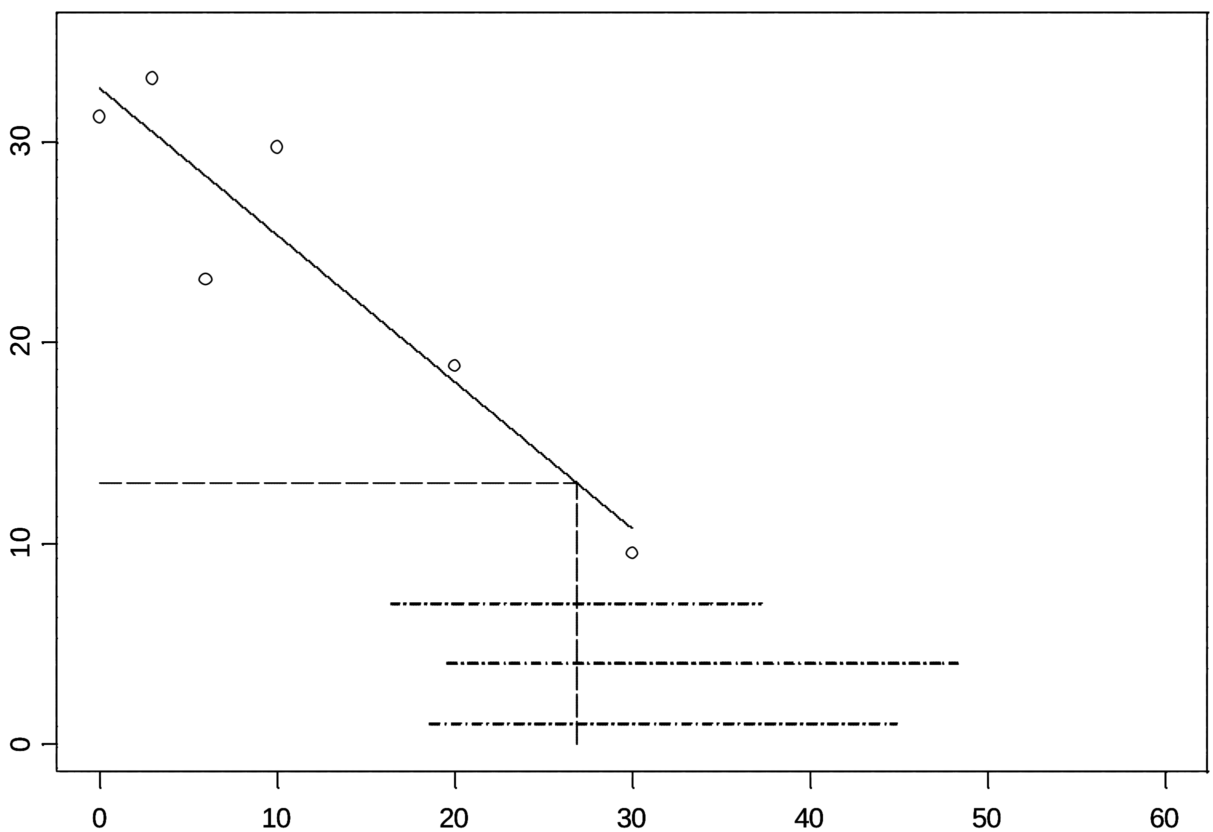
A. <u>Laetisaric Acid – p.7 example 2 in Chapter 5</u>

Model Function: $\eta(x) = 13 + \beta(x - \gamma_{13})$

Fungal Growth versus Concentration of Laetisaric Acid

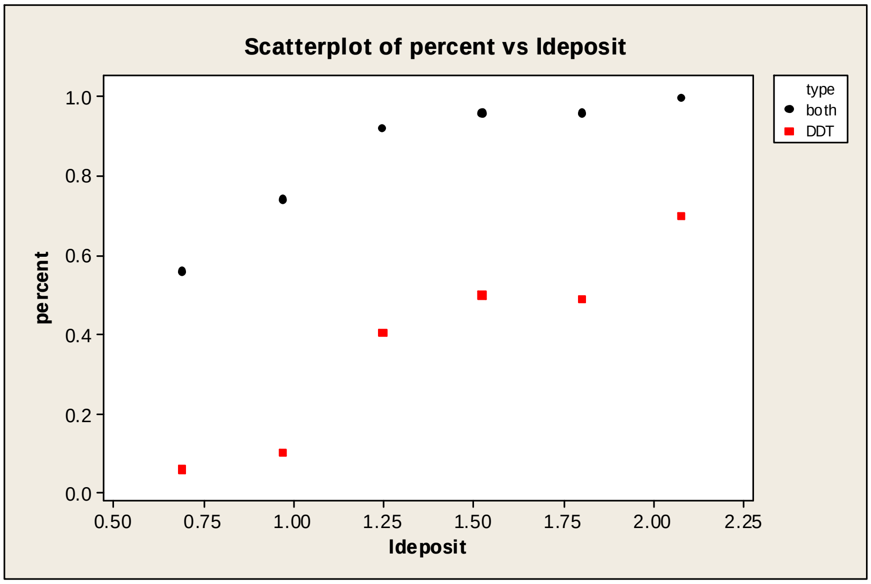


<u>95% Confidence Intervals for g_{13}</u>

Wald	16.45	37.29
PLCI	19.50	48.36
MCCI	18.53	44.88

B. Additional Comments on Dummy Variables

Homework 4, Exercise 4a



type	ldeposit	dead	N	percent	typeboth	TB*LDep
DDT	0.69315	3	50	0.06000	0	0.00000
DDT	0.97078	5	49	0.10204	0	0.00000
DDT	1.24703	19	47	0.40426	0	0.00000
DDT	1.52388	19	38	0.50000	0	0.00000
DDT	1.80171	24	49	0.48980	0	0.00000
DDT	2.07944	35	50	0.70000	0	0.00000
both	0.69315	28	50	0.56000	1	0.69315
both	0.97078	37	50	0.74000	1	0.97078
both	1.24703	46	50	0.92000	1	1.24703
both	1.52388	48	50	0.96000	1	1.52388
both	1.80171	48	50	0.96000	1	1.80171
both	2.07944	50	50	1.00000	1	2.07944

For simplicity, let X denote "ldeposit", T denote the "typeboth" dummy variable, and TX denote the product, TB*LDep = typeboth*ldeposit.

model function

$\log[\pi/(1-\pi)] = \alpha + \beta*X + \delta T + \phi TX$, so the RHS is equal to

$\alpha + \beta*X$ for those receiving DDT, and equal to

$(\alpha + \delta) + (\beta + \phi)*X$ for those receiving both DDT and g-BHC

It follows that since d **is the difference of the intercepts**, and since f **is the difference of the slopes**, we test whether one curve fits both groups (that is, whether the intercepts and slopes are the same) by testing

H_0: $\delta = \phi = 0$
Versus
H_A: either δ or ϕ is non-zero or both.

In the previous exercise, there are two treatment groups, and a dummy variable is created (called "typeboth") which is unity for one of the groups (BOTH) and zero for the other group (DDT). In contrast, the strategy used in Example 2.6 of Chapter 5 (see p.11) is to create a parameter for each of the two groups. The groups here are the months of May and June, and the dummy variables are D_M (which is unity for May and zero for June) and D_J (which is unity for June and zero for May), although these are created in the NLIN procedure with the commands "(month=5)" and "(month=6)" respectively.

It follows that in the latter example, the parameters are

- θ_{1M} and θ_{1J} (the lower asymptotes),
- θ_{2M} and θ_{2J} (the upper asymptotes),
- θ_{3M} and θ_{3J} (the slopes), and
- θ_{4M} and θ_{4J} (the LD_{50}'s).

Notice that in contrast with the previous example, here no parameter represents the ***difference*** of parameters.

If instead, we let θ_{1M} be the lower asymptote for May and ($\theta_{1M} + \delta$) be the lower asymptote for June, then we would test for equal lower asymptotes by testing

$$H_0: \delta = 0.$$

Using the current method (with θ_{1M} for May and θ_{1J} for June), we test for equal lower asymptotes by testing

$$H_0: \theta_{1M} = \theta_{1J}$$

Of course, we get the same results, but t-tests can be used using the previous method (over), whereas here we must use (equivalent) Full and Reduced F tests.

C. SE1 Example to illustrate curvature

Model Function: $\eta(x) = \exp(-\theta^* x)$

Data: (x,y) = (0.5,0.93), (4.0,0.025) graphed on top of next page with fitted curve

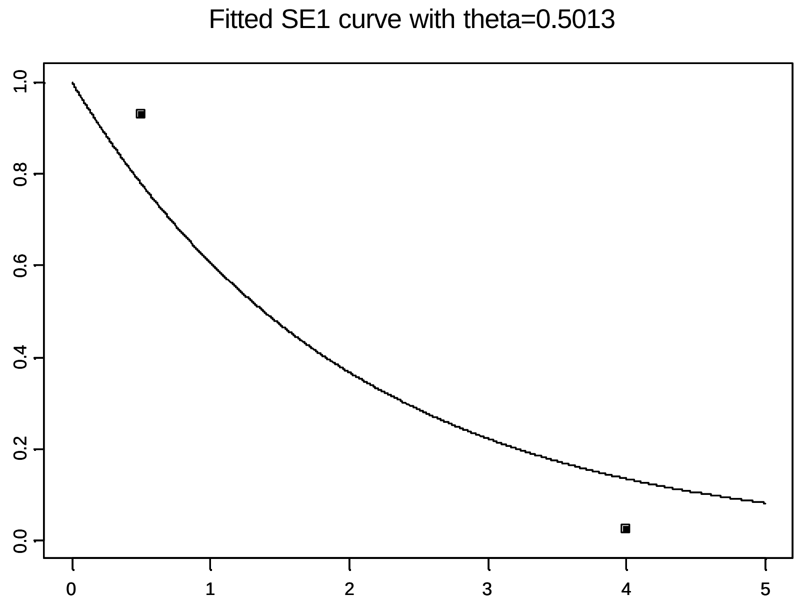
SAS program

```
data one;
  do x=0.5,4;
    input y @@; output;
  end; datalines;
0.93 0.025
;
proc nlin;
  parms th=20;
  model y=exp(-th*x);
run;
```

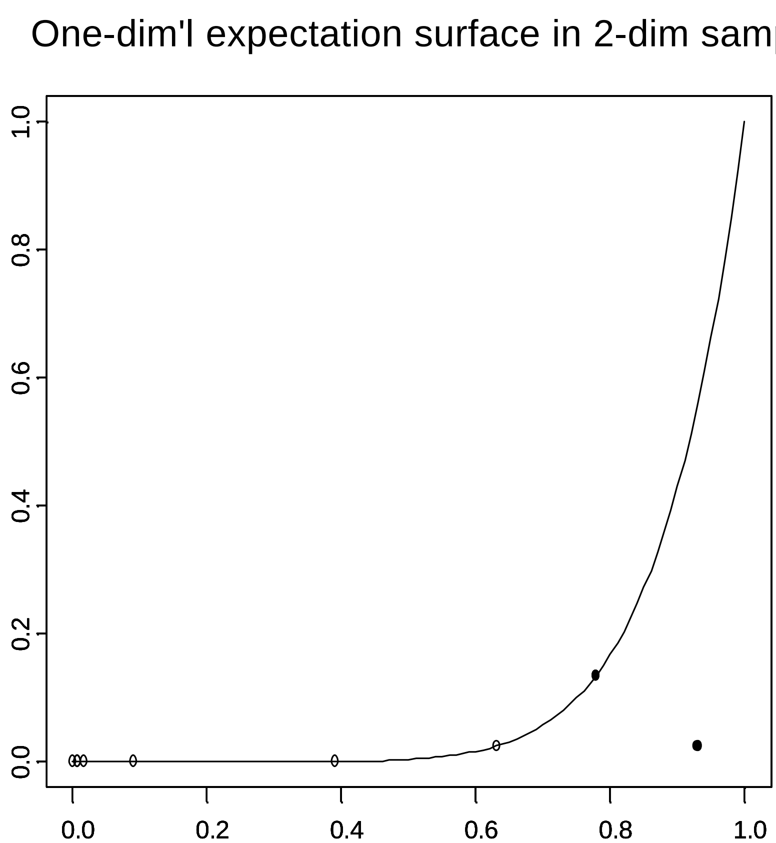
SAS output

```
The NLIN Procedure     Dependent Variable y
              Method: Gauss-Newton

                 Iterative Phase
                              Sum of
          Iter           th      Squares
             0      20.0000       0.8654
             1       9.9982       0.8530
             2       9.6595       0.8507
             3       8.2347       0.8355
             4       4.7958       0.7047
             5       1.8818       0.2919
             6       0.9224       0.0897
             7       0.5356       0.0357
             8       0.4866       0.0352

            20       0.5013       0.0350
NOTE: Convergence criterion met.

                             Estimation Summary
                  Method                       Gauss-Newton
                  Iterations                             20
                  Subiterations                          14
                  Average Subiterations                 0.7

                                Sum of        Mean                  Approx
Source                    DF   Squares      Square    F Value     Pr > F
Model                      1    0.8305      0.8305      23.71     0.1290
Error                      1    0.0350      0.0350
Uncorrected Total          2    0.8655

                                 Approx
Parameter       Estimate      Std Error    Approximate 95% Confidence Limits
th                0.5013         0.2817      -3.0782       4.0808
```

Data and fitted curve (model function)

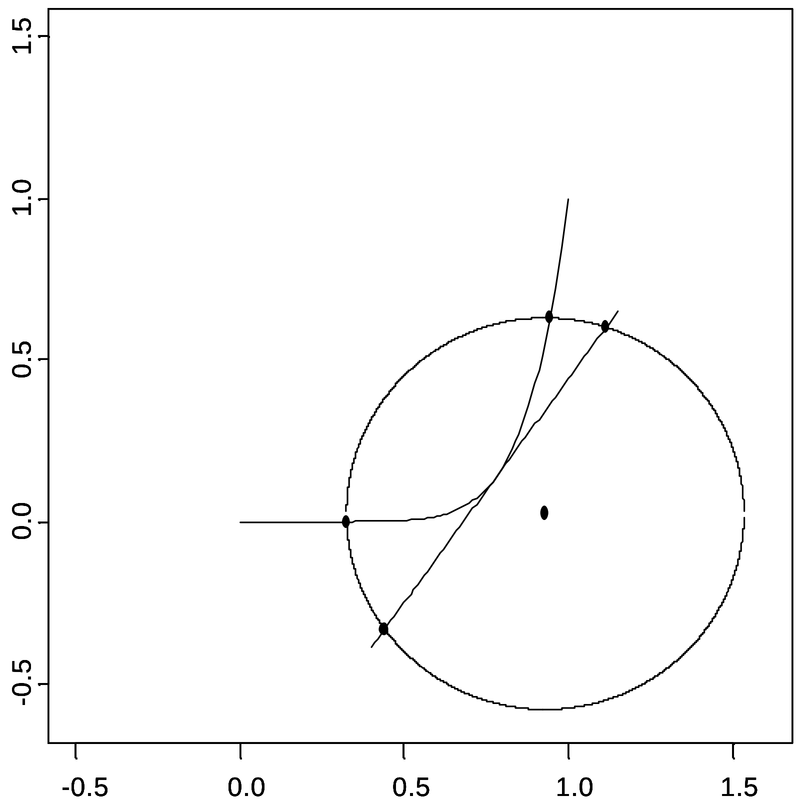


Graph of Expectation Surface (ES) with data (y) – point on ES corresponds to LSE



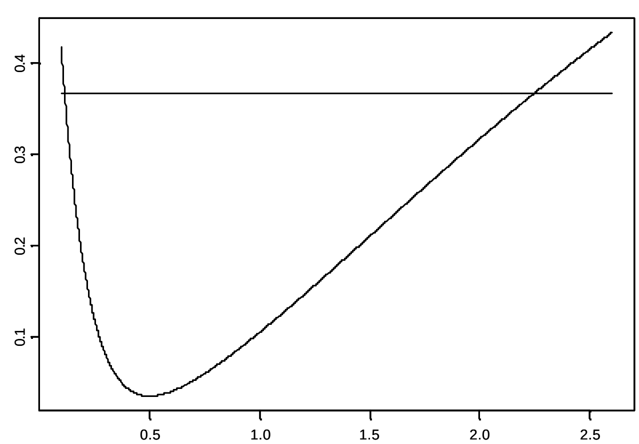
Graphs of Expectation Surface, tangent plane approximation, data, and 80% CR in Sample Space

SE1: Expectation surface, tangent plane



Graph of Likelihood Curve and 80% Cut Line

80% LCI for theta in SE1 model



D. Return to Ex. 2.11 (p.17) – Budworms (Generalized Nonlinear Model)

Are the two curves “parallel”?

Full Model

```
data one;
  do dose=1,2,4,8,16,32;
  do sex='male  ','female';
     l2d=log2(dose); fem=(sex='female'); male=(sex='male  ');
    input knockout @@; n=20; output;
  end; end; datalines;
1 0 4 2 9 6 13 10 18 12 20 16
;
proc nlmixed;
  parms bmale=1 bfem=1 gmale=6 gfem=6;
    l2gmale=log2(gmale); l2gfem=log2(gfem);
    b=bmale*male+bfem*fem; l2g=l2gmale*male+l2gfem*fem;
  eta=b*(l2d-l2g); ex=exp(eta); pi=ex/(1+ex);
  model knockout~binomial(n,pi);
run;
```

Output 2.9a. The NLMIXED Procedure (Parameter Estimates)

-2 Log Likelihood = 35.1

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
bmale	1.2589	0.2121	12	5.94	<.0001	0.05	0.7969	1.7210
bfem	0.9060	0.1671	12	5.42	0.0002	0.05	0.5420	1.2701
gmale	4.7201	0.6674	12	7.07	<.0001	0.05	3.2660	6.1742
gfem	9.8765	1.7819	12	5.54	0.0001	0.05	5.9941	13.7588

Reduced Model

```
proc nlmixed;
  parms b=1 gmale=6 gfem=6;
    l2gmale=log2(gmale); l2gfem=log2(gfem);
    l2g=l2gmale*male+l2gfem*fem;
    eta=b*(l2d-l2g); ex=exp(eta); pi=ex/(1+ex);
  model knockout~binomial(n,pi);
run;
```

Output 2.9b. The NLMIXED Procedure (Parameter Estimates)

-2 Log Likelihood = 36.9

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
b	1.0642	0.1311	12	8.12	<.0001	0.05	0.7786	1.3498
gmale	4.6889	0.7344	12	6.38	<.0001	0.05	3.0888	6.2891
gfem	9.6037	1.5294	12	6.28	<.0001	0.05	6.2714	12.9360