```
using Markdown
```

1D Gaussians [10 pts]

Let X be a univariate random variable distributed according to a Gaussian distribution with mean μ and variance σ^2

```
md"""

# 1D Gaussians [10 pts]

Let $X$ be a univariate random variable distributed according to a Gaussian
distribution with mean $\mu$ and variance $\sigma^2$

"""
```

Can the probability density function (pdf) of X ever take values greater than 1?

Answer:

```
md"""
### Can the probability density function (pdf) of $X$ ever take values greater than
$1$?

Answer:
"""
```

Write the expression for the pdf of a univariate gaussian:

Answer:

Write the code for the function that computes the pdf at x.

```
gaussian_pdf (generic function with 1 method)
```

```
function gaussian_pdf(x; mean=0., variance=0.01)
  #default variables mean and variance
  #set with keyword arguments
  return #TODO: implement pdf at x
end
```

Test your implementation against a standard implementation

E.g. from a library, e.g. Distributions.jl.

```
Enter cell code...
```

```julia
using Test
```

```julia
using Distributions: pdf, Normal
# Note Normal uses N(mean, stddev) for parameters
```

Some tests did not pass: 0 passed, 0 failed, 2 errored, 0 broken.

1. finish(::Test.DefaultTestSet) @ *Test.jl:879*
2. top-level scope @ *Test.jl:1125*
3. top-level scope @ *Local: 2*

```julia
@testset "Implementation of Gaussian pdf" begin
  x = randn()
  @test gaussian_pdf(x) ≈ pdf.(Normal(0.,sqrt(0.01)),x)
  # ≈ is syntax sugar for isapprox, typed with '\approx <TAB>'
  # or use the full function, like below
  @test isapprox(gaussian_pdf(x,mean=10., variance=1) , pdf.(Normal(10., sqrt(1)),x))
end
```

What is the value of the pdf at $x = 0$? What is probability that $x = 0$?

```julia
md"""
###  What is the value of the pdf at $x=0$? What is probability that $x=0$?
"""
```

```
Enter cell code...
```

A Write the transformation that takes $x \sim \mathcal{N}(0., 1.)$ to $z \sim \mathcal{N}(\mu, \sigma^2)$

A Gaussian with mean μ and variance σ^2 can be written as a simple transformation of the standard Gaussian with mean $0.$ and variance $1.$.

Answer:

```julia
md"""
###  A Write the transformation that takes $x \sim \mathcal{N}(0.,1.)$ to $z \sim
\mathcal{N}(\mu, \sigma^2)$

A Gaussian with mean $\mu$ and variance $\sigma^2$ can be written as a simple
transformation of the standard Gaussian with mean $0.$ and variance $1.$.

Answer:
"""
```

```
Enter cell code...
```

Write a code to sample from $\mathcal{N}(\mu, \sigma^2)$

Implement function returning n independent samples from $\mathcal{N}(\mu, \sigma^2)$ by transforming n samples from $\mathcal{N}(0., 1.)$

```
function sample_gaussian(n; mean=0., variance=0.01)
  # n samples from standard gaussian
  x = #TODO

  # TODO: transform x to sample z from N(mean,variance)
  z =
  return z
end;
```

Test your implementation by computing statistics on the samples

```
using Statistics: mean, var
```

```
@testset "Numerically testing Gaussian Sample Statistics" begin
  #TODO: choose some values of mean and variance to test
  #TODO: Sample 100000 samples with sample_gaussian
  #TODO: Use `mean` and `var` to compute statistics
  #TODO: test statistics against true values
  # hint: use isapprox with keyword argument atol=1e-2
end;
```

Plot pdf and normalized histogram of samples

Sample 10000 samples from a Gaussian with mean $10.$ and variance 2.0.

1. Plot the **normalized** `histogram` of these samples.
2. On the same axes `plot!` the pdf of this distribution.

Confirm that the histogram approximates the pdf.

(Note: with `Plots.jl` the function `plot!` will add to the existing axes.)

```
md"""
### Plot pdf and normalized histogram of samples

Sample $10000$ samples from a Gaussian with mean $10.$ and variance $2.0$.

1. Plot the **normalized** `histogram` of these samples.
2. On the same axes `plot!` the pdf of this distribution.
Confirm that the histogram approximates the pdf.

(Note: with `Plots.jl` the function `plot!` will add to the existing axes.)
"""
```

```julia
using Plots
```

```julia
#histogram() #TODO
#plot!() #TODO
```