

The context for the problem is as follows:

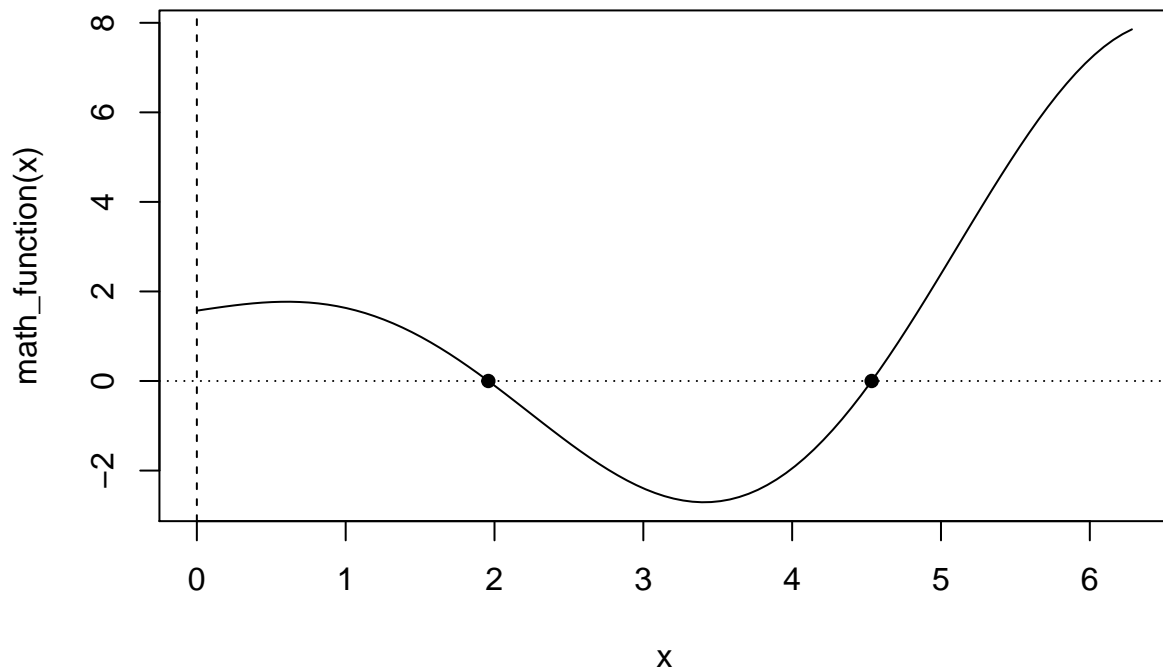
A farmer has a regular circular field filled with grass. If he ties a cow to the edge of the circle, how long does the lead have to be in order for the cow to eat exactly half of the field.

One approach involves a geometric approach of calculating the total area using arcs and sectors of two joined circles.

Another valid approach involves polar coordinates. The former method was used to find a solution.

```
library(rootSolve)
library(Rmpfr)

## Loading required package: gmp
##
## Attaching package: 'gmp'
## The following objects are masked from 'package:base':
##
##      %*%, apply, crossprod, matrix, tcrossprod
## C code of R package 'Rmpfr': GMP using 64 bits per limb
##
## Attaching package: 'Rmpfr'
## The following objects are masked from 'package:stats':
##
##      dbinom, dnorm, dpois, pnorm
## The following objects are masked from 'package:base':
##
##      cbind, pmax, pmin, rbind
math_function <- function(x) {
  value <- (x*cos(x) - sin(x/2) + (pi/2))
  return(value);
}
curve(math_function(x), 0, 2*pi)
abline(h = 0, lty = 3)
abline(v = 0, lty = 2)
solutions_list <- uniroot.all(math_function, c(0, 2*pi))
points(solutions_list, y = rep(0, length(solutions_list)), pch = 16, cex = 1)
```



```
check_function <- function(x) {
  value <- (2*x*cos(x/2)*cos(x/2)) + (pi/2) - (x) - (sin(x/2))
  return(value);
}
```

```
check_function(solutions_list)
```

```
## [1] -3.602617e-08  1.443301e-07
```

```
solutions_list
```

```
## [1] 1.958613 4.534221
```

```
mpfr(solutions_list[1], precBits=2)
```

```
## 1 'mpfr' number of precision 2 bits
```

```
## [1] 2
```

```
2*cos(solutions_list[1]/2)
```

```
## [1] 1.115197
```

So, the length of the rope the cow is tethered to must be 1.1152 times the radius of the circular enclosure.