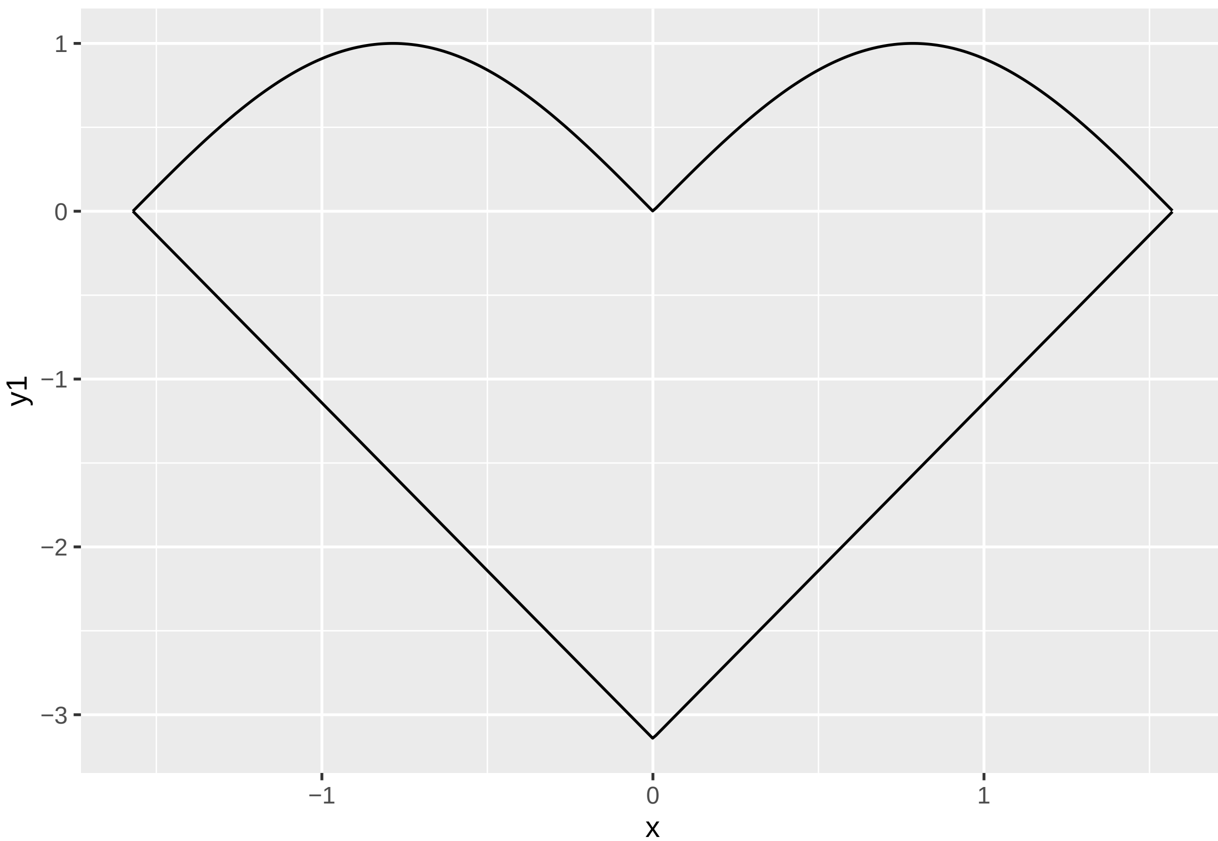
# HW1

```
library(ggplot2)
```

Let's print the graph

```
x <- seq(from=-pi/2, to=pi/2, by=0.01)
y1 <- 2 * abs(x) - pi
y2 <- abs(sin(2*x))

df <- data.frame(x=x, y1=y1, y2=y2)
ggplot(df, aes(x=x)) +
  geom_line(aes(x=x, y=y1)) +
  geom_line(aes(x=x, y=y2))
```




We will uniformly generate points inside the $(\pi) \times (\pi + 1)$ rectangle with corners in $(-\frac{\pi}{2}, -\pi), (\frac{\pi}{2}, 1)$. Then, the proportion of points inside the figure to the points outside will be equal to the proportion of figure's area to rectangle's areas. In other words:

$$\frac{N_{inside}}{N_{total}} = \frac{S_{figure}}{S_{rectangle}} \implies S_{figure} = \frac{N_{inside}}{N_{total}} \cdot S_{rectangle}$$

Let's generate $10^5$ points and plot them to check whether everything is fine.

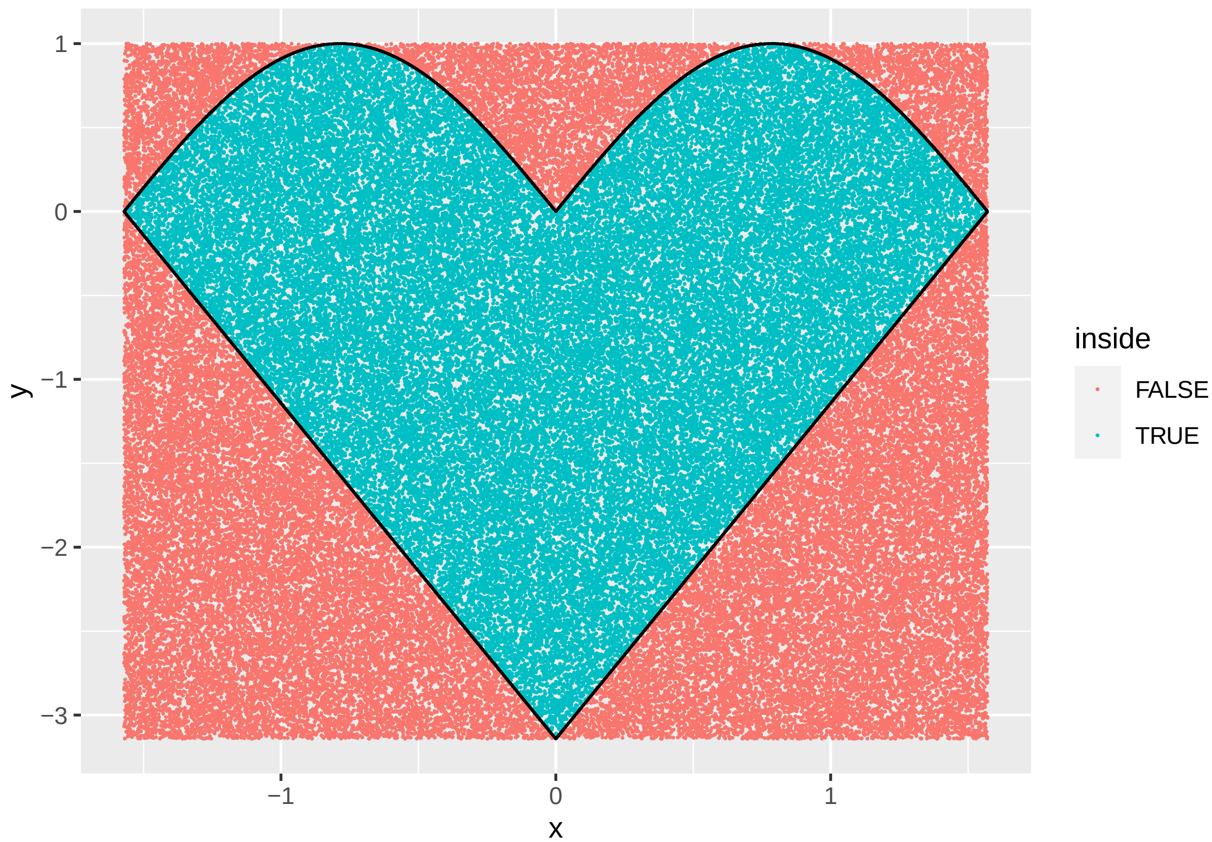
```
x <- runif(min=-pi/2, max=pi/2, n=100000)
y <- runif(min=-pi, max=1, n=100000)

bot_curve <- 2 * abs(x) - pi
top_curve <- abs(sin(2*x))

inside  <- (y < top_curve) & (y > bot_curve)

df <- data.frame(x=x, y=y, inside=inside,
                 top_curve=top_curve, bot_curve=bot_curve)

ggplot(df, aes(x)) +
  geom_point(aes(x=x, y=y, col=inside), size=0.01) +
  geom_line(aes(x=x, y=top_curve)) +
  geom_line(aes(x=x, y=bot_curve))
```




The proportion of point inside is equal to 0.53295. Then

$$S_{figure} = \frac{N_{inside}}{N_{total}} \cdot S_{rectangle} = 0.53295 \cdot \pi \cdot (\pi + 1) \approx 6.9343175$$

If we calculate this quantity analytically, we get:

$$\left| \int_{-\pi/2}^{\pi/2} (2|x| - \pi) dx \right| + \left| \int_{-\pi/2}^{\pi/2} \sin|2x| dx \right| = \frac{\pi^2}{2} + 2 \approx 6.9348$$

So, the MC approximation was very close to the actual result.