Playing with points

Geometrical points are entities characterized by their position with respect to a given refernece frame. In Anakin, the class `point` allows creating them.

Start by importing the Anakin framework into Matlab. Be sure to include Anakin's base directory before you run this line:

```
import anakin.*
```

Object creation

The default geometric point is the canonical origin:

```
O = point % default call
```

```
O =
Point with canonical position vector components:
     0
     0
     0
```

Points can be created by passing their position vector or its canonical coordinates:

```
ra = tensor([1;2;3])
```

```
ra =
Vector with canonical components:
     1
     2
     3
```

```
A = point(ra) % as a vector
```

```
A =
Point with canonical position vector components:
     1
     2
     3
```

```
A = point([4;5;6]) % as a column array
```

```
A =
Point with canonical position vector components:
     4
     5
     6
```

```
A = point([7,8,9]) % as a row array
```

```
A =
Point with canonical position vector components:
     7
     8
     9
```

The components that define the point can be given in another reference frame. Internally, the point object stores only its coordinates in the canonical reference frame:

```
O1 = point([1;2;3]);
B1 = basis([1;0;0],[0;cos(pi/6);sin(pi/6)],[0;-sin(pi/6);cos(pi/6)]);
S1 = frame(O1,B1);

A = point([1,1,1],S1)
```

```
A =
Point with canonical position vector components:
    2.0000
    2.3660
    4.3660
```

For convenience, any object of point class or a subclass can be passed as input. The result is converted to class point:

```
P = particle; % a particle object, subclass of point
A = point(P); % converted to point
```

Basic functionality

To obtain the position vector of a point with respect to the origin of a reference frame, use method `pos`:

```
O1 = point([1;2;3]);
S1 = frame(O1);
A = point([1,1,1],S1);

A.pos
```

```
ans =
Vector with canonical components:
     2
     3
     4
```

```
A.pos(S1)
```

```
ans =
Vector with canonical components:
     1
```

```
     1
     1
```

Coordinates can be extracted similarly:

```
A.coordinates(S1)
```

```
ans = 3×1
     1
     1
     1
```

```
A.x(1,S1)
```

```
ans = 1
```

```
A.x(2,S1)
```

```
ans = 1
```

```
A.x(3,S1)
```

```
ans = 1
```

One can displace the position of a point by a given vector:

```
A = point([1,2,3]);
v = tensor([2;2;2]);

A.displace(v)
```

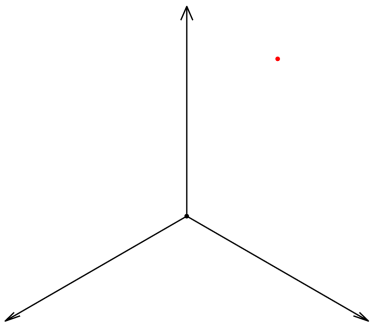
```
ans =
Point with canonical position vector components:
     3
     4
     5
```

A numeric point can be plotted using `plot`:

```
ax = axes('DataAspectRatio',[1,1,1]);
ax.XAxis.Visible = 'off';
ax.YAxis.Visible = 'off';
ax.ZAxis.Visible = 'off';
view([1,1,1]);

S1.plot; % plot the frame first

A = point([1;1.5;2],S1);
A.plot('color','r'); % pass quiver3 plotting arguments to change color, style, etc.
```



Symbolic points

Points with symbolic coordinates have additional functionality (running this requires the Symbolic Math Toolbox installed):

```
syms t xi(t) eta(t) zeta(t) phi(t); % declare symbolic variables
assume([in(t, 'real'), in(xi(t), 'real'), in(eta(t), 'real'), in(zeta(t), 'real'), in(phi(t),

A = point([xi,eta,zeta]) % a symbolic point
```

```
A =
Point with canonical position vector components:
   xi(t)
  eta(t)
 zeta(t)
```

One may compute the velocity and acceleration of a point with respect to a given reference frame. If no reference frame is provided, the canonical one is assumed:

```
A.vel
```

```
ans =
Vector with canonical components:
   diff(xi(t), t)
```

```
  diff(eta(t), t)
 diff(zeta(t), t)
```

```
A.accel
```

```
ans =
Vector with canonical components:
   diff(xi(t), t, t)
  diff(eta(t), t, t)
 diff(zeta(t), t, t)
```

```
O = point([xi^2,0,0]);
B1 = basis([1;0;0],[0;cos(phi);sin(phi)],[0;-sin(phi);cos(phi)]);
S1 = frame(O,B1);

A.vel(S1)
```

```
ans =
Vector with canonical components:
             -(2*xi(t) - 1)*diff(xi(t), t)
 zeta(t)*diff(phi(t), t) + diff(eta(t), t)
 diff(zeta(t), t) - eta(t)*diff(phi(t), t)
```

```
A.accel(S1)
```

```
ans =
Vector with canonical components:
                                                                  - 2*diff(xi(t), t)^2 - (2*xi(t) - 1)*diff(xi(t), t, t)
 zeta(t)*diff(phi(t), t, t) - eta(t)*diff(phi(t), t)^2 + 2*diff(phi(t), t)*diff(zeta(t), t) + diff(eta(t), t, t)
 diff(zeta(t), t, t) - zeta(t)*diff(phi(t), t)^2 - 2*diff(eta(t), t)*diff(phi(t), t) - eta(t)*diff(phi(t), t, t)
```

To particularize a symbolic point at particular values of its parameters, one may use `subs`, by specifying them in a list:

```
A.subs({xi},{6}) % replace xi with 6
```

```
ans =
Point with canonical position vector components:
       6
  eta(t)
 zeta(t)
```