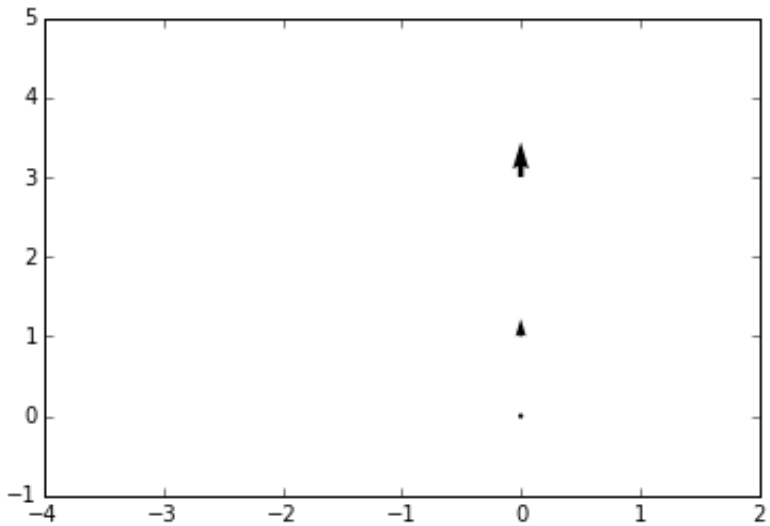
In [1]:
```
import numpy as np;
import matplotlib;
import pylab;
%matplotlib inline

def unit_vector_2d(v1, v2):
    """ This function computes the unit vector """
    dV = v1 - v2
    if np.allclose(dV, np.array([0., 0.])):
        return np.array([0., 0.])
    return dV/np.linalg.norm(dV)

def unit_vector_1d(v1, v2):
    """ This function computes the unit vector """
    dV = v1 - v2
    if np.allclose(dV, 0.):
        return 0.
    return dV/np.linalg.norm(dV)

def mag(v):
    return np.sqrt(v[0]**2+v[1]**2)
```

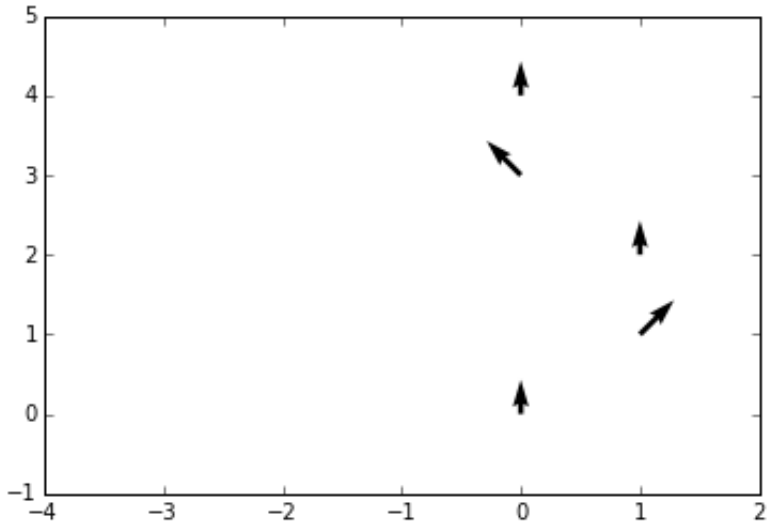
In [2]:
```
class vehicle:
    P=np.array([0., 0.])  # global position
    O=np.array([0., 0.])  # orientation
    dO=np.array([0., 0.]) # change in orientation
    V=0.  # velocity
    dV=0. # change in velocity

    def __init__(self, P, O, V):
        self.P, self.O, self.V = P, O, V

    def follow(self, Lo, Lv, t):
        """ Follows a leading function L, accepts only the next positi
on-velocity pair L """
        self.dO = unit_vector_2d(Lo, self.O)
        self.dV = unit_vector_1d(Lv, self.V)
        self.O += self.dO * t
        self.V += self.dV * t
        self.P += self.O * self.V
        if np.allclose(self.O, Lo) and np.allclose(self.V, Lv):
            return False
        return True

    def out(self, Lo, Lv):
        print('P: ', self.P)
        print('F: ', self.O, self.V)
        print('d: ', self.dO, self.dV)
        print('L: ', Lo, Lv)
        print('')
```

In [3]:
```
def main(path):
    Px=[]
    Py=[]
    Fx=[]
    Fy=[]
    O, V = path.pop(0)
    car=vehicle(np.array([0., 0.]), O, V)
    Px.append(car.P[0])
    Py.append(car.P[1])
    Fx.append(car.O[0]*car.V)
    Fy.append(car.O[1]*car.V)
    while path != []:
        O, V=path.pop(0)
        while car.follow(O, V, 1):
            Px.append(car.P[0])
            Py.append(car.P[1])
            Fx.append(car.O[0]*car.V)
            Fy.append(car.O[1]*car.V)
        Px.append(car.P[0])
        Py.append(car.P[1])
        Fx.append(car.O[0]*car.V)
        Fy.append(car.O[1]*car.V)

    matplotlib.pyplot.quiver(Px, Py, Fx, Fy)
    matplotlib.pyplot.axis((-4,2,-1,5))
    matplotlib.pyplot.show()
```

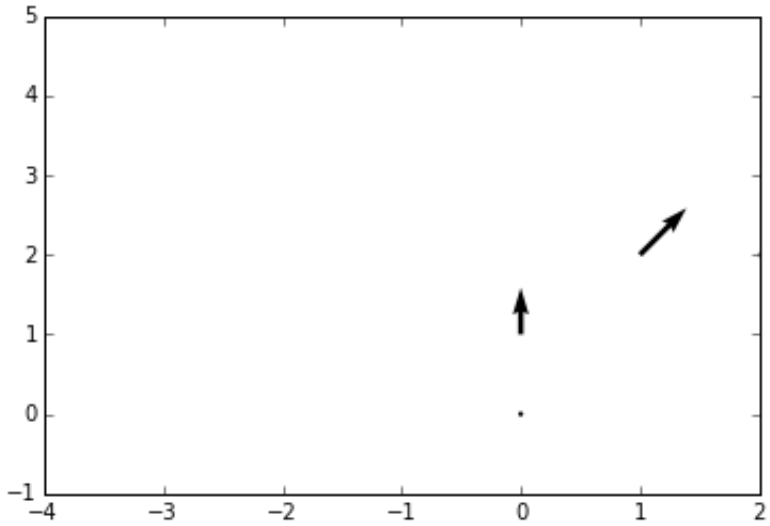
In [4]:
```
# driving straight: from a stopped position, speed up and then slow do
wn back to a stop.
path=[
    [np.array([0., 1.]), 0.],
    [np.array([0., 1.]), 5.],
    [np.array([0., 1.]), 0.]
]
main(path)
```



In [5]:
```
# lane changing

path=[
    [np.array([0., 1.]), 1.],
    [np.array([1., 1.]), 1.],
    [np.array([0., 1.]), 1.],
    [np.array([-1., 1.]), 1.],
    [np.array([0., 1.]), 1.]
]
main(path)
```



In [6]:
```
# Street intersection: right turn
path=[
        [np.array([0., 0.]), 0.],
        [np.array([0., 1.]), 1.],
        [np.array([1., 1.]), 1.],
        [np.array([1., 0.]), 1.]
]
main(path)
```



In [7]:
```
# Street intersection: left turn
path=[
        [np.array([0., 1.]), 2.],

        [np.array([-1., 1.]), 1.],
        [np.array([-1., 0.]), 1.]
]
main(path)
```