VIA EXCEPTION LOGISTIC Regression Model Logistic Regression MLE 1Y1X in Excel 2013

by Milo Schield

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Slides and data at: www.StatLit.org/ pdf/Excel2013-Model-Logistic-MLE-1Y1X-Slides.pdf xls/Excel2013-Model-Logistic-MLE-1Y1X-Data.xlsx











- 1) Prepare data for logistic MLE regression
- 2) Insert desired intercept

V1A

- 3) Use Solver to solve for intercept and slope
- 4) Generate various graphs
- 5) Test for statistical significance

To do: Get data at www.StatLit.org/xls/ Model-Logistic-MLE-1Y1X-Excel2013-Data.xlsx

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| | V1A | | | | Excel2013 Model Logistic MLE 1 | Y1X Slides | | 9 | | | | | | | |
|---|---|--|--|--|---|--|---|--|--|---|--|--|--|--|--|
| | | | 1c | :) R | leview/ | An | aly | ze | | | | | | | |
| | Intercept of 1 gives $P(Y = 1 = male) = 73\%$. But 62% of these students are male. Step 2: Adjust intercept so $P(Y=1) = 62\%$. | | | | | | | | | | | | | | |
| | C | н | 1 | .1 | K | M | N | 0 | D | 0 | | | | | |
| | | | | | | | 1.4 | 0 | - | 1.4 | | | | | |
| 1 | Height | Male | Intercept | Slope | | Logit | Odds | Prob Y=1 | Prob OK | Ln-LH-OK | | | | | |
| 1 2 | Height 68 | Male 1 | Intercept 1.00 | Slope 0.00 | | Logit 1.00 | Odds 2.72 | Prob Y=1 0.73 | Prob OK 0.73 | Ln-LH-OK -0.31 | | | | | |
| 1 2 3 | Height 68 69 | Male 1 | Intercept 1.00 | Slope 0.00 | | Logit 1.00 1.00 | Odds 2.72 2.72 | Prob Y=1 0.73 0.73 | Prob OK 0.73 0.73 | Ln-LH-OK -0.31 -0.31 | | | | | |
| 1 2 3 4 | Height 68 69 69 | Male 1 1 | Intercept 1.00 Sum LnLk | Slope 0.00 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 | Odds 2.72 2.72 2.72 | Prob Y=1 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 | | | | | |
| 1 2 3 4 5 | Height 68 69 69 72 | Male 1 1 1 | Intercept 1.00 Sum LnLk Original | Slope 0.00 -63.82 -63.82 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 1.00 | Odds 2.72 2.72 2.72 2.72 2.72 | Prob Y=1 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 | | | | | |
| 1 2 3 4 5 6 | Height 68 69 69 72 66 | Male 1 1 1 1 1 1 | Intercept 1.00 Sum LnLk Original Intercept | Slope 0.00 -63.82 -63.82 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 1.00 1.00 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 | | | | | |
| 1 2 3 4 5 6 7 | Height 68 69 69 72 66 67 | Male 1 1 1 1 1 0 | Intercept 1.00 Sum LnLk Original Intercept Full | Slope 0.00 -63.82 -63.82 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.27 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 | | | | | |
| 1 2 3 4 5 6 7 8 | Height 68 69 69 72 66 67 71 | Male 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | Intercept 1.00 Sum LnLk Original Intercept Full | Slope 0.00 -63.82 -63.82 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 1.00 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.27 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 -0.31 | | | | | |
| 1 2 3 4 5 6 7 8 9 | Height 68 69 69 72 66 67 71 71 71 | Male 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | Intercept 1.00 Sum LnLk Original Intercept Full FO | Slope 0.00 -63.82 -63.82 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.27 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 -0.31 -0.31 -0.31 | | | | | |
| 1 2 3 4 5 6 7 8 9 10 | Height 68 69 69 72 66 67 71 71 71 71.5 | Male 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | Intercept 1.00 Sum LnLk Original Intercept Full FO Logit | Slope 0.00 -63.82 -63.82 PRMULAS M2 | =SUM(Q2:Q93) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.27 0.73 0.73 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 | | | | | |
| 1 2 3 4 5 6 7 8 9 10 11 | Height 68 69 69 72 66 67 71 71 71 71.5 62 | Male 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 0 0 1 1 0 | Intercept 1.00 Sum LnLk Original Intercept Full FO Logit Odds | Slope 0.00 -63.82 -63.82 -63.82 RMULAS M2 N2 | =SUM(Q2-Q93) =SUM(Q2-Q93) =I\$2+J\$2*C2 =EXP(M2) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 -0.31 -0.31 -0.31 -0.31 -1.31 | | | | | |
| 1 2 3 4 5 6 7 8 9 10 11 12 | Height 68 69 69 72 66 67 71 71 71 71.5 62 65.5 | Male 1 1 1 1 1 1 1 1 1 1 0 1 1 0 0 0 | Intercept 1.00 Sum LnLk Original Intercept Full FO Logit Odds Prob Y=1 | Slope 0.00 -63.82 -63.82 -63.82 -63.82 M2 N2 02 | =SUM(Q2:Q93) =SUM(Q2:Q93) =IS2+JS2*C2 =EXP(M2) =N2((1+N2) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 -1.31 | | | | | |
| 1 2 3 4 5 6 7 8 9 10 11 12 13 | Height 68 69 69 72 66 67 71 71 71,5 62 65,5 73,5 | Male 1 1 1 1 1 1 1 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 | Intercept 1.00 Sum LnLk Original Intercept Full FO Logit Odds Prob Y=1 Prob OK | Slope 0.00 -63.82 -63.93 -63.9 | =SUM(Q2-Q93) =SUM(Q2-Q93) =IS2+JS2*C2 =EXP(M2) =N2(1+N2) =IF(H2=1,O2,1-O2) | Logit 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0 | Odds 2.72 2.72 2.72 2.72 2.72 2.72 2.72 2.7 | Prob Y=1 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.73 | Prob OK 0.73 0.75 0.7 | Ln-LH-OK -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -0.31 -1.31 -1.31 -0.31 | | | | | |

| V1 | A | | Excel2013 I | Model Logistic MLE 1Y13 | X Slides | | 10 | | | | | | | |
|--------|---|-------------|---------------|-------------------------|----------|-------|------|----------|--|--|--|--|--|--|
| | 2a) Calculate Intercept2 Paste Value into I2 | | | | | | | | | | | | | |
| С | Н | 1 | J | ĸ | L | М | N | 0 | | | | | | |
| Height | Male | Intercept | Slope | 1 | | Logit | Odds | Prob Y=1 | | | | | | |
| 68 | 1 | 0.488 | 0.00 | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 69 | 1 | T | | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 69 | 1 | Sum LnLk | -61.11 | -SUM(O | 2:Q93) | 0.49 | 1.63 | 0.62 | | | | | | |
| 72 | 1 | Original | -63.82 | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 66 | 1 | Intercept | 1 | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 67 | 0 | Full | 1 | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 71 | 1 | | 1 | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 71 | 1 | | \rightarrow | | | 0.49 | 1.63 | 0.62 | | | | | | |
| 71.5 | 1 | CALCULATE I | NTERCEPT | (Slope=0) | | 0.49 | 1.63 | 0.62 | | | | | | |
| 62 | 0 | Binary Ave: | 0.620 =A* | VERAGE(H2 | :H93) | 0.49 | 1.63 | 0.62 | | | | | | |
| 65.5 | 0 | Intercept2 | 0.488 =LM | N(J42/(1-J42) |)) | 0.49 | 1.63 | 0.62 | | | | | | |
| 73 5 | 1 | | | | | 0.49 | 1.63 | 0.62 | | | | | | |

| | V1A | | | E | cel2013 Model Logi | tic MLE 1Y1X | Slides | | | 11 | |
|---------|----------------------|---------------------|-------------|---------|---------------------------|----------------------|---------------------|------|--------------------------------|-------------------------|---------|
| I it | 2 f we : t wou | Pi musi ild b | Res roba | a sing | s are ity o gle val | e as f M ue to | s er lal prec | e = | ecte 62% he out are m | d: 6 come, en. | _ |
| 4 | С | н | | J | к | L | м | N | 0 | Р | Q |
| 1 | Height | Male | Intercept | Slope | | | Logit | Odds | Prob Y=1 | Prob OK | Ln-LH-O |
| 2 | 68 | 1 | 0.49 | 0.00 | | | 0.49 | 1.63 | (0.62) | 0.62 | -0.48 |
| 3 | 69 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 4 | 69 | 1 | Sum LnLk | -61.11 | =SUM(Q2:0 | 293) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 5 | 72 | 1 | Original | -63.82 | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 6 | 66 | 1 | Intercept | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 7 | 67 | 0 | Full | | | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 8 | 71 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 9 | 71 | 1 | FC | ORMULAS | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*C | 2 | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,0 | 2,1-02) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| | 72 | 1 | Lo LH OK | 02 | -1 M/(22) | | 0.49 | 1.63 | 0.62 | 0.62 | .0.48 |
| 14 | 16 | | UPUPON | VAC. | -Lis(-2) | | 0.40 | 1.00 | G. G. | 0.02 | -0.40 |



| | V1A | | | 1 | Excel2013 Model Logisti | c MLE 1Y13 | X Slides | | | | 13 |
|-------------------|--------------------------|--------------------------|--------------|-------------|-------------------------|--------------|-----------|-------------------------|---------------|-------------------|----------|
| | 3a F |) So ror | olve n Da | for ta 1 | Slop men | e a u, | an sel | d Iı lec | nte: t So | rcej lve: / | pt r |
| FI Get E Di | LE Disternal ata * | HOME Refresh All • | INSERT PAG | t Filter | FORMULAS | DATA effi | REVIEW | N VIEW Analysi er | OF Arch | hitect Mile | o A Sc * |
| 2 | 68 | Connection | ons So | nt & Filter | | | Ani | alysis | | | -0.48 |
| 3 | 69 | 1 | 0.10 | 0.00 | | | Solver | | | | -0.48 |
| 4 | 69 | 1 | Sum LnLk | -61.11 | SUM(02:09 | 31 | What- | if analysis | tool that fir | nds the | -0.48 |
| 5 | 72 | 1 | Original | -63.82 | o o milaz. ao | -, | optim | al value of | a target ce | ll by | -0.48 |
| 6 | 66 | 1 | Intercept | -61.11 | | | chang | ing values | in cells use | d to | -0.48 |
| 7 | 67 | 0 | Full | | | | calcul | ste trië tar | get cell. | | -0.97 |
| 8 | 71 | 1 | | | | | B 50 | UVER.XL | AM | | -0.48 |
| 9 | 71 | 1 | FC | RMULAS | | | Te | me mor | e | | -0.48 |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*C2 | | | 1.99 | V. V6 | V.V6 | -0.48 |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,02, | 1-02) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 1.4 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 1.4 | | | | | | | | | | | |





| V1 | A 3d) | Free | 16 | | | |
|----|----------|-------|------|----------|---------|---------------|
| (| Class | sifie | d ga | als in 7 | 7, 11 å | 12 OK |
| 4 | С | Н | L | 0 | Р | |
| 1 | Height | Male | | Prob Y=1 | Prob OK | |
| 2 | 68 | 1 | | 0.61 | 0.61 | |
| 3 | 69 | 1 | | 0.77 | 0.77 | |
| 4 | 69 | 1 | | 0.77 | 0.77 | |
| 5 | 72 | 1 | | 0.97 | 0.97 | |
| 6 | 66 | 1 | | 0.24 | 0.24 | Misclassified |
| 7 | 67 | 0 | | 0.41 | 0.59 | |
| 8 | 71 | 1 | | 0.94 | 0.94 | |
| 9 | 71 | 1 | | 0.94 | 0.94 | |
| 10 | 71.5 | 1 | | 0.96 | 0.96 | |
| 11 | 62 | 0 | | 0.01 | 0.99 | |
| 12 | 65.5 | 0 | | 0.18 | 0.82 | |
| 13 | 73.5 | 1 | | 0.99 | 0.99 | |

| V | /1A | | Excel2013 Model Logistic ML | | 17 | |
|--------|--------------------|-------------------|-------------------------------------|------------------|-----------------|------|
| | 3e for | e) Pro | e <mark>pare to</mark> istical s |) test signif | slope icance | |
| F P | rom J4, aste-Sp | copy ' ecial V | 'Sum LnL' alue onto J | k" to cli 17. | pboard. | |
| | C | Н | 1 | J | K | L |
| 1 | Height | Male | Intercept | Slope | | |
| 2 | 68 | 1 | -53.32 | 0.79 | | |
| 3 | 69 | 1 | | | | |
| 4 | 69 | 1 | Sum LnLk | -30.55 | =SUM(Q2: | Q93) |
| 5 | 72 | 1 | Original | -63.82 | | |
| 6 | 66 | 1 | Intercept | -61.11 | | |
| 7 | 67 | 0 | Full | -30.55 | · | |
| 8 | 71 | 1 | | | | |



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| V1A Excel2013 Model I | ogistic MLE 1Y1X Slides | | | 19 a. -1) Prob Y=1 1% 1% 1% 2% 3% 4% 6% | |
|-----------------------------|-----------------------------------|-------|------|--|--|
| 4b) Prepare X is Height. | pare X and Y d ight. Y is Prob | | | | |
| Select T2:V2. | S | Т | U | V | |
| Drag down 1 row | HT-Graph | Logit | Odds | Prob Y=1 | |
| Diug down i low | 61.00 | -5.10 | 0.01 | 1% | |
| | 61.50 | -4.71 | 0.01 | 1% | |
| Select \$2.V3 | 62.00 | -4.31 | 0.01 | 1% | |
| Dread to hottom | 62.50 | -3.92 | 0.02 | 2% | |
| Drag to bottom | 63.00 | -3.52 | 0.03 | 3% | |
| | 63.50 | -3.12 | 0.04 | 4% | |
| | 64.00 | -2.73 | 0.07 | 6% | |
| Select columns S & V | 64.50 | -2.33 | 0.10 | 9% | |
| for logistic graph | 65.00 | -1.94 | 0.14 | 13% | |
| ior iogistic graph. | 65.50 | -1.54 | 0.21 | 18% | |
| | 66.00 | -1.15 | 0.32 | 24% | |
| | 66.50 | -0.75 | 0.47 | 32% | |
| | 67.00 | -0.36 | 0.70 | 41% | |
| | 67.50 | 0.04 | 1.04 | 51% | |
| | 68.00 | 0.43 | 1.54 | 61% | |



| 5)1 | Hvp | oth | esis t | est: | ls noi | 1-zero |
|---|-----------|--------|------------------------|----------|-----------|--------------|
| | one | st | atistic | ally | siani | fican |
| | ope | | | , can y | | |
| alou | late d | iffor | ence wi | th 'full | | nly hy ' |
| aicu | | · | | in iun | , munu | ply by -2 |
| ondu | ict a rig | ght-ta | ul Chi ² te | st with | 1 degree | freedom. |
| - 4 | С | Н | 1 | J | K | L |
| 1 | Height | Male | Intercept | Slope | | |
| 2 | 68 | 1 | -53.32 | .0.79 | | |
| 3 | 69 | 1 | | | | |
| 4 | 69 | 1 | Sum LnLk | -30.55 | =sum(Q2: | Q9) |
| 5 | 72 | 1 | Original | -63.82 | Manual pa | iste |
| 6 | 66 | 1 | Intercept | -61.11 | Manual pa | iste |
| 7 | 67 | 0 | Full | -30.55 | Manual pa | iste |
| 8 | 71 | 1 | Difference | -30.56 | =J6-J7 | |
| 9 | 71 | 1 | DegFree | 1 | Manual en | itry |
| 10 C | 715 | 1 | P-value (| 5.35E-15 | =CHISQ.DI | ST.RT(-2"J8. |



ACKNOWLEDGMENT:

This presentation closely follows the Carlberg (2012) presentation in Chapter 2: pages 21-52. These slides present the how – step by step –

of logistic regression for a single case. Carlberg (2012) discusses the how and the why. Schield introduced the shortcut on slide 10.

REFERENCE:

V1A

Carlberg, Conrad (2012). Decision Analytics: Microsoft Excel. Que Publishing.

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by Milo Schield

Member: International Statistical Institute US Rep: International Statistical Literacy Project Director, W. M. Keck Statistical Literacy Project

Slides and data at: www.StatLit.org/

pdf/Excel2013-Model-Logistic-MLE-1Y1X-Slides.pdf xls/Excel2013-Model-Logistic-MLE-1Y1X-Data.xlsx

Background & Goals

Modelling a binary outcome (buy/look, payoff/default, go/nogo or male/female) requires logistic regression.

Doing logistic regression in Excel requires Solver. "Since its introduction in .. 1991, ... Excel Solver has become the most widely distributed – and almost surely the most widely used – general-purpose optimization modeling system." www.utexas.edu/courses/lasdon/design3.htm

This presentation uses college student data: pulse.xls. This demo models gender (male) based on height.

Goals: Create graphs on slides 4 and 22. Determine if slope is statistically significant.

This demo uses Height (col C) to predict Gender (col H)

Column H: 1=Male, 0 = Female (circled)

Ave Heights: M: 70.75" 62%

Difference:

5.35"

F: 65.3" 38%

| - 24 | A | В | C | D | E | F | G | H |
|------|--------|--------|--------|--------|----------|------|---------|-------|
| 1 | Pulse1 | Pulse2 | Height | Weight | Activity | Run? | Smokes? | Male? |
| 2 | 48 | 54 | 68 | 150 | 1 | 0 | 1 | 1 |
| 3 | 54 | 56 | 69 | 145 | 2 | 0 | 1 | 1 |
| 4 | 54 | 50 | 69 | 160 | 2 | 0 | 0 | 1 |
| 5 | 58 | 70 | 72 | 145 | 2 | 1 | 0 | 1 |
| 6 | 58 | 58 | 66 | 135 | 3 | 0 | 0 | 1 |
| 7 | 58 | 56 | 67 | 125 | 2 | 0 | 0 | (0) |
| 8 | 60 | 76 | 71 | 170 | 3 | 1 | 0 | 1 |
| 9 | 60 | 62 | 71 | 155 | 2 | 0 | 0 | 1 |
| 10 | 60 | 70 | 71.5 | 164 | 2 | 0 | 1 | 1 |
| 11 | 60 | 66 | 62 | 120 | 2 | 0 | 0 | 0 |
| 12 | 61 | 70 | 65.5 | 120 | 2 | 0 | 0 | 0/ |
| 13 | 62 | 76 | 73.5 | 160 | 3 | 1 | 1 | 1 |
| 14 | 62 | 75 | 72 | 195 | 2 | 1 | 0 | 1 |
| 15 | 62 | 58 | 72 | 175 | 3 | 1 | 0 | 1 |
| 16 | 62 | 100 | 66 | 120 | 2 | 1 | 0 | 0 |
| 17 | 62 | 98 | 62.75 | 112 | 2 | 1 | 1 | 0 |

To Do: Model Gender by Height Show Trend-line and Equation

This trend-line does not satisfy the least-squares assumptions and it goes outside the valid range.



This shape handles all heights: even if negative.



Outline of Approach: Five Steps

- 1) Prepare data for logistic MLE regression
- 2) Insert desired intercept
- 3) Use Solver to solve for intercept and slope
- 4) Generate various graphs
- 5) Test for statistical significance

To do: Get data at www.StatLit.org/xls/ Model-Logistic-MLE-1Y1X-Excel2013-Data.xlsx

1a) Load Data; Hide columns; Enter formula

Hide columns A-B and D-G. Let I2=1; J2=0 Enter formula in M2-Q2 and J4

| M | M2 * : | | $\times \checkmark f_x$ | | =I\$2+J\$2*C2 | | | | | | | |
|----|--------|------|-------------------------|--------|---------------|---------|-------|------|----------|---------|----------|--|
| | С | Н | I | J | K | L | М | Ν | 0 | Р | Q | |
| 1 | Height | Male | Intercept | Slope | | | Logit | Odds | Prob Y=1 | Prob OK | Ln-LH-OK | |
| 2 | 68 | 1 | 1.00 | 0.00 | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 | |
| 3 | 69 | 1 | | | | | 1 | 1 | 1 | 1 | 7 | |
| 4 | 69 | 1 | Sum LnLk | -0.31 | =SUM(Q2:0 | 293) | | | | | | |
| 5 | 72 | 1 | Original | | | | | | | | | |
| 6 | 66 | 1 | Intercept | | | | | | | | | |
| 7 | 67 | 0 | Full | | | | | | | | | |
| 8 | 71 | 1 | | | | | | | | | | |
| 9 | 71 | 1 | FC | RMULAS | s / | | | | | | | |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*C | 2// | | | | | | |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | // | | | | | | |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2) | // | | | | | | |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,0 | 2,1-02) | | | | | | |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | / | | | | | | |
| 15 | 72 | 1 | | | | | | | | | | |

1b) Select M2:Q2. Pull \downarrow to 93 Copy/Paste Value of J4 onto J5

| | С | Н | | J | K L | M | N | 0 | Р | Q |
|----|--------|------|-----------|--------|----------------|---------|---------|----------|---------|----------|
| 1 | Height | Male | Intercept | Slope | | Log | it Odds | Prob Y=1 | Prob OK | Ln-LH-OK |
| 2 | 68 | 1 | 1.00 | 0.00 | | 1.0 | 2.72 | 0.73 | 0.73 | -0.31 |
| 3 | 69 | 1 | | | | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 4 | 69 | 1 | Sum LnLk | -63.82 | =SUM(Q2:Q93) | 1.0 | 2.72 | 0.73 | 0.73 | -0.31 |
| 5 | 72 | 1 | Original | -63.82 | | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 6 | 66 | 1 | Intercept | | | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 7 | 67 | 0 | Full | | | 1.0 | 0 2.72 | 0.73 | 0.27 | -1.31 |
| 8 | 71 | 1 | | | | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 9 | 71 | 1 | FO | RMULAS | | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*C2 | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | 1.0 | 0 2.72 | 0.73 | 0.27 | -1.31 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2) | 1.0 | 0 2.72 | 0.73 | 0.27 | -1.31 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,O2,1- | 02) 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | 1.0 | 0 2.72 | 0.73 | 0.73 | -0.31 |

Odds = Prob(Y=1)/[1-Prob(Y=1)] Range: 0 to infinity Logit = LN(Odds). Range: -infinity to +infinity. Logistic regress: Logit = Intercept + Slope*Height

1c) Review/Analyze

Intercept of 1 gives P(Y = 1 = male) = 73%. But 62% of these students are male. Step 2: Adjust intercept so P(Y=1) = 62%.

| | С | H | 1 | J | K | L | M | N | 0 | Р | Q |
|----|--------|------|-----------|--------|--------------|---------|-------|------|----------|---------|----------|
| 1 | Height | Male | Intercept | Slope | | | Logit | Odds | Prob Y=1 | Prob OK | Ln-LH-OK |
| 2 | 68 | 1 | 1.00 | 0.00 | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 3 | 69 | 1 | | | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 4 | 69 | 1 | Sum LnLk | -63.82 | =SUM(Q2:0 | 293) | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 5 | 72 | 1 | Original | -63.82 | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 6 | 66 | 1 | Intercept | | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 7 | 67 | 0 | Full | | | | 1.00 | 2.72 | 0.73 | 0.27 | -1.31 |
| 8 | 71 | 1 | | | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 9 | 71 | 1 | FO | RMULAS | | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*C | 2 | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | | 1.00 | 2.72 | 0.73 | 0.27 | -1.31 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2) |) | 1.00 | 2.72 | 0.73 | 0.27 | -1.31 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,C | 2,1-02) | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | | 1.00 | 2.72 | 0.73 | 0.73 | -0.31 |

2a) Calculate Intercept2 Paste Value into I2

| С | Н | 1 | J | K | L | М | Ν | 0 |
|--------|------|-------------|-----------|---------------|--------|-------|------|----------|
| Height | Male | Intercept | Slope | | | Logit | Odds | Prob Y=1 |
| 68 | 1 | 0.488 | 0.00 | | | 0.49 | 1.63 | 0.62 |
| 69 | 1 | | | | | 0.49 | 1.63 | 0.62 |
| 69 | 1 | Sum LnLk | -61.11 | =SUM(Q | 2:Q93) | 0.49 | 1.63 | 0.62 |
| 72 | 1 | Original | -63.82 | | | 0.49 | 1.63 | 0.62 |
| 66 | 1 | Intercept | | | | 0.49 | 1.63 | 0.62 |
| 67 | 0 | Full | | | | 0.49 | 1.63 | 0.62 |
| 71 | 1 | | | | | 0.49 | 1.63 | 0.62 |
| 71 | 1 | | | | | 0.49 | 1.63 | 0.62 |
| 71.5 | 1 | CALCULATE | NTERCEPT | Slope=0) | | 0.49 | 1.63 | 0.62 |
| 62 | 0 | Binary Ave: | 0.620 =AV | /ERAGE(H2: | :H93) | 0.49 | 1.63 | 0.62 |
| 65.5 | 0 | Intercept2 | 0.488 =LN | I(J42/(1-J42) |)) | 0.49 | 1.63 | 0.62 |
| 73.5 | 1 | | | | | 0.49 | 1.63 | 0.62 |

2b) Results are as expected: Probability of Male = 62%

If we must select a single value to predict the outcome, it would be the percentage of students who are men.

| 1.1 | С | Н | I I | J | K | L | M | N | 0 | P | Q |
|-----|--------|------|-----------|--------|--------------|----------|-------|------|----------|---------|----------|
| 1 | Height | Male | Intercept | Slope | | | Logit | Odds | Prob Y=1 | Prob OK | Ln-LH-OK |
| 2 | 68 | 1 | 0.49 | 0.00 | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 3 | 69 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 4 | 69 | 1 | Sum LnLk | -61.11 | =SUM(Q2: | Q93) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 5 | 72 | 1 | Original | -63.82 | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 6 | 66 | 1 | Intercept | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 7 | 67 | 0 | Full | | | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 8 | 71 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 9 | 71 | 1 | FO | RMULAS | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*(| 22 | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2 |) | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,0 | 02,1-02) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 15 | 72 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |

2c) Copy sum of Ln-Lk-OK Copy J4; Paste value into J6

Copy "Sum LnLk" from J4 to clipboard. Paste-Special Value in J6

| - 24 | С | Н | 1 | J | K | L | М | N | 0 | P | Q |
|------|--------|------|-----------|--------|--------------|----------|-------|------|----------|---------|----------|
| 1 | Height | Male | Intercept | Slope | | | Logit | Odds | Prob Y=1 | Prob OK | Ln-LH-OK |
| 2 | 68 | 1 | 0.49 | 0.00 | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 3 | 69 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 4 | 69 | 1 | Sum LnLk | -61.11 | =SUM(Q2: | Q93) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 5 | 72 | 1 | Original | -63.82 | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 6 | 66 | 1 | Intercept | -61.11 | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 7 | 67 | 0 | Full | | | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 8 | 71 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 9 | 71 | 1 | FO | RMULAS | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*(| C2 | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2 | 2) | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,0 | 02,1-02) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 15 | 72 | 1 | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |

Now solve for the slope in logistic regression

3a) Solve for Slope and Intercept From Data menu, select Solver

| FI | ILE | HOME | INSERT PA | GE LAYOUT | FOR | RMULAS | DATA | REVIE | W VIEW | PDF Arcl | hitect Mile | o A Sc ▼ |
|-------|-------------------|------------------|--|-----------------|--------|-----------------|---------|---|----------------|---------------|-------------|----------|
| Get E | External ata * | Refresh All • | 2↓ ZA Z↓ A A↓ So | AZ rt Filter | N 10 1 | Data Tools * | 0utline | 🕒 Data 🍫 Solv | Analysia er | | | |
| | | Connectio | ons So | ort & Filter | | | | An | alysis | | | |
| 2 | 68 | 1 | 0.49 | 0.00 | | | | 6.1 | - | | | -0.48 |
| 3 | 69 | 1 | | | | | | Solve | r | | | -0.48 |
| 4 | 69 | 1 | Sum LnLk | -61.11 | =SU | M(Q2:Q | 93) | What-if analysis tool that finds the optimal value of a target cell by | | | nds the | -0.48 |
| 5 | 72 | 1 | Original | -63.82 | | | | | | | ll by | -0.48 |
| 6 | 66 | 1 | Intercept | -61.11 | | | | chang | ing values | ant cells use | d to | -0.48 |
| 7 | 67 | 0 | Full | | | | | Calcul | | yet cen. | | -0.97 |
| 8 | 71 | 1 | | | | | | 3 SC | DLVER.XL | AM | | -0.48 |
| 9 | 71 | 1 | F | ORMULAS | | | | Te | ell me moi | re | | -0.48 |
| 10 | 71.5 | 1 | Logit | M2 | =1\$2- | +J\$2*C2 | 2 | 0.70 | 1.00 | 0.02 | V.VL | -0.48 |
| 11 | 62 | 0 | Odds | N2 | =EXF | P(M2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/ | (1+N2) | | 0.49 | 1.63 | 0.62 | 0.38 | -0.97 |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H | 12=1,02 | 2,1-02) | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(| P2) | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |
| 15 | 72 | 1 | | | | | | 0.49 | 1.63 | 0.62 | 0.62 | -0.48 |

3b) Set Solver Parameters

Select Intercept and slope (I2:J2) in "Changing Variable Cells".



3c) Results: All constraints and conditions are satisfied

| | × v | fx | Solver Results | |
|---|----------------------|------------------|---|-------------------------------|
| _ | Intercent | J | Solver found a solution. All Constraints and o conditions are satisfied. | ptimality Re <u>p</u> orts |
| | -53.32 | 0.79 | | Answer Sensitivity |
| | Sum LnLk Original | -30.55 -63.82 | O <u>R</u> estore Original Values | Chines |
| | Intercept Full | -61.11 | Return to Solver Parameters Dialog | O <u>u</u> tline Repo |
| | FC | ORMULAS | <u>OK</u> <u>C</u> ancel | <u>Save Scena</u> |
| | Logit | M2 = | | |
| | Odds | N2 = | Solver found a solution. All Constraints and on | timality conditions are |
| | Prob Y=1 | 02 = | satisfied. | |
| | | | | |

3d) Error in row 6: short guy. Classified gals in 7, 11 & 12 OK

| | С | H | L | 0 | Р |
|----|--------|------|---|----------|---------|
| 1 | Height | Male | | Prob Y=1 | Prob OK |
| 2 | 68 | 1 | | 0.61 | 0.61 |
| 3 | 69 | 1 | | 0.77 | 0.77 |
| 4 | 69 | 1 | | 0.77 | 0.77 |
| 5 | 72 | 1 | | 0.97 | 0.97 |
| 6 | 66 | 1 | | 0.24 | 0.24 |
| 7 | 67 | 0 | | 0.41 | 0.59 |
| 8 | 71 | 1 | | 0.94 | 0.94 |
| 9 | 71 | 1 | | 0.94 | 0.94 |
| 10 | 71.5 | 1 | | 0.96 | 0.96 |
| 11 | 62 | 0 | | 0.01 | 0.99 |
| 12 | 65.5 | 0 | | 0.18 | 0.82 |
| 13 | 73.5 | 1 | | 0.99 | 0.99 |

Misclassified

3e) Prepare to test slope for statistical significance

From J4, copy "Sum LnLk" to clipboard. Paste-Special Value onto J7.

| - 52 | С | Н | | J | K L | |
|------|--------|------|-----------|--------|--------------|---|
| 1 | Height | Male | Intercept | Slope | | ļ |
| 2 | 68 | 1 | -53.32 | 0.79 | | |
| 3 | 69 | 1 | | | | |
| 4 | 69 | 1 | Sum LnLk | -30.55 | =SUM(Q2:Q93) | |
| 5 | 72 | 1 | Original | -63.82 | | |
| 6 | 66 | 1 | Intercept | -61.11 | | |
| 7 | 67 | 0 | Full | -30.55 | ← | |
| 8 | 71 | 1 | | | | |

4a) Prepare data for Graphs

Start Ht-Graph at minimum of height in S2 Enter formulas for Logit, Odds and Prob(Y=1).

| T2 | 2 | * | XV | f _x | =l\$2+J\$2*S2 | | | | | | | |
|----|--------|------|-----------|----------------|---------------|--------|----------|-------|------|----------|--|--|
| 1 | С | Н | 1 | J | К | L | S | Т | U | V | | |
| 1 | Height | Male | Intercept | Slope | | | HT-Graph | Logit | Odds | Prob Y=1 | | |
| 2 | 68 | 1 | -53.32 | 0.79 | | | 61.00 | -5.10 | 0.01 | 1% | | |
| 3 | 69 | 1 | | | | | 61.50 | 1 | 1 | 1 | | |
| 4 | 69 | 1 | Sum LnLk | -30.55 | =SUM(Q2:Q9 | 93) | | | | | | |
| 5 | 72 | 1 | Original | -63.82 | | | | | | | | |
| 6 | 66 | 1 | Intercept | -61.11 | | | | | | | | |
| 7 | 67 | 0 | Full | -30.55 | | | | | / | | | |
| 8 | 71 | 1 | | | .i | | | | | | | |
| 9 | 71 | 1 | FC | RMULAS | | | | | | | | |
| 10 | 71.5 | 1 | Logit | M2 | =I\$2+J\$2*C2 | | | | | | | |
| 11 | 62 | 0 | Odds | N2 | =EXP(M2) | | | | | | | |
| 12 | 65.5 | 0 | Prob Y=1 | 02 | =N2/(1+N2) | | | | | | | |
| 13 | 73.5 | 1 | Prob OK | P2 | =IF(H2=1,O2 | ,1-02) | | | | | | |
| 14 | 72 | 1 | Ln-LH-OK | Q2 | =LN(P2) | | | | | | | |
| 15 | 72 | 1 | | | / | | | | | | | |
| 16 | 66 | 0 | Logit | T2 | =I\$2+J\$2*S2 | | | | | | | |
| 17 | 62.75 | 0 | Odds | U2 | =EXP(T2) | | | | | | | |
| 18 | 74 | 1 | Prob Y=1 | V2 | =U2/(1+U2) | | | | | | | |
| | | | | | | | | | | | | |

4b) Prepare X and Y data. X is Height. Y is Prob (Y=1)

Select T2:V2. Drag down 1 row

Select S2:V3. Drag to bottom

Select columns S & V for logistic graph.

| S | Т | U | V |
|----------|-------|------|----------|
| HT-Graph | Logit | Odds | Prob Y=1 |
| 61.00 | -5.10 | 0.01 | 1% |
| 61.50 | -4.71 | 0.01 | 1% |
| 62.00 | -4.31 | 0.01 | 1% |
| 62.50 | -3.92 | 0.02 | 2% |
| 63.00 | -3.52 | 0.03 | 3% |
| 63.50 | -3.12 | 0.04 | 4% |
| 64.00 | -2.73 | 0.07 | 6% |
| 64.50 | -2.33 | 0.10 | 9% |
| 65.00 | -1.94 | 0.14 | 13% |
| 65.50 | -1.54 | 0.21 | 18% |
| 66.00 | -1.15 | 0.32 | 24% |
| 66.50 | -0.75 | 0.47 | 32% |
| 67.00 | -0.36 | 0.70 | 41% |
| 67.50 | 0.04 | 1.04 | 51% |
| 68.00 | 0.43 | 1.54 | 61% |

4c) Graph Logistic Regression of Gender by Height.



5) Hypothesis test: Is non-zero slope statistically significant?

Calculate difference with 'full'; multiply by -2.

Conduct a right-tail Chi² test with 1 degree freedom.

| | | п | | J | ĸ | L | |
|----|--------|------|------------|----------|--------------|-----------------|--|
| 1 | Height | Male | Intercept | Slope | | | |
| 2 | 68 | 1 | -53.32 | .0.79 | | | |
| 3 | 69 | 1 | | | | | |
| 4 | 69 | 1 | Sum LnLk | -30.55 | =sum(Q2:Q9) | | |
| 5 | 72 | 1 | Original | -63.82 | Manual paste | | |
| 6 | 66 | 1 | Intercept | -61.11 | Manual pa | ste | |
| 7 | 67 | 0 | Full | -30.55 | Manual pa | ste | |
| 8 | 71 | 1 | Difference | -30.56 | =J6-J7 | | |
| 9 | 71 | 1 | DegFree | 1 | Manual en | try | |
| 10 | 71.5 | 1 | P-value | 5.35E-15 | =CHISQ.DI | ST.RT(-2*J8,J9) | |

Slope is statistically significant: P-value < 0.05

Acknowledgment and Reference

ACKNOWLEDGMENT:

This presentation closely follows the Carlberg (2012) presentation in Chapter 2: pages 21-52.
These slides present the how – step by step – of logistic regression for a single case.
Carlberg (2012) discusses the how and the why.
Schield introduced the shortcut on slide 10.

REFERENCE:

Carlberg, Conrad (2012). *Decision Analytics: Microsoft Excel.* Que Publishing.