ISyE 2028 – Basic Statistical Methods - Fall 2015
Bonus Project: "Big" Data Analytics
Final Report

Georgia Tech Aquatic Center Oxidation Reduction Potential Statistical Analysis

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Abstract:
For many students at Georgia Tech, the Campus Recreation Center (CRC) is a staple of student life. Home to a vast workout facility, multiple recreational courts, and a state of the art aquatic center, the CRC is an iconic landmark on campus. Since its beginnings at the 1996 Olympics, the swimming pools at the CRC are notably a complex and impressive feat of engineering. Today the leisure pool, competition pool, and dive well house millions of gallons of water and serves thousands of students. To ensure the safety of the swimmers and quality of the water, certain chemicals must be introduced and monitored to kill bacteria and other harmful agents. Chlorine and Bromine are the chemicals of choice for the pools at the CRC. Oxidation reduction potential (ORP) measures the ability of chlorine or bromine to eliminate harmful agents. It is necessary to maintain ORP level to maintain the overall safety of the pool. This analysis will take a large sample of ORP readings from the three main pools and conduct a confidence interval on each to determine if the interval contains the set point at which the pool's ORP is supposed to be.

Measurements:
ORP – Oxidation Reduction Potential (millivolts)

Sample Data:
The ORP readings will be collected from the log books at the CRC. Everyday walkthroughs are conducted to collect current and accurate readings of multiple measurements of the pool. There will be 50 samples collected from 50 previous days of measurements.

Date	CP	DP	LP
8/31/2015	841	824	686
9/1/2015	844	829	699
9/2/2015	841	834	694
9/4/2015	844	828	694
9/5/2015	844	830	695
9/6/2015	849	825	699
9/8/2015	842	820	702
9/9/2015	847	826	700
9/11/2015	848	834	696
9/12/2015	840	825	699
9/13/2015	849	833	695
9/14/2015	849	828	696
9/15/2015	848	831	695
9/16/2015	839	829	698
9/17/2015	850	826	694
9/18/2015	847	827	695
9/21/2015	847	833	698
9/23/2015	847	831	698
9/25/2015	850	825	697
9/26/2015	848	830	696
9/27/2015	842	842	696
9/28/2015	842	836	694
9/29/2015	846	834	682
9/30/2015	845	827	686
10/1/2015	849	834	686
10/2/2015	850	836	682
10/4/2015	846	858	664
10/5/2015	846	855	688
10/6/2015	849	855	674
10/7/2015	850	829	697
10/8/2015	851	832	697
10/14/2015	846	826	688
10/19/2015	848	825	686
10/20/2015	847	817	685
10/21/2015	841	835	681
10/22/2015	840	828	682
10/23/2015	843	827	682
10/26/2015	841	834	709
10/28/2015	848	832	723
10/29/2015	841	827	716
10/30/2015	850	835	766
10/31/2015	846	836	748
11/2/2015	842	838	737
11/3/2015	841	832	727
11/4/2015	846	828	714
11/5/2015	844	835	692
11/6/2015	847	824	746
11/7/2015	847	828	737
11/8/2015	844	835	721
11/9/2015	846	838	715
11/10/2015	845	837	704

Figure 1 The table above lists 50 ORP readings beginning on 8/31/15. CP denotes competition pool, DP denotes dive pool, and LP denotes leisure pool.

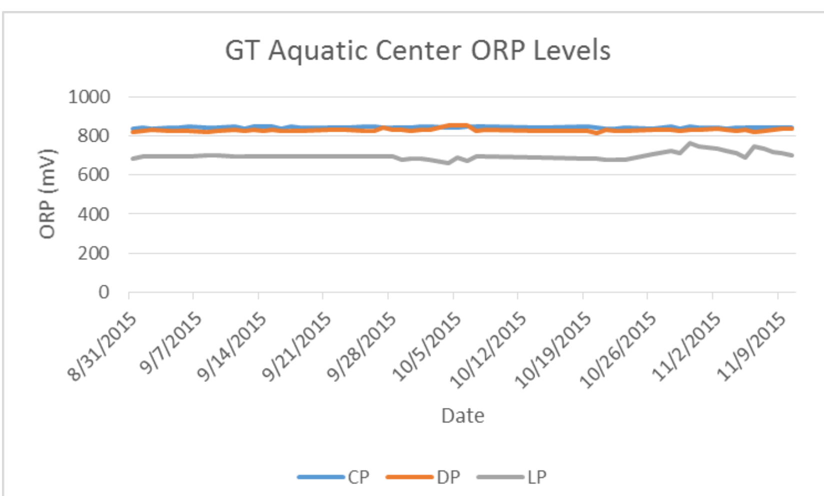

Figure 2 The graph above is a time series graph of the data points listed in Figure 1.

Statistical Methods:
Original Proposal: A two-sided confidence interval for a population with an unknown standard deviation will be conducted on the sample data. A confidence level of 95% will be used. I plan to use Excel and graphing technology to compute interval and illustrate trends. The conclusion from the confidence interval will show if many samples were taken from each pool, 99% of the time the true mean will fall within the interval. The set point can be compared to the interval to determine if the true mean is actually within the interval.
Final Method: A single sample hypothesis test for a population with an unknown standard deviation will be conducted on the sample data. Each pool has a set point ORP that must be met to conform to safety standards. The set average set points for the competition pool, dive pool, and leisure pool are 835 mV, 825 mV, and 690 mV respectively. These procedures will test the hypothesis that the population mean of the ORP readings are not equal to the set points with a significance level of α=0.05.

Computations:

1. Competition Pool
    a. Parameter of Interest: μ
    b. H_0: μ = 835
       H_A: μ ≠ 835
    c. Test Statistic
        xbar = 845.5 #sample mean
        mu0 = 835 #hypothesized value
        s = 3.263824 #sample standard deviation
        n = 51 #sample size
        t = (xbar-mu0)/(s/sqrt(n))
        t = 22.97458 #test statistic
    d. Rejection Region
        alpha = .05
        t.half.alpha = qt(1-alpha/2,df=n-1)
        c(-t.half.alpha,t.half.alpha)
        (-2.008559 2.008559)
       If the test statistic is greater than or less than this rejection region, we reject the null hypothesis.
    e. Conclusion
        i. Because the test statistic is significantly greater than the rejection region, we reject the null in favor of the alternative hypothesis that the population ORP level is not equal to the set point.

2. Dive Pool
    a. Parameter of Interest: μ
    b. H_0: μ = 825
       H_A: μ ≠ 825
    c. Test Statistic
        xbar = 831.8 #sample mean
        mu0 = 825 #hypothesized value
        s = 7.814617 #sample standard deviation

n = 51 #sample size
t = (xbar-mu0)/(s/sqrt(n))
t = -2.924337 #test statistic

d. Rejection Region

alpha = .05
t.half.alpha = qt(1-alpha/2,df=n-1)
c(-t.half.alpha,t.half.alpha)
(-2.008559 2.008559)

If the test statistic is greater than or less than this rejection region, we reject the null hypothesis.

e. Conclusion
    i. Because the test statistic is less than the rejection region, we reject the null in favor of the alternative hypothesis that the population ORP level is not equal to the set point.

3. Leisure Pool
    a. Parameter of Interest: μ
    b. H_0: μ = 690
       H_A: μ ≠ 690
    c. Test Statistic

xbar = 703.8 #sample mean
mu0 = 690 #hypothesized value
s = 19.65307 #sample standard deviation
n = 51 #sample size
t = (xbar-mu0)/(s/sqrt(n))
t = 3.851772 #test statistic

    d. Rejection Region

alpha = .05
t.half.alpha = qt(1-alpha/2,df=n-1)
c(-t.half.alpha,t.half.alpha)
(-2.008559 2.008559)

If the test statistic is greater than or less than this rejection region, we reject the null hypothesis.

    e. Conclusion
        i. Because the test statistic is greater than the rejection region, we reject the null in favor of the alternative hypothesis that the population ORP level is not equal to the set point.

Results:

a. For each hypothesis test conducted, we rejected the null hypothesis that the true ORP level was equal to the set point in favor of the alternative that the true population ORP level is not equal to the set point. These results can tell us two things:
    i. ORP level is below acceptable level
    ii. ORP is above acceptable level

If the ORP level is below acceptable level, the pool does not have adequate chemical levels to eliminate harmful agents. If the ORP level is too high, the chlorine level is too high and can lead to skin and eye irritation. Overall, the ORP level needs to be maintained

around the set point to maintain the safety of the pools. The results from the hypothesis test shows that on average, the set point is not being maintained.
From experience this makes sense. The ORP level fluctuates frequently due to frequent use, chemical supply level, and pump maintenance. Although the results do show the set point is maintained, it does not necessarily mean the pools are not safe to swim in. The results more so showcase the instability in ORP levels.
Moving forward, these results should be presented to the Aquatics Director in order to establish an improved system to increase and decrease ORP levels without letting the levels get too low or high.