6.s02: EECS II - From A Medical Perspective

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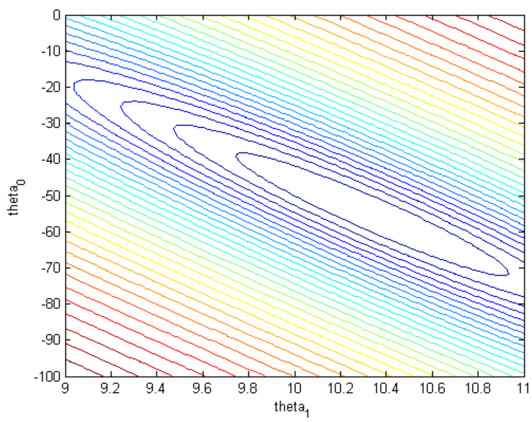
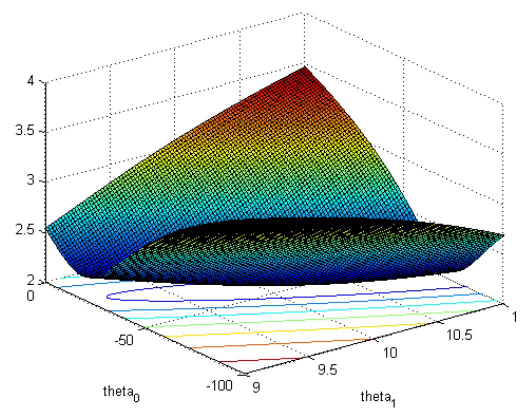
March 17, 2014

1. Visual estimate of minimum of $J(\theta_0, \theta_1)$ at $\theta_0 = -55$ and $\theta_1 = 10.4$

   Contour and surface plots





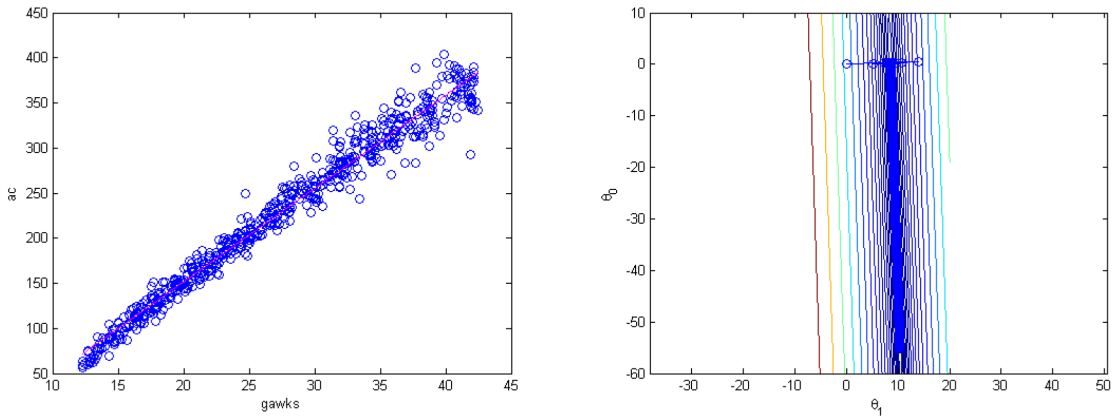

```
function [theta0_vals, theta1_vals, J] = lossfctn( x, y, theta0range, theta1range )
    theta0_vals = zeros(1,100);
    theta1_vals = zeros(1,100);
    theta0s = theta0range(1):(theta0range(2) - theta0range(1))/99:theta0range(2);
    theta1s = theta1range(1):(theta1range(2) - theta1range(1))/99:theta1range(2);
    J = zeros(100);
    numPoints = length(x);
    for i = 1:length(theta0s)
        theta0_vals(i) = theta0s(i);
        for j = 1:length(theta1s)
            theta1_vals(j) = theta1s(j);
            total = 0;
            for n = 1:numPoints
                h = theta0s(i) + theta1s(j)*x(n);
                total = total + (h - y(n))^2;
            end
            total = (0.5/numPoints) * total;
            J(i, j) = total;
        end
    end
end
```

2. For $\alpha = 2$ after 42,687 iterations the algorithm converged at $\theta_0 = -55.1441$ and $\theta_1 = 10.3370$
For $\alpha = 3$ the algorithm times out after 50,000 iterations with `NaN` for θ_0 and θ_1 because the step size was too large. This led to it being unstable and diverging.

Polyfit results were $\theta_0 = -55.1756$ and $\theta_1 = 10.3381$

Both sets of values are close to the visual estimate of θ_0 and θ_1 from `(1c)`

Left: Best fit line (magenta) overlaid on `ac` and `gawks` data (blue).
Right: Contour plot displaying progression of θ_0 and θ_1



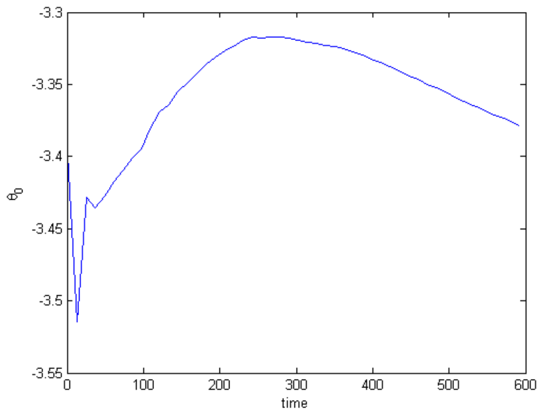

```
function theta = gradientdescent( x, y, alpha, theta_init, tol )
    maxIters = 50000;
    iter = 0;
    numPoints = length(x);
    theta0 = theta_init(1);
    theta1 = theta_init(2);
    theta = [theta0 theta1];
    while iter < maxIters
        iter = iter + 1;
        theta0Total = 0;
        theta1Total = 0;
        for i = 1:numPoints
            h = theta0 + theta1 * x(i);
            theta0Total = theta0Total + (h - y(i));
            theta1Total = theta1Total + (h - y(i)) * x(i);
        end
        theta0_old = theta0;
        theta1_old = theta1;
        theta0 = theta0 - alpha / numPoints * theta0Total;
        theta1 = theta1 - alpha / numPoints * theta1Total;
        theta = [theta; theta0 theta1];
        theta0Check = abs((theta0 - theta0_old) / theta0_old);
        theta1Check = abs((theta1 - theta1_old) / theta1_old);
        if theta0Check < tol && theta1Check < tol, break, end
    end
end
```

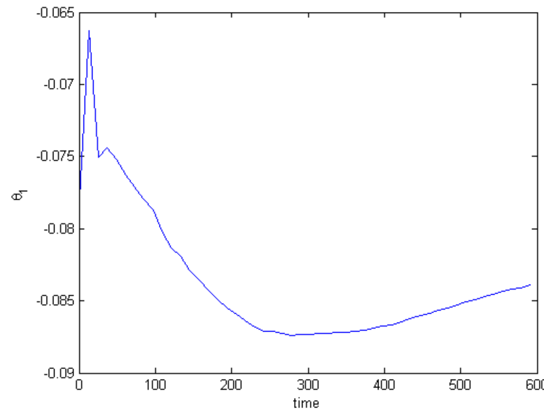
3. For the `ac` and `gawks` data $CI(1) = 3.922$ and $CI(2) = 0.137$

```
function CI = confidenceintervals(x, y, theta)
    theta0 = theta(1);
    theta1 = theta(2);
    numPoints = length(x);
    totalSE = 0;
    for n = 1:numPoints
        h = theta0 + theta1*x(n);
        totalSE = totalSE + (h - y(n))^2;
    end
    SEres = sqrt(totalSE / (numPoints - 2));
    D = numPoints * sum(x.^2) - sum(x)^2;
    SETheta0 = SEres * sqrt(sum(x.^2) / D);
    SETheta1 = SEres * sqrt(numPoints / D);
    CI = [1.96*SETheta0 1.96*SETheta1];
end
```

4. `i_start` $= 594$
   `i_exp` $= 994$
   `t(i_start)` $= 5.93$
   `t(i_exp)` $= 9.93$

   Maximum step size before instability is $\alpha = 1.5$, which results in $\theta_0 = -55.175$ and $\theta_1 = 10.338$






```
function [ theta0, theta1, ci ] = glucosepredict( t, I )

    x_norm = (t - min(t))/(max(t)-min(t));
    y_norm = (I - min(I))/(max(I)-min(I));

    descentLog = gradientdescent(x_norm, y_norm, 0.01, [0 0], 1e-4);
    temp = descentLog(end, :);
    theta0Prime = temp(1);
    theta1Prime = temp(2);

    theta0 = min(I) + theta0Prime * (max(I) - min(I)) - theta1Prime * min(t) * ((max(I) -
        min(I)) / (max(t) - min(t)));
    theta1 = theta1Prime * ((max(I) - min(I)) / (max(t) - min(t)));

    ci = confidenceintervals(t, I, [theta0 theta1]);
end
```