Ray-cylinder intersection

- Infinite cylinder along y axis of radius r axis has equation

  x^2 + z^2 -r^2 = 0

- The equation for a more general cylinder of radius r oriented along a line **c** + **n***t
  where **c** is the center of the one surface sphere and **n** is the surface normal has following:

  (**d** - **n***dot(**n**, **d**))^2 - r^2 = 0 **,**where **d**=**x**-**c**, x is a point on the cylinder

simplified LHS = dot(**d**, **d**) - 2 dot(**n**, **d**)^2 + dot(**n**, **d**)^2 - r^2

= dot(**d**, **d**) - dot(**n**, **d**)^2 -r^2

To find the intersection points with a ray **o** + t***dir**, substitute in:

d = **x**-**c** = t * **dir** + **o** - **c** ;

reduces to A*t^2 + B*t + C = 0 with following:

0 = normsq(t * **dir** + **o** - **c**) - dot(**n**, t * **dir** + **o** - **c**)^2 - r^2

= t^2 normsq(**dir**) + 2t dot(**dir**, **o**-**c**) + normsq(**o**-**c**) - t^2 dot(**n**, **dir**)^2 - 2 t dot(**n**, **dir**) dot(**n**, **o**-**c**) - dot(**n**, **o**-**c**)^2 - r^2

= t^2 [normsq(**dir**) - dot(**n**, **dir**)^2] + t [2 dot(**dir**, **o**-**c**)] + normsq(**o**-**c**) - dot(**n**, **o**-**c**)^2 - r^2

-> A*t^2 B*t + C = 0

Thus, A = dot(**dir**, **dir**) - dot(**n**, **dir**)^2 = (**dir** - **n***dot(**n**, **dir**))^2

B = 2 * dot(**dir**, **o**-**c**) - 2 * dot(**n**, **dir**) dot(**n**, **dir**)

C = dot(**o**-**c**, **o**-**c**) - dot(**n**, **o**-**c**)^2 - r^2 = (**o**-**c** - **n***dot(**n**, **o**-**c**))^2 - r^2 calculate t with A,B,C we get, then the intersection point.

Normal deriviations

Let **I** be the intersection point, and **T** be the point on the axis through center of cylinder

There is dot(**I**, **T**)^2 − r^2 = 0 where **I** = t∗**dir** + o and **T** = a∗**n** + **c**

To simplify, substitute in **I** and **T**, reduces to A∗t^2 + B∗t + C = 0 with following:

[t∗**dir** + **o** − (a∗**n** + **c**)]^2 − r^2 = 0
(t∗**dir** + **oc** − a∗**n**)^2 − r^2 = 0
a^2 − 2**n**(t∗**dir** + **oc**)∗a + (t∗**dir** + **oc**)^2 − r^2 = 0

-> A∗t^2 B∗t + C = 0
Thus, A = 1
B = − 2**n**(t∗**dir** + **oc**)
C = (t∗**dir** + **oc**)^2 − r^2

calculate a with A,B,C we get, then the point **T** on the axis **n** through **c**.

With equation for points **I** and **T** we calculated above, the normal at intersection point **I** is:

Normal = (**I** − **T**)/r