

```

% gda07_02

% draw vectors in 3D space
% supports Figure 7.2

clear all;

% independent variable, x
xmin = 0;
xmax = 1;

% independent variable, y
ymin = 0;
ymax = 1;

% independent variable, z
zmin = 0;
zmax = 1;

% graph 1

% these three vectors span 3D space
m1 = [0.7, 0.8, 0.8]';
m2 = [0.5, 0.7, 0.8]';
m3 = [0.8, 0.6, 0.7]';

figure(1);
clf;
set(gca, 'LineWidth', 3);
set(gca, 'FontSize', 14);
hold on;
axis( [xmin, xmax, ymin, ymax, zmin, zmax] );

% improvise outline of 3D box
plot3( [xmin,xmin], [ymin,ymin], [zmin,zmax], 'k-', 'LineWidth', 2 );
plot3( [xmin,xmin], [ymin,ymax], [zmin,zmin], 'k-', 'LineWidth', 2 );
plot3( [xmin,xmax], [ymin,ymin], [zmin,zmin], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmax], [ymax,ymax], [zmax,zmin], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmax], [ymax,ymin], [zmax,zmax], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmin], [ymax,ymax], [zmax,zmax], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmin], [ymin,ymin], [zmax,zmax], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmax], [ymin,ymin], [zmax,zmin], 'k-', 'LineWidth', 2 );
plot3( [xmin,xmin], [ymax,ymin], [zmax,zmax], 'k-', 'LineWidth', 2 );
plot3( [xmin,xmin], [ymax,ymax], [zmax,zmin], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmax], [ymax,ymin], [zmin,zmin], 'k-', 'LineWidth', 2 );
plot3( [xmax,xmin], [ymax,ymax], [zmin,zmin], 'k-', 'LineWidth', 2 );
xlabel('m_1');
ylabel('m_2');
zlabel('m_3');

% pretty crazy way to draw arrowheads!
% first arrowhead
rbar=m1; % point of the arrow
plot3( [0, rbar(1)], [0, rbar(2)], [0, rbar(3)], 'k-', 'LineWidth', 3 );
tangent = rbar/sqrt(rbar'*rbar); % tangent to the vector
per1 = cross( tangent, [0, 0, 1]' ); % a vector perpendicular to tangent
per1 = per1/sqrt(per1'*per1);
per2 = cross( tangent, per1 ); % another vector perpendicular to tangent
per2 = per2/sqrt(per2'*per2);

```

```

% arrowhead has 4 lines, each sloping back from the tip
L = 0.05;
v1 = rbar - L*tangent + 0.25*L*per1;
v2 = rbar - L*tangent - 0.25*L*per1;
v3 = rbar - L*tangent + 0.25*L*per2;
v4 = rbar - L*tangent - 0.25*L*per2;
plot3( [rbar(1), v1(1)], [rbar(2), v1(2)], [rbar(3), v1(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v2(1)], [rbar(2), v2(2)], [rbar(3), v2(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v3(1)], [rbar(2), v3(2)], [rbar(3), v3(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v4(1)], [rbar(2), v4(2)], [rbar(3), v4(3)], 'k-', 'LineWidth', 3 );

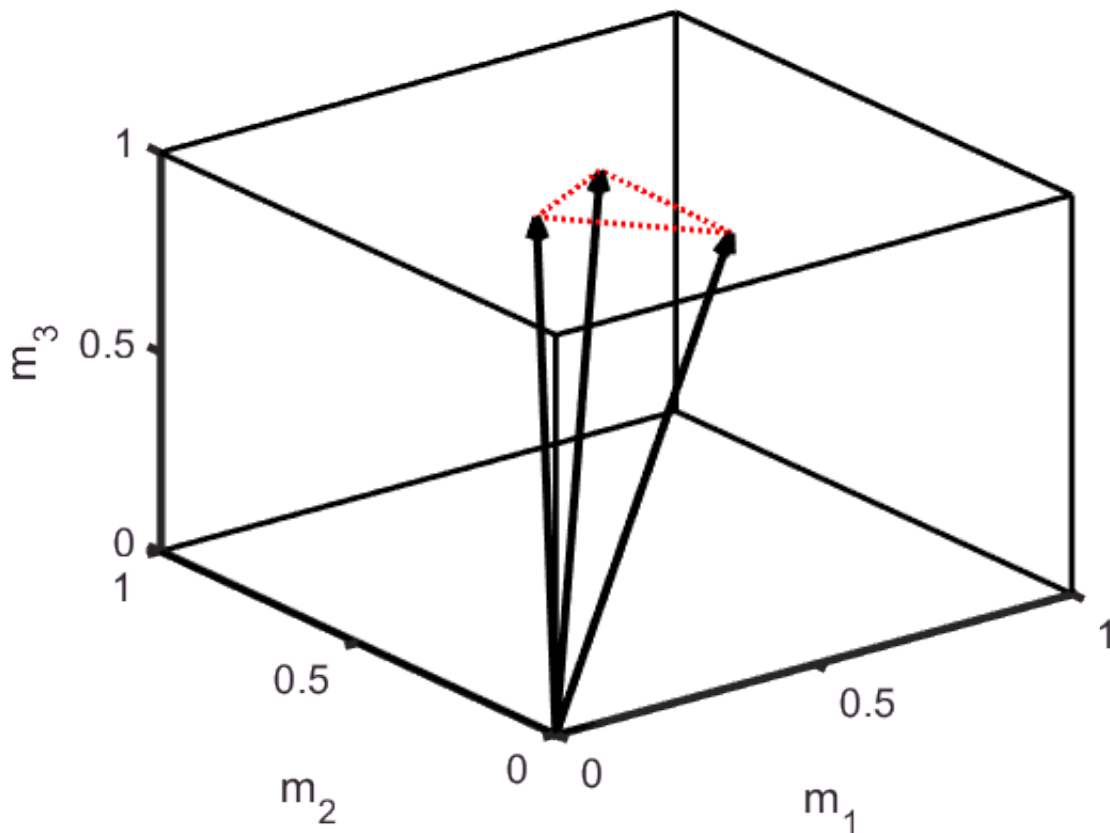
% second arrowhead
rbar=m2;
plot3( [0, rbar(1)], [0, rbar(2)], [0, rbar(3)], 'k-', 'LineWidth', 3 );
tangent = rbar/sqrt(rbar'*rbar);
per1 = cross( tangent, [0, 0, 1]' );
per1 = per1/sqrt(per1'*per1);
per2 = cross( tangent, per1 );
per2 = per2/sqrt(per2'*per2);
L = 0.05;
v1 = rbar - L*tangent + 0.25*L*per1;
v2 = rbar - L*tangent - 0.25*L*per1;
v3 = rbar - L*tangent + 0.25*L*per2;
v4 = rbar - L*tangent - 0.25*L*per2;
plot3( [rbar(1), v1(1)], [rbar(2), v1(2)], [rbar(3), v1(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v2(1)], [rbar(2), v2(2)], [rbar(3), v2(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v3(1)], [rbar(2), v3(2)], [rbar(3), v3(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v4(1)], [rbar(2), v4(2)], [rbar(3), v4(3)], 'k-', 'LineWidth', 3 );

% third arrowhead
rbar=m3;
plot3( [0, rbar(1)], [0, rbar(2)], [0, rbar(3)], 'k-', 'LineWidth', 3 );
tangent = rbar/sqrt(rbar'*rbar);
per1 = cross( tangent, [0, 0, 1]' );
per1 = per1/sqrt(per1'*per1);
per2 = cross( tangent, per1 );
per2 = per2/sqrt(per2'*per2);
L = 0.05;
v1 = rbar - L*tangent + 0.25*L*per1;
v2 = rbar - L*tangent - 0.25*L*per1;
v3 = rbar - L*tangent + 0.25*L*per2;
v4 = rbar - L*tangent - 0.25*L*per2;
plot3( [rbar(1), v1(1)], [rbar(2), v1(2)], [rbar(3), v1(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v2(1)], [rbar(2), v2(2)], [rbar(3), v2(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v3(1)], [rbar(2), v3(2)], [rbar(3), v3(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v4(1)], [rbar(2), v4(2)], [rbar(3), v4(3)], 'k-', 'LineWidth', 3 );

% draw triangle connecting vector tips
plot3( [m1(1), m2(1)], [m1(2), m2(2)], [m1(3), m2(3)], 'r:', 'LineWidth', 2 );
plot3( [m2(1), m3(1)], [m2(2), m3(2)], [m2(3), m3(3)], 'r:', 'LineWidth', 2 );
plot3( [m3(1), m1(1)], [m3(2), m1(2)], [m3(3), m1(3)], 'r:', 'LineWidth', 2 );

% set view
view(3);

```



% Figure 7.2 (A) These three vectors span the three-dimensional space  $S(m)$ . MatLab script gda6

% graph 2

% these three vectors dont span 3D space

```
m1 = [0.7, 0.8, 0.9]';
```

```
m2 = [0.5, 0.7, 0.8]';
```

```
m3 = 0.5*(m1+m2);
```

```
figure(2);
```

```
clf;
```

```
set(gca,'LineWidth',3);
```

```
set(gca,'FontSize',14);
```

```
hold on;
```

```
axis([xmin,xmax,ymin,ymax,zmin,zmax]');
```

% improvise outline of 3D box

```
plot3([xmin,xmin],[ymin,ymin],[zmin,zmax],'k-','LineWidth',2);
```

```
plot3([xmin,xmin],[ymin,ymax],[zmin,zmin],'k-','LineWidth',2);
```

```
plot3([xmin,xmax],[ymin,ymin],[zmin,zmin],'k-','LineWidth',2);
```

```
plot3([xmax,xmax],[ymax,ymax],[zmax,zmin],'k-','LineWidth',2);
```

```
plot3([xmax,xmax],[ymax,ymin],[zmax,zmax],'k-','LineWidth',2);
```

```
plot3([xmax,xmin],[ymax,ymax],[zmax,zmax],'k-','LineWidth',2);
```

```
plot3([xmax,xmin],[ymin,ymin],[zmax,zmax],'k-','LineWidth',2);
```

```
plot3([xmax,xmax],[ymin,ymin],[zmax,zmin],'k-','LineWidth',2);
```

```
plot3([xmin,xmin],[ymax,ymin],[zmax,zmax],'k-','LineWidth',2);
```

```
plot3([xmin,xmin],[ymax,ymax],[zmax,zmin],'k-','LineWidth',2);
```

```
plot3([xmax,xmax],[ymax,ymin],[zmin,zmin],'k-','LineWidth',2);
```

```
plot3([xmax,xmin],[ymax,ymax],[zmin,zmin],'k-','LineWidth',2);
```

```
xlabel('m_1');
```

```
ylabel('m_2');
```

```

xlabel('m_3');

% pretty crazy way to draw arrowheads!
% first arrowhead
rbar=m1;
plot3( [0, rbar(1)], [0, rbar(2)], [0, rbar(3)], 'k-', 'LineWidth', 3 );
tangent = rbar/sqrt(rbar'*rbar);
per1 = cross( tangent, [0, 0, 1]' );
per1 = per1/sqrt(per1'*per1);
per2 = cross( tangent, per1 );
per2 = per2/sqrt(per2'*per2);
L = 0.05;
v1 = rbar - L*tangent + 0.25*L*per1;
v2 = rbar - L*tangent - 0.25*L*per1;
v3 = rbar - L*tangent + 0.25*L*per2;
v4 = rbar - L*tangent - 0.25*L*per2;
plot3( [rbar(1), v1(1)], [rbar(2), v1(2)], [rbar(3), v1(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v2(1)], [rbar(2), v2(2)], [rbar(3), v2(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v3(1)], [rbar(2), v3(2)], [rbar(3), v3(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v4(1)], [rbar(2), v4(2)], [rbar(3), v4(3)], 'k-', 'LineWidth', 3 );

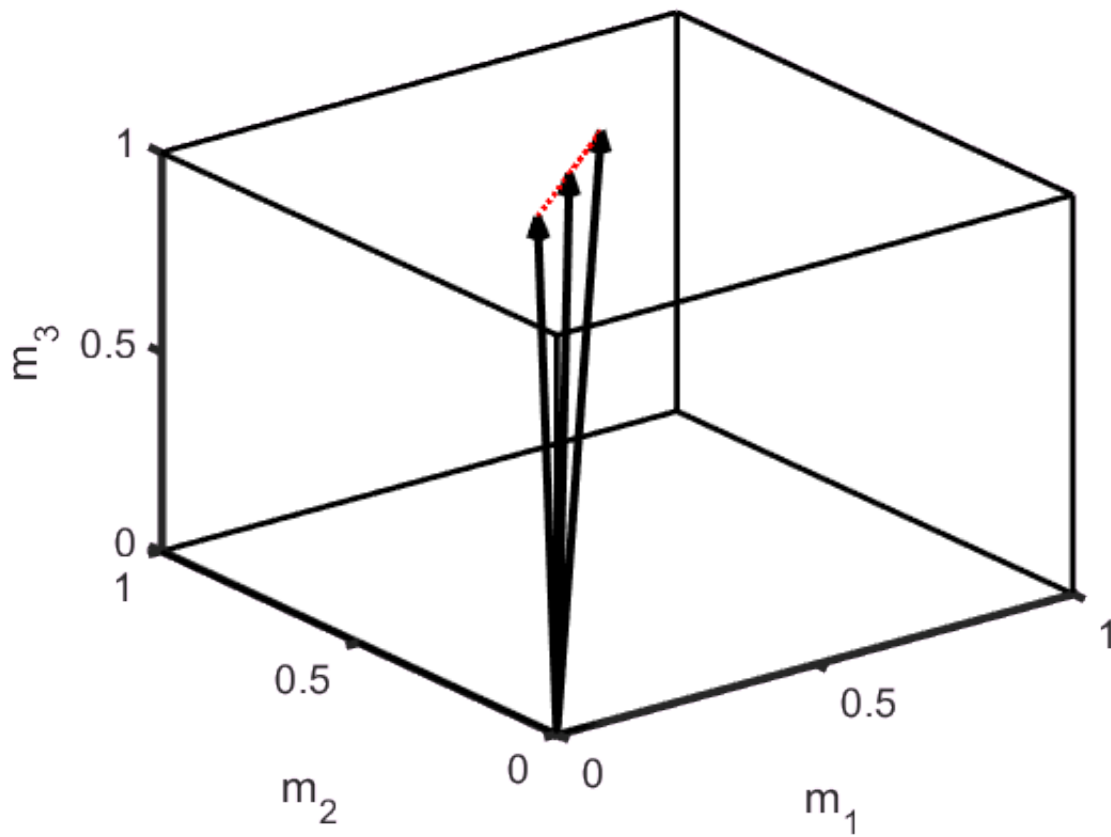
% second arrowhead
rbar=m2;
plot3( [0, rbar(1)], [0, rbar(2)], [0, rbar(3)], 'k-', 'LineWidth', 3 );
tangent = rbar/sqrt(rbar'*rbar);
per1 = cross( tangent, [0, 0, 1]' );
per1 = per1/sqrt(per1'*per1);
per2 = cross( tangent, per1 );
per2 = per2/sqrt(per2'*per2);
L = 0.05;
v1 = rbar - L*tangent + 0.25*L*per1;
v2 = rbar - L*tangent - 0.25*L*per1;
v3 = rbar - L*tangent + 0.25*L*per2;
v4 = rbar - L*tangent - 0.25*L*per2;
plot3( [rbar(1), v1(1)], [rbar(2), v1(2)], [rbar(3), v1(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v2(1)], [rbar(2), v2(2)], [rbar(3), v2(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v3(1)], [rbar(2), v3(2)], [rbar(3), v3(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v4(1)], [rbar(2), v4(2)], [rbar(3), v4(3)], 'k-', 'LineWidth', 3 );

% third arrowhead
rbar=m3;
plot3( [0, rbar(1)], [0, rbar(2)], [0, rbar(3)], 'k-', 'LineWidth', 3 );
tangent = rbar/sqrt(rbar'*rbar);
per1 = cross( tangent, [0, 0, 1]' );
per1 = per1/sqrt(per1'*per1);
per2 = cross( tangent, per1 );
per2 = per2/sqrt(per2'*per2);
L = 0.05;
v1 = rbar - L*tangent + 0.25*L*per1;
v2 = rbar - L*tangent - 0.25*L*per1;
v3 = rbar - L*tangent + 0.25*L*per2;
v4 = rbar - L*tangent - 0.25*L*per2;
plot3( [rbar(1), v1(1)], [rbar(2), v1(2)], [rbar(3), v1(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v2(1)], [rbar(2), v2(2)], [rbar(3), v2(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v3(1)], [rbar(2), v3(2)], [rbar(3), v3(3)], 'k-', 'LineWidth', 3 );
plot3( [rbar(1), v4(1)], [rbar(2), v4(2)], [rbar(3), v4(3)], 'k-', 'LineWidth', 3 );

% draw triangle connecting vector tips
plot3( [m1(1), m2(1)], [m1(2), m2(2)], [m1(3), m2(3)], 'r:', 'LineWidth', 2 );
plot3( [m2(1), m3(1)], [m2(2), m3(2)], [m2(3), m3(3)], 'r:', 'LineWidth', 2 );
plot3( [m3(1), m1(1)], [m3(2), m1(2)], [m3(3), m1(3)], 'r:', 'LineWidth', 2 );

```

```
% set view  
view(3);
```



```
% Figure 7.2 (B) These three vectors do not span the space as they all lie on the same plane.  
% MatLab script gda07_02.
```