HW05 Report

Ninh (Vincent) DO

March 7, 2019

Problem 1b

```
# Parameter of Poisson
lambda_0 = 1

# Number of data points and level of significance alpha
n = 20
alpha = 0.05

# Number of experiment
N = 500

test_results = rep(0, N)
p_values = rep(0, N)
for (i in 1 : N) {
  # Generate Poisson data
  X = rpois(n, lambda_0)

  # Perform Wald test for Poisson
  X_mean = mean(X)
  se_hat = (X_mean / n) ^ 0.5
  W = (X_mean - lambda_0) / se_hat
  z_alpha_half = qnorm(1 - alpha / 2)    # or -qnorm(alpha / 2)
  test_results[i] = abs(W) > z_alpha_half
  p_values[i] = 2 * (1 - pnorm(abs(W)))    # or 2 * pnorm(-abs(W))
}

# Test results: 0 means accept null, 1 - reject null
test_results
```

```
##   [1] 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0
##  [36] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
##  [71] 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [106] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0
## [141] 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0
## [176] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0
## [211] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
## [246] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
## [281] 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [316] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0
## [351] 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [386] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0
## [421] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [456] 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
## [491] 0 0 0 0 0 0 0 0 0 1
```

```r
# p-values
p_values
```

```
##   [1] 1.0000000000 0.8185458084 0.3173105079 0.8185458084 0.0066556055
##   [6] 0.6698153576 1.0000000000 0.4668542708 0.5316145769 0.5316145769
##  [11] 0.8272593466 0.6373518882 0.6373518882 0.6373518882 0.5316145769
##  [16] 0.4142161782 0.5316145769 1.0000000000 0.1305700181 0.0946707198
##  [21] 0.0163512216 0.3173105079 0.6698153576 0.1779317253 0.6698153576
##  [26] 1.0000000000 0.2393165412 0.0522036353 0.8272593466 0.1779317253
##  [31] 0.4668542708 0.8272593466 0.0209213353 0.8185458084 0.8272593466
##  [36] 0.2393165412 0.8272593466 0.8272593466 0.6698153576 0.8272593466
##  [41] 0.8272593466 1.0000000000 0.1088094300 0.1088094300 0.6373518882
##  [46] 0.1967056025 1.0000000000 0.4668542708 0.6373518882 0.6698153576
##  [51] 0.2393165412 0.3173105079 0.4668542708 1.0000000000 0.8185458084
##  [56] 0.3173105079 0.8185458084 0.0946707198 0.3173105079 0.6373518882
##  [61] 0.8185458084 0.5316145769 0.4668542708 0.3173105079 0.3173105079
##  [66] 0.6373518882 0.1088094300 0.3173105079 0.1967056025 0.8272593466
##  [71] 0.8272593466 0.3173105079 0.8272593466 0.8185458084 0.6698153576
##  [76] 0.5316145769 0.6698153576 0.3173105079 0.8272593466 0.1088094300
##  [81] 0.0066556055 0.8272593466 0.1088094300 0.6373518882 1.0000000000
##  [86] 0.3173105079 0.3173105079 0.3173105079 0.1305700181 0.8185458084
##  [91] 0.5316145769 0.8272593466 0.8272593466 0.6698153576 0.8272593466
##  [96] 1.0000000000 0.6373518882 0.1967056025 0.8185458084 0.6373518882
## [101] 0.1967056025 0.3173105079 0.8185458084 0.1088094300 0.4668542708
## [106] 0.8185458084 0.6373518882 0.8272593466 0.6373518882 0.6373518882
## [111] 0.6373518882 0.3173105079 1.0000000000 0.4668542708 0.8272593466
## [116] 0.5316145769 0.2393165412 0.6373518882 0.4142161782 1.0000000000
## [121] 0.2393165412 0.8272593466 0.4668542708 0.2393165412 1.0000000000
## [126] 0.5316145769 0.8272593466 1.0000000000 0.5316145769 0.6698153576
## [131] 0.3173105079 0.8185458084 0.1305700181 0.6698153576 0.1779317253
## [136] 1.0000000000 0.0209213353 1.0000000000 0.8185458084 0.0522036353
## [141] 0.1779317253 0.3173105079 0.0002457328 0.3173105079 0.3173105079
## [146] 0.0338948535 0.8185458084 0.1967056025 1.0000000000 0.8272593466
## [151] 0.8272593466 0.6373518882 0.1967056025 0.4668542708 0.8272593466
## [156] 0.3173105079 0.8185458084 0.1967056025 0.0946707198 0.0209213353
## [161] 0.8185458084 0.4668542708 0.0066556055 0.0678891549 0.0066556055
## [166] 0.4668542708 0.1967056025 0.1967056025 0.6698153576 0.8185458084
## [171] 0.5316145769 1.0000000000 0.1779317253 0.6698153576 0.1088094300
## [176] 1.0000000000 0.6698153576 0.6698153576 0.4668542708 0.3173105079
## [181] 0.4668542708 0.8272593466 0.8185458084 0.6698153576 0.4142161782
## [186] 0.1967056025 0.6373518882 0.4668542708 0.5316145769 1.0000000000
## [191] 0.5316145769 0.5316145769 0.4668542708 1.0000000000 0.6373518882
## [196] 0.6698153576 0.6373518882 0.3173105079 0.5316145769 1.0000000000
## [201] 0.2393165412 0.1088094300 0.3173105079 0.8272593466 0.8272593466
## [206] 0.1305700181 0.4142161782 0.0066556055 1.0000000000 0.1088094300
## [211] 0.8272593466 0.4668542708 0.6373518882 0.6373518882 0.6698153576
## [216] 0.1779317253 0.1967056025 0.1088094300 0.3173105079 0.8272593466
## [221] 0.6373518882 0.5316145769 0.4142161782 0.8185458084 0.4668542708
## [226] 0.6698153576 0.5316145769 0.8185458084 0.1088094300 0.1967056025
## [231] 0.0209213353 0.6373518882 0.1088094300 0.6698153576 0.5316145769
## [236] 0.1088094300 0.6698153576 0.3173105079 0.4142161782 0.6373518882
## [241] 0.4668542708 0.1088094300 0.6698153576 0.3173105079 0.8185458084
## [246] 0.0678891549 0.3173105079 0.3173105079 0.3173105079 1.0000000000
## [251] 0.8185458084 0.5316145769 0.3173105079 1.0000000000 0.4142161782
```

```
## [256] 0.5316145769 0.6373518882 0.3173105079 0.8272593466 0.4668542708
## [261] 0.1779317253 0.6698153576 0.6373518882 0.1967056025 1.0000000000
## [266] 0.6373518882 0.6698153576 1.0000000000 0.6373518882 0.0209213353
## [271] 0.6373518882 0.3173105079 0.3173105079 0.0678891549 0.2393165412
## [276] 0.4142161782 0.1305700181 0.6698153576 1.0000000000 0.3173105079
## [281] 0.6373518882 0.8272593466 1.0000000000 0.8272593466 1.0000000000
## [286] 1.0000000000 0.4668542708 0.3173105079 0.1967056025 0.3173105079
## [291] 0.0015654023 0.8185458084 0.8272593466 0.5316145769 0.8185458084
## [296] 0.4142161782 0.8185458084 0.5316145769 0.6373518882 1.0000000000
## [301] 0.6698153576 0.1779317253 0.2393165412 0.5316145769 0.4142161782
## [306] 0.6698153576 1.0000000000 1.0000000000 0.2393165412 0.1088094300
## [311] 0.6698153576 0.8185458084 0.1967056025 0.1967056025 0.8185458084
## [316] 0.1779317253 0.1088094300 0.5316145769 0.4668542708 0.5316145769
## [321] 0.1779317253 0.2393165412 0.1967056025 0.5316145769 0.1779317253
## [326] 0.8272593466 0.8185458084 0.1779317253 0.1088094300 0.6698153576
## [331] 0.8185458084 0.1088094300 0.6698153576 0.0066556055 0.4668542708
## [336] 0.0002457328 0.8272593466 0.8185458084 0.8185458084 0.8272593466
## [341] 0.0678891549 0.8185458084 0.0522036353 0.1088094300 0.3173105079
## [346] 0.5316145769 0.4668542708 0.4142161782 0.6373518882 0.4142161782
## [351] 0.0522036353 0.1967056025 0.2393165412 0.6698153576 0.8185458084
## [356] 0.1967056025 0.3173105079 0.4668542708 0.1967056025 0.0522036353
## [361] 0.3173105079 0.6373518882 0.0209213353 0.6373518882 0.4668542708
## [366] 0.0209213353 0.6698153576 0.0678891549 0.8185458084 0.4142161782
## [371] 0.8272593466 0.3173105079 0.8185458084 0.1305700181 0.3173105079
## [376] 0.0522036353 0.8272593466 0.6373518882 0.3173105079 1.0000000000
## [381] 0.4668542708 0.6373518882 0.6373518882 0.4668542708 0.8185458084
## [386] 0.3173105079 0.2393165412 0.6698153576 0.3173105079 0.6698153576
## [391] 1.0000000000 0.4142161782 1.0000000000 0.8272593466 0.8272593466
## [396] 0.6373518882 0.8272593466 0.6698153576 0.8185458084 1.0000000000
## [401] 0.4668542708 0.6373518882 0.6373518882 0.1967056025 0.5316145769
## [406] 0.6373518882 0.3173105079 0.4668542708 0.1967056025 0.2393165412
## [411] 0.8185458084 0.0209213353 0.0522036353 0.4668542708 0.4668542708
## [416] 0.8185458084 0.4142161782 0.0338948535 0.2393165412 0.6373518882
## [421] 1.0000000000 1.0000000000 0.2393165412 0.0946707198 0.5316145769
## [426] 0.1967056025 0.4142161782 0.8185458084 1.0000000000 0.8272593466
## [431] 0.5316145769 0.8185458084 0.8272593466 0.8185458084 0.3173105079
## [436] 0.3173105079 0.1967056025 0.0066556055 0.0066556055 0.1967056025
## [441] 1.0000000000 0.8272593466 0.1967056025 0.8185458084 0.4142161782
## [446] 0.1088094300 0.6373518882 0.6698153576 0.8272593466 0.4142161782
## [451] 1.0000000000 0.0522036353 0.4668542708 1.0000000000 0.6373518882
## [456] 0.1088094300 0.5316145769 0.0946707198 0.3173105079 0.6698153576
## [461] 0.8185458084 0.4142161782 0.8272593466 0.0002457328 0.0209213353
## [466] 0.3173105079 1.0000000000 0.8272593466 1.0000000000 0.4668542708
## [471] 1.0000000000 0.1779317253 1.0000000000 1.0000000000 0.3173105079
## [476] 0.6698153576 0.8272593466 0.3173105079 0.3173105079 0.4668542708
## [481] 0.8185458084 0.3173105079 0.1779317253 0.6698153576 0.5316145769
## [486] 0.8185458084 0.1779317253 0.8272593466 0.8185458084 0.0066556055
## [491] 0.6373518882 0.4668542708 0.3173105079 1.0000000000 0.1088094300
## [496] 0.4668542708 0.5316145769 0.8185458084 0.8185458084 0.0209213353
```

```
# The type I error rate
sum(test_results) / N
```

```
## [1] 0.052
```

The type I error rate is close to 0.05, but not equal. It is probably because the sample size is small (n = 20).