```
function [C] = createdC(a)
n=length(a);
u0=ones(n,1);
C=zeros(n,n);
C=diag(ones(1,n-1),-1);
C(1:n,n)=-a;
end
```

```
function [r,V,H]=Schur(H,u)
A=H;
n=length(H);
H=Hessenberg(H);
[l,m]=Ifschur(H,u);
k=0;
while m<n
    H22=H(1+l:n-m,1+l:n-m);
    [H22,P]=FrancisQR(H22);
    H(1:l,1+l:n-m)=H(1:l,1+l:n-m)*P;
    H(1+l:n-m,n-m+1:n)=P'*H(1+l:n-m,n-m+1:n);
    H(1+l:n-m,1+l:n-m)=H22;
    [l,m]=Ifschur(H,u);
    k=k+1;
end
[r]=Eig(H);
V=zeros(n);
for j=1:n
    V(1:n,j)=Eigenvector(A,r(j),10);
end
end
```

```
function [l,m]=Ifschur(H,u)
n=length(H);
x=0;
y=zeros(1,n-1);
k=0;
for i=1:n-1
    y(i)=H(i+1,i);
end
for i=1:n-1
    if abs(y(i))<(abs(H(i,i))+abs(H(i+1,i+1)))*u
        k=k+1;
        y(i)=0;
    end
end
if k==0
    m=0;
```

```
    l=0;
else
    z=zeros(1,k);
    j=1;
    i=1;
    while(i<n)
        if abs(y(i))==0
            z(j)=i;
            j=j+1;
        end
        i=i+1;
    end
    if z(k)<=n-3
        m=0;
        l=z(k);
    else
        i=k;
        while i>1
            if z(i)-z(i-1)<=2
                i=i-1;
            else
                break
            end
        end
        if i>1
            m=n-z(i);
            l=z(i-1);
        end
        if i==1
            if z(1)<=2
                m=n;
                l=0;
            else
                m=n-z(1);
                l=0;
            end
        end
end
end



function [H,P] = FrancisQR(H)
n=length(H);
m=n-1;
s=H(m,m)+H(n,n);
t=H(n,n)*H(m,m)-H(n,m)*H(m,n);
x=H(1,1)*H(1,1)+H(1,2)*H(2,1)-s*H(1,1)+t;
y=H(2,1)*(H(1,1)+H(2,2)-s);
z=H(2,1)*H(3,2);
P=eye(n);
for k=0:n-3
    [v,beta]=house([x y z]');
    q=max(1,k);
```

```
    H(k+1:k+3,q:n)=(eye(3)-beta*v*v')*H(k+1:k+3,q:n);
    r=min(k+4,n);
    H(1:r,k+1:k+3)=H(1:r,k+1:k+3)*(eye(3)-beta*v*v');
    P0=blkdiag(eye(k),eye(3)-beta*v*v',eye(n-k-3));
    P=P*P0;
    x=H(k+2,k+1);
    y=H(k+3,k+1);
    if k<n-3
        z=H(k+4,k+1);
    end
end
[v,beta]=house([x y]');
H(n-1:n,n-2:n)=(eye(2)-beta*v*v')*H(n-1:n,n-2:n);
H(1:n,n-1:n)=H(1:n,n-1:n)*(eye(2)-beta*v*v');
P0=blkdiag(eye(n-2),eye(2)-beta*v*v');
P=P*P0;
end



function [r]=Eig(H)
n=length(H);
r=zeros(1,n);
y=zeros(1,n-1);
u=1e-5;
for i=1:n-1
    y(i)=H(i+1,i);
end
m=0;
for i=1:n-1
    if abs(y(i))<u
        m=m+1;
        y(i)=0;
    end
end
z=zeros(1,m);
j=1;
i=1;
while(i<n)
    if abs(y(i))==0
        z(j)=i;
        j=j+1;
    end
    i=i+1;
end
if z(1)==2
    r(1:2)=eig2(H(1:2,1:2));
    j=1;
    while j<m
        if z(j+1)-z(j)==1
            r(z(j+1))=H(z(j+1),z(j+1));
        end
        if(z(j+1)-z(j)==2)
```

```
            r((z(j+1)-1):z(j+1))=eig2(H((z(j+1)-1):z(j+1),(z(j
+1)-1):z(j+1)));
        end
        j=j+1;
    end
     if n-z(m)==1
        r(n)=H(n,n);
    else
        r(n-1:n)=eig2(H(n-1:n,n-1:n));
    end
else
    r(1)=H(1,1);
    j=1;
    while j<m
        if z(j+1)-z(j)==1
            r(z(j+1))=H(z(j+1),z(j+1));
        end
        if(z(j+1)-z(j)==2)
            r((z(j+1)-1):z(j+1))=eig2(H((z(j+1)-1):z(j+1),(z(j
+1)-1):z(j+1)));
        end
        j=j+1;
    end
     if n-z(m)==1
        r(n)=H(n,n);
    else
        r(n-1:n)=eig2(H(n-1:n,n-1:n));
     end
end
r=r';
end



function [a] = eig2(A)
a=zeros(1,2);
derta=(A(1,1)+A(2,2))^2-4*det(A);
a0=1/2*(A(1,1)+A(2,2)+sqrt(derta));
b0=1/2*(A(1,1)+A(2,2)-sqrt(derta));
a(1)=a0;a(2)=b0;
end



function [v,b] = house(x)
n = length(x);
t = norm(x,inf);
x = x./t;
c = x(2:n)'*x(2:n);
v=zeros(n,1);
v(2:n) = x(2:n);
if c == 0
    b=0;
```

```
else
    a=sqrt((x(1))^2 + c);
    if x(1)<=0
        v(1)=x(1)-a;
    else
        v(1) = -c/(x(1)+a);
    end
    b=2*v(1)*v(1)/(c+(v(1))^2);
    v=v/v(1);
end
end
```

```
function [A] = Hessenberg(A)
n=length(A);
for k=1:n-2
    [v,beta]=house(A(k+1:n,k));
    A(k+1:n,k:n)=(eye(n-k)-beta*v*v')*A(k+1:n,k:n);
    A(1:n,k+1:n)=A(1:n,k+1:n)*(eye(n-k)-beta*v*v');
end
end
```

```
function [v1]=Eigenvector(A,t,kmax)
n=length(A);
epsilon=1e-10;
[L,U,P]=lu(A-(t+epsilon)*eye(n));
z0=ones(n,1);
v1=utriangle(U,ltriangle(L,P*z0,n),n);
[x,i]=max(abs(v1));
x=v1(i);
x0=0;
v1=v1/x;
k=1;
while k<kmax & abs(x0-x)>1e-5
    x0=x;
    z0=v1;
    v1=utriangle(U,ltriangle(L,P*z0,n),n);
    [x,i]=max(abs(v1));
    x=v1(i);
    v1=v1/x;
    k=k+1;
end
end
```

```
function [y] = utriangle(U,y,n)
for j=n:-1:2
    y(j)=y(j)/U(j,j);
```

```
    y(1:j-1)=y(1:j-1)-y(j)*U(1:j-1,j);
end
y(1)=y(1)/U(1,1);
end



function [b] = ltriangle(L,b,n)
for j=1:n-1
    b(j)=b(j)/L(j,j);
    b(j+1:n)=b(j+1:n)-b(j)*L(j+1:n,j);
end
b(n)=b(n)/L(n,n);
end



u=1e-33;
a=zeros(41,1);
a(1)=1;a(4)=1;
C=createdC(a);
[r0,V0,H0]=Schur(C,u);r0
x=0.9;
A=[9.1 3 2.6 4;4.2 5.3 4.7 1.6;3.2 1.7 9.4 x;6.1 4.9 3.5 6.2];
[r1,V1,H1]=Schur(A,u);r1,V1
x=1;
A=[9.1 3 2.6 4;4.2 5.3 4.7 1.6;3.2 1.7 9.4 x;6.1 4.9 3.5 6.2];
[r2,V2,H2]=Schur(A,u);r2,V2
x=1.1;
A=[9.1 3 2.6 4;4.2 5.3 4.7 1.6;3.2 1.7 9.4 x;6.1 4.9 3.5 6.2];
[r3,V3,H3]=Schur(A,u);r3,V3


r0 =

   1.0143 - 0.0809i
   1.0143 + 0.0809i
   0.9872 - 0.2404i
   0.9872 + 0.2404i
   0.9337 - 0.3925i
   0.9337 + 0.3925i
   0.8552 - 0.5326i
   0.8552 + 0.5326i
   0.7537 - 0.6554i
   0.7537 + 0.6554i
   0.6323 - 0.7534i
   0.6323 + 0.7534i
   0.5076 - 0.8106i
   0.5076 + 0.8106i
   0.4172 - 0.8711i
   0.4172 + 0.8711i
   0.2898 - 0.9464i
   0.2898 + 0.9464i
```

```
   0.1392 - 0.9925i
   0.1392 + 0.9925i
  -0.0197 - 1.0094i
  -0.0197 + 1.0094i
  -0.1802 - 0.9980i
  -0.1802 + 0.9980i
  -0.3370 - 0.9592i
  -0.3370 + 0.9592i
  -0.4853 - 0.8945i
  -0.4853 + 0.8945i
  -0.6207 - 0.8059i
  -0.6207 + 0.8059i
  -0.7391 - 0.6959i
  -0.7391 + 0.6959i
  -0.8369 - 0.5678i
  -0.8369 + 0.5678i
  -0.9105 - 0.4255i
  -0.9105 + 0.4255i
  -0.9563 - 0.2738i
  -0.9563 + 0.2738i
  -0.9681 - 0.1209i
  -0.9681 + 0.1209i
  -0.9525 + 0.0000i


r1 =

  17.4397 + 0.0000i
   2.8704 - 0.6429i
   2.8704 + 0.6429i
   6.8195 + 0.0000i


V1 =

   0.9249 + 0.0000i  -0.7294 + 0.3555i  -0.7294 - 0.3555i  -0.8596 +
 0.0000i
   0.6945 + 0.0000i   0.0927 - 0.5356i   0.0927 + 0.5356i   0.3066 +
 0.0000i
   0.6270 + 0.0000i   0.1902 - 0.0535i   0.1902 + 0.0535i   1.0000 +
 0.0000i
   1.0000 + 0.0000i   1.0000 - 0.0000i   1.0000 + 0.0000i  -0.3898 +
 0.0000i


r2 =

  17.4765 + 0.0000i
   2.8680 - 0.6887i
   2.8680 + 0.6887i
   6.7875 + 0.0000i


V2 =
```

```
   0.9243 + 0.0000i  -0.7121 + 0.3750i  -0.7121 - 0.3750i  -0.8615 +
 0.0000i
   0.6959 + 0.0000i   0.0868 - 0.5694i   0.0868 + 0.5694i   0.3120 +
 0.0000i
   0.6365 + 0.0000i   0.1676 - 0.0532i   0.1676 + 0.0532i   1.0000 +
 0.0000i
   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 - 0.0000i  -0.3859 +
 0.0000i


r3 =

  17.5130 + 0.0000i
   2.8655 - 0.7322i
   2.8655 + 0.7322i
   6.7561 + 0.0000i


V3 =

   0.9238 + 0.0000i  -0.6950 + 0.3924i  -0.6950 - 0.3924i  -0.8635 +
 0.0000i
   0.6973 + 0.0000i   0.0811 - 0.6007i   0.0811 + 0.6007i   0.3173 +
 0.0000i
   0.6461 + 0.0000i   0.1451 - 0.0522i   0.1451 + 0.0522i   1.0000 +
 0.0000i
   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i  -0.3820 +
 0.0000i
```

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