BMEG 802 – Advanced Biomedical Experimental Design and Analysis

Assignment 6

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Question 1

```
a = c(8.453532, 10.025041, 11.495339,  9.367600,  8.333229,
      9.788753, 10.883344, 10.543059,  9.869095, 10.799819)
```

Question 1 Cont'd

```
n = length(a)
mu = sum(a)/length(a)
var = ((sum((a - mu)^2)/n))
mu
```

```
## [1] 9.955881
```

```
var
```

```
## [1] 0.9563501
```

Question 1 Cont'd

```
mle <- array(dim=c(1000,100))
for (i in 0:1000) {
  for (j in 0:100){
    mu0 = 5 + i * 0.01
    var0 = 0.5 + j * 0.01
    mle[i,j] = -1.0 * (-n/2 * log(2*pi) - n/2 * log(var0) - sum((a - mu0)^2)/(2*var0))
  }
}

MLE <- which(mle == min(mle), arr.ind = TRUE)
mu_min = 5 + MLE[1] * 0.01
var_min = 0.5 + MLE[2] * 0.01
mu_min
```

```
## [1] 9.96
```

```
var_min
```

```
## [1] 0.96
```

Question 1 Cont'd

```
neglogl <- function(X) {
  mu0 <- X[1]
  var0 <- X[2]
  a = c(8.453532, 10.025041, 11.495339,  9.367600,  8.333229,  9.788753, 1
  n = length(a)
  loglik <- -n/2 * log(2*pi) - n/2 * log(var0) -
    sum((a - mu0)^2)/(2*var0)
  return(-1 * loglik)
}
opt <- nlm(f=neglogl, c(8,0.5))
```

```
## Warning in log(var0): NaNs produced
```

```
## Warning in nlm(f = neglogl, c(8, 0.5)): NA/Inf replaced by maximum posi
## value
```

Question 1 Cont'd

```
opt$estimate
```

```
## [1] 9.9558761 0.9563495
```

Question 2

2a: Answer: [0.63157895, 0.74611399, 0.83437953]

2b: Answer: [0.01702128, 0.02882883, 0.04842371]

2c: Answer: all zeroes

2d: Answer: [0.38095238, 0.27467811, 0.18899963]

Question 3a

```
mu0 = 11.0
sigma0 = 1.0
sigma1 = 1.0
mu1 = c(8.453532, 10.025041, 11.495339,  9.367600,  8.333229,
        9.788753, 10.883344, 10.543059,  9.869095, 10.799819)
mu2= (mu0 / sigma0 ** 2 + sum(mu1) / sigma1 ** 2) /
  (1 / sigma0 ** 2 + length(mu1) / sigma1 ** 2)
sigma2 = ((1 / sigma0 ** 2 + length(mu1) / sigma1 ** 2)**(-1.0)) ** (1/2.)
mu2
```

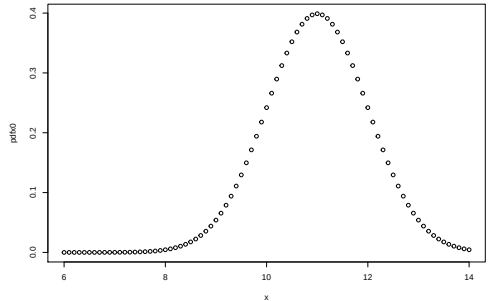
```
## [1] 10.0508
```

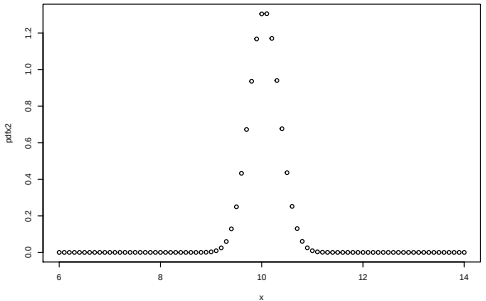
```
sigma2
```

```
## [1] 0.3015113
```

Question 3b

```
x <- seq(from = 6.0, to = 14, by = 0.1)
pdfx0 = (1/(sigma0 * sqrt(2 * pi)))*exp(-(1/2) * ((x - mu0)/sigma0)^2)
pdfx2 = (1/(sigma2 * sqrt(2 * pi)))*exp(-(1/2) * ((x - mu2)/sigma2)^2)
plot(x,pdfx0)
plot(x,pdfx2)
```





Question 3cd

Why do our estimates of μ differ between Question 1 and 3 (1 mark)?

- They are different because we accounted for a prior.

What does the posterior represent and how does this differ MLE (1 mark)?

- The probability of μ_2 [i.e., $p(\mu|\sigma, x)$]
- We get more than a point estimate — we get the probability of μ_2 for different values of μ_2