P$ implies $P^2 = P^T$