Math 323
Linear Algebra and Matrix Theory I
Fall 1999

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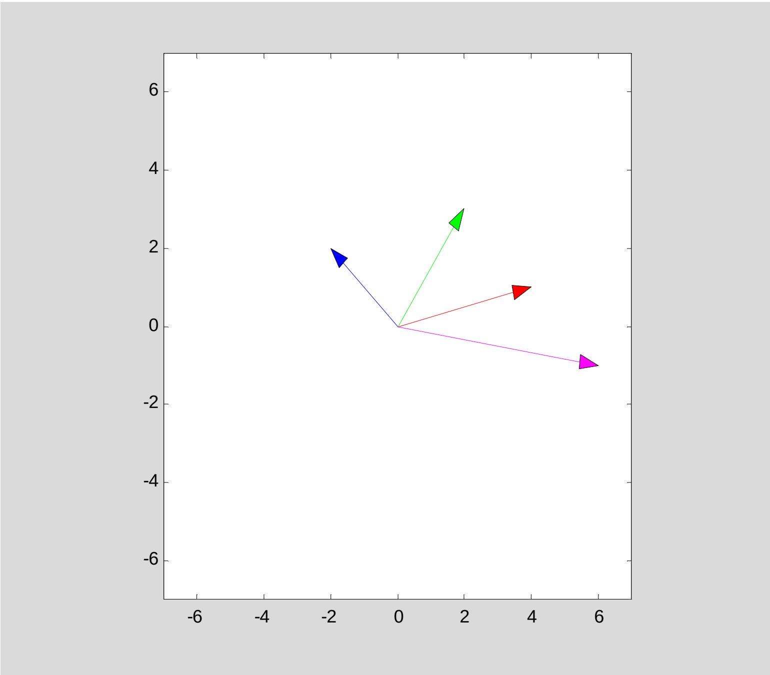
Key Homework 1

Strang Page 6 no: 1

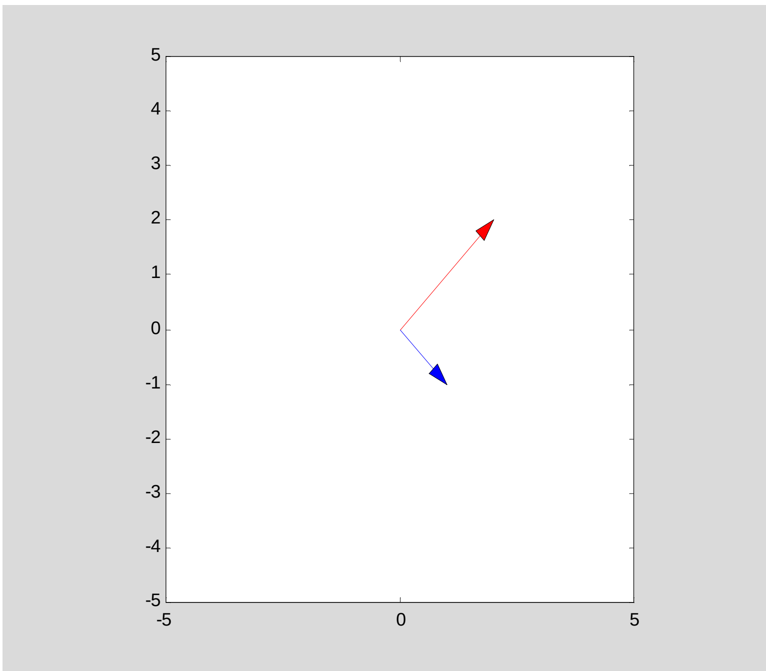
```
v=[4; 1], w=[-2; 2]

v =
     4
     1
w =
    -2
     2

drawvec(v, 'red', 7); hold on, drawvec(w, 'blue', 7); hold on,
drawvec(v+w, 'green', 7); hold on, drawvec(v-w, 'magenta', 7);
```



Strang Page 6 no: 2

a)
```
vPw=[3; 1], vMw=[1;3], v=(vPw+vMw)/2, w=(vPw-vMw)/2, drawvec(v, 'red');
hold on, drawvec(w, 'blue');
```

```
vPw =
     3
     1
vMw =
     1
     3
v =
     2
     2
w =
     1
    -1
```



Strang Page 6 no: 4

a)

```
u=[1; 2; 3], v=[-3; 1; -2], w=[2; -3; -1], ans1=u+v, ans2=u+v+w,
ans3=2*u+2*v+w
```

```
u =
     1
     2
     3
v =
    -3
     1
    -2
w =
     2
    -3
    -1
ans1 =
    -2
     3
     1
```

```
ans2 =
     0
     0
     0
ans3 =
    -2
     3
     1
```

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a) First backward on **w** and then forward on **v**.
b) The plane through **u** and **v**.

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a)

```
v=[4; 2], w=[-1; 2], left_side=norm(v, 2)^2+norm(w, 2)^2,
right_side=norm(v+w, 2)^2
```

```
v =
     4
     2
w =
    -1
     2
left_side =
   25.0000
right_side =
    25
```

b) The formula fails if **u** and **v** are not perpendicular, for instance:

```
v=[5; 2], w=[-1; 2], left_side=norm(v, 2)^2+norm(w, 2)^2,
right_side=norm(v+w, 2)^2
```

```
v =
     5
     2
w =
    -1
     2
left_side =
    34
right_side =
   32.0000
```

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a) This sum equals the vector (0, 0).
b) This sum equals negative the 4:00 vector.
c) This sum equals negative one half of the 1:00 vector.

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$c + 3d = 14$

$2c + d = 8$

Strang Page 17 no: 2

```
u=[-0.6; 0.8], v=[3; 4], w=[4; 3]

u =
   -0.6000
    0.8000
v =
     3
     4
w =
     4
     3
```

Compute the lengths of the vectors.

```
Nu=norm(u, 2), Nv=norm(v, 2), Nw=norm(w, 2)

Nu =
     1
Nv =
     5
Nw =
     5
```

Check the Cauchy Schwarz inequalities $|u \bullet v| - \|u\|\,\|v\| \le 0$ and $|v \bullet w| - \|v\|\,\|w\| \le 0$.

```
check1=abs(u'*v)-Nu*Nv, check2=abs(v'*w)-Nv*Nw

check1 =
   -3.6000
check2 =
    -1
```

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a) If $w = (w_1, w_2)$ is to be perpendicular to $v = (2,-1)$, then the dot product of the two vectors needs to equal zero. $\Rightarrow 2w_1 - w_2 = 0 \Rightarrow w_2 = 2w_1$. So we can write all vectors perpendicular to **v** as $w = \alpha\,(1,2)$.

b) All vectors perpendicular to **V** = (1, 1, 1), constitute a plane through the origin and perpendicular to the vector **V**.

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For instance the v = (1, 0, -1), and w = (1, -2, 1).

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$$\|v+w\|^2 = (v+w)\bullet(v+w) = \|v\|^2 + 2(v\bullet w) + \|w\|^2$$
$$\leq \|v\|^2 + 2|v\bullet w| + \|w\|^2 \leq \|v\|^2 + 2\|v\|\,\|w\| + \|w\|^2 = (\|v\| + \|w\|)^2.$$

Taking the square root of both sides yields the triangle inequality $\|v+w\| \leq \|v\| + \|w\|$