# Spatial objects

## Point2ds

## Point3ds

## Plane2ds

**p** is any point on the plane.  
**n** is the plane normal.

### Construction from point and normal

## Plane3ds

**p** is any point on the plane.  
**n** is the plane normal.

### Construction from point and normal

## Circle2ds

**p** is any point on the edge of or in the circle.  
**p0** is the centre of the circle.  
**r** is the circle radius.

## Sphere3ds

**p** is any point on the surface of or in the sphere.  
**p0** is the centre of the sphere.  
**r** is the sphere radius.

## Line2ds

**x** is any position along the line.  
**p** is an arbitrary position on the line.  
**d** is a direction vector parallel to the line.  
**t** is a parameter, .

## Line3ds

**x** is any position along the line.  
**p** is an arbitrary position on the line.  
**d** is a direction vector parallel to the line.  
**t** is a parameter, .

# Object-object queries

## Point and point

Point **p0**  
Point **p1**

### Point-point distance

## Line and point

Point **p0**  
Line **x1** = **p1** + t1 **d1**

### Point-line distance

#### Parameter t1 that minimizes distance

Project onto the line’s direction, and normalize to get a distance by dividing by .  
Divide by again to get a parameter, .

**d1**

#### Distance to line

From the above diagram:

Substituting into gives , which is equivalent.