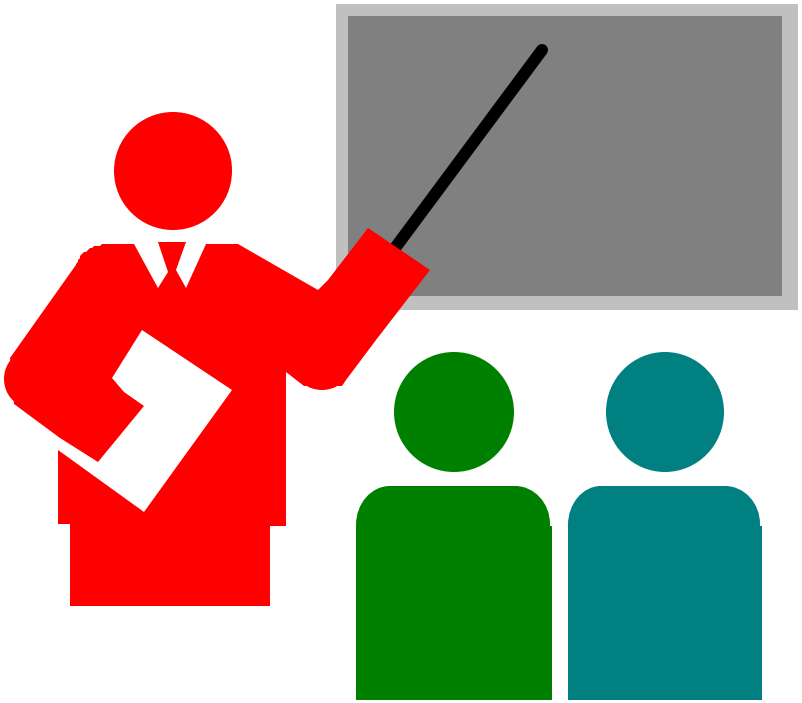
RASCH MODELS



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RASCH MODELS

Rasch Formula

$$\pi = \exp \lambda / (1 + \exp \lambda)$$

Logit

$$\log [\pi / 1 - \pi] = \lambda$$

Note: λ = probability unit defined by modeling process used!

To measure distance, compare differences, or determine rate of change we define scale units or measures using different modeling process (response models), i. e. dichotomous, partial, rating, or facets.

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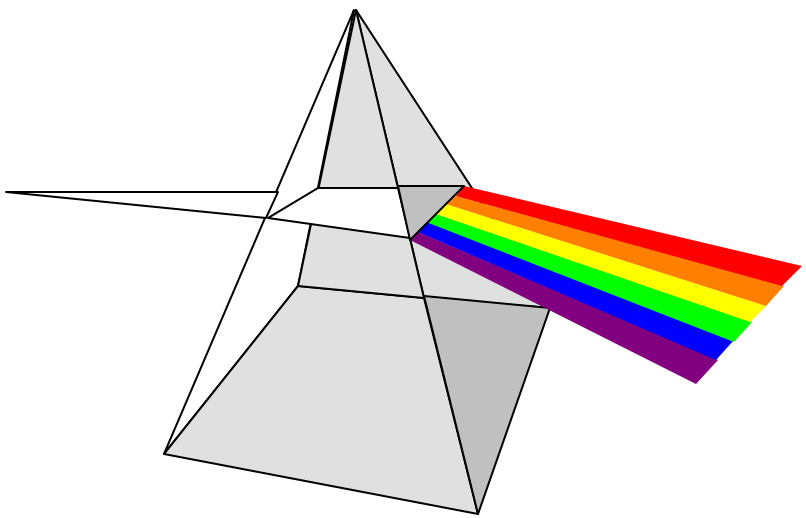
Partial Credit Models



- Traditional binary scored items (right/wrong) are scored differently.
- Points are awarded for intermediate levels of performance on an item.

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The Rasch logit calibration formula is:

$$\ln [P_{nix} / P_{nix-1}] = e [\beta_n - \delta_{ix}] / 1 + e [\beta_n - \delta_{ix}]$$

$$\ln [P_{nix} / P_{nix-1}] = \beta_n - \delta_{ix}$$

Where:

P_{nix} / P_{nix-1} = probability of individual n reaching item i step x

β_n = logit "ability" calibrated measure for person n scoring x on item i

δ_{ix} = logit "item" calibrated measure for item i step x

Performance across item levels generates operating curves (logistic ogives) with similar slopes, but different locations on ability continuum. Difficulties of steps in items vary and is captured by the term δ_{ix} .

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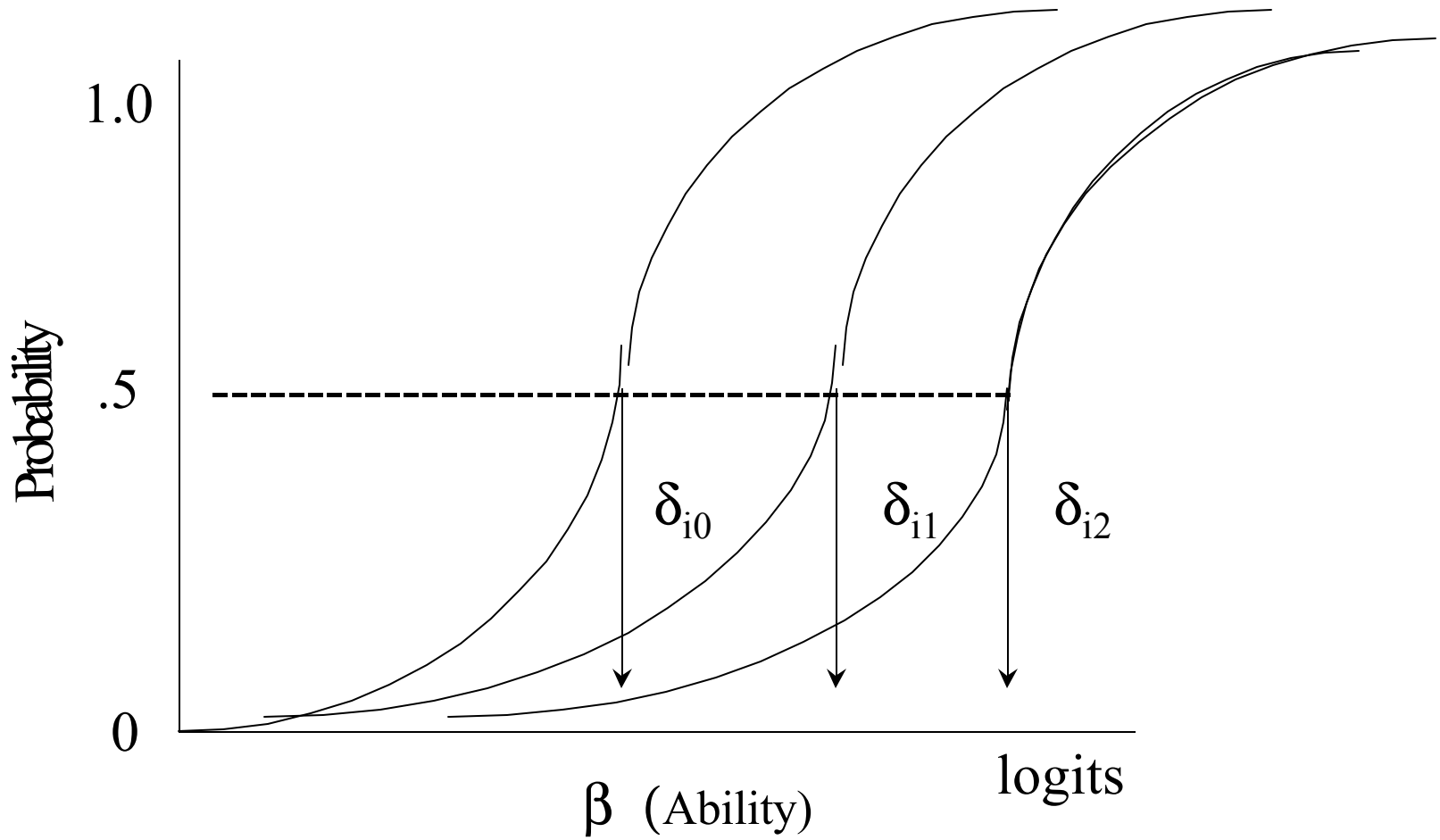
Partial Credit Operating Curve

(Item Scored 0, 1, 2)



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DEVELOPMENTAL SOCCER ABILITY

LEVEL	DEVELOPMENTAL ABILITY
1	WALKS INTO BALL
2	STRAIGHT LEG KICK
3	BACK SWING KICK FROM KNEE
4	FULL SWING KICK FROM HIP
5	FULL SWING KICK FROM HIP USING ARMS

Soccer ability was observed in 2 year olds for 5 items (catching, throwing, kicking, jumping, and striking).

Kids were given partial credit depending upon level of ability (0 - fair, 1 -moderate 2 -exceptional) .

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Partial Credit Example

```
&INST
TITLE=' Partial Credit Model for Soccer Ability -  n = 10 '
NI=5                          ; 5 item instrument
CHARTF=2                      ; Bayesian estimates for extreme s cores
ITEM1=1
NAME1=7
CODES='012'                   ;  partial credit scoring values
GROUPS=0                      ;  allows scoring to vary across items
MODELS=R                      ;  Partial Credit Model when GROUPS =0
CURVES=111                    ;  Three curves for each item
STKEEP=Y                      ;  Keep non-observed steps or categories
STEPT3=N                      ;  Report scale statistics in Tab le 21
TABLES='111111111111100100010'
IFILE='PCMODEL.IF'     ;  Output item logits
PFILE='PCMODEL.PF'   ;  Output person logits
&END
```

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Partial Credit Example (continued)

1 CATCH
2 THROW
3 KICK
4 JUMP
5 STRIKE
END NAMES
01112 BILLY
01122 AMY
01100 JILL
10000 JUAN
21110 STEVE
21100 PETER
11000 MARY
01100 JAMIE
01200 MARK
12222 GEORGE

Items placed in developmental order.

NOTE: Items can be sequentially numbered and data read from a separate file.

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Partial Credit Output

```
 PERSON STATISTICS:  MEASURE ORDER
+)))))))))))))))))))))))))))))))))))))0)))))))))0)))))))))0)))))0)))))))),
*ENTRY   RAW                          *   INFIT  *  OUTFIT  *PTBIS*       *
*  NUM  SCORE  COUNT  MEASURE  ERROR*MNSQ  ZSTD*MNSQ  ZSTD*CORR.* PERSON*
/)))))))))))))))))))))))))))))))))))))3)))))))))3)))))))))3)))))3)))))))1
*   10      9     5     2.56    1.14*1.29    .3*1.16    .1*  .00* GEORGE*
*    2      6     5      .60     .63*1.13    .3* .99    .0* -.67* AMY   *
*    1      5     5      .22     .63* .86   -.4* .63   -.7* -.47* BILLY *
*    5      5     5      .22     .63* .77   -.7* .61   -.7* -.17* STEVE *
*    6      4     5     -.20     .68*1.00    .0* .83   -.2*  .00* PETER *
*    9      3     5     -.74     .82*1.02    .0*1.09    .1*  .73* MARK  *
*    3      2     5    -1.63    1.08* .20  -1.1* .16   -.8*  .96* JILL  *
*    7      2     5    -1.63    1.08*1.31    .3* .96    .0*  .05* MARY  *
*    8      2     5    -1.63    1.08* .20  -1.1* .16   -.8*  .96* JAMIE *
*    4      1     5    -3.07    1.32*2.33   1.3*3.37    .3* -.41* JUAN  *
/)))))))))))))))))))))))))))))))))))))3)))))))))3)))))))))3)))))3)))))))1
* MEAN      4.    5.    -.53     .91*1.01   -.1*1.00   -.3*     *       *
* S.D.      2.    0.    1.49     .25* .57    .7* .86    .4*     *       *

.)))))))))))))))))))))))))))))))))))))2)))))))))2)))))))))2)))))2)))))))-
```

Note: Juan could only catch the ball (10000) while George could catch, throw, kick, jump, and spike (12222).

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Partial Credit Output

```
ITEMS  STATISTICS:  MEASURE ORDER
+)))))))))))))))))))))))))))))))))))))0)))))))))0)))))))))0)))))0
*ENTRY   RAW                          *   INFIT  *  OUTFIT  *PTBIS*
*  NUM  SCORE  COUNT  MEASURE  ERROR*MNSQ  ZSTD*MNSQ  ZSTD*CORR.*
/)))))))))))))))))))))))))))))))))))3)))))))))3)))))))))3)))))3
*    4      6    10      .47     .54* .41  -1.7* .29  -1.1*  .79*
*    5      6    10      .30     .48* .65  -1.0* .31   -.3*  .53*
*    1      7    10      .26     .55*2.22   2.1*3.28   2.3* -.19*
*    2     10    10     -.48     .82* .43  -1.3* .28  -1.5*  .68*
*    3     10    10     -.54     .63* .83   -.4* .82   -.4*  .40*
/)))))))))))))))))))))))))))))))))))3)))))))))3)))))))))3)))))3
* MEAN      8.   10.     .00     .60* .91   -.5*1.00   -.2*     *
* S.D.      2.    0.     .43     .12* .68   1.4*1.16   1.3*     *
.)))))))))))))))))))))))))))))))))))2)))))))))2)))))))))2)))))2
```

```
ITEMS
4  JUMP
5  STRIKE
1  CATCH
2  THROW
3  KICK
```

Note: Items are not ordered developmentally as one would expect. Item 1 - Catch is misfitting.

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Partial Credit Output

```
                    (MAP OF PERSONS AND ITEMS)
MEASURE
              PERSONS)3)ITEMS
   3.0                3
                      *
      GEORGE        X *
                      *
   2.0                3
                      *
                      *
   1.0                3
                      *
      AMY           X *
                      * X    JUMP
      BILLY,STEVE  XX * XX   STRIKE, CATCH
    .0                3
      PETER         X *
                      * X    THROW
                      * X    KICK
      MARK          X *
  -1.0                3
                      *
                      *
     JILL, MARY,  XXX *
     JAMIE            *
  -2.0                3
                      *
                      *
  -3.0    JUAN      X 3
```

GOOD SOCCER ABILITY

POOR SOCCER ABILITY

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