COMPUTER ADAPTIVE TESTING

• Different from computer based testing where paper and pencil tests are given using a computer.
• Item banks provide ability to give fewer items and different items to examinees.
Routing Approach

10 Item Test
Wide range of item difficulties
Performance determines routing to 1 of 3 other tests

Difficult Test
20 items

Intermediate Test
20 items

Easy Test
20 items
CAT Models

Pyramid Approach

<table>
<thead>
<tr>
<th>Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>right</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wrong</td>
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<tr>
<td>right</td>
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<tr>
<td>wrong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Decision Tree Approach permits probabilistic outcome

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CAT Models

Adaptive Approach

1. Set $D=0$, $L=0$, $H=0$, $R=0$, $T =$ cut score
2. Find next item near difficulty, $D$.
3. Set $D =$ calibrated item value
4. Administer Item
5. Obtain and score response
6. $L = L + 1$ (Count items taken)
7. $H = H + D$ (Sum item difficulties used)
8. $D = D-2/L$ (Update item difficulty - incorrect response) OR $D = D+2/L$ (Update item difficulty - correct response)
9. $R = R + 1$ (Count right answers and go to back Step 2) OR $W = L - R$ (Decide pass or fail?)
10. $B = H/L + \log (R/W)$ (Estimate person measure)
11. $S = \left[ L / (R*W) \right]^{1/2}$ (Calculate standard error)
12. If $(B - S) > T$ (Pass)
13. If $(B + S) < T$ (Fail)
CAT Models

Adaptive Approach Concepts

- **Stopping rule**
  - Number of items or standard error is used to determine when to stop testing

- **Start value**
  - Initial Ability estimate used to begin item selection

- **Information Function** \( (P^2 / PQ) \)
  - Additive over items as variance estimate
  - Provides contribution to precision of estimating ability
CAT Models

Bayesian Approach

Bayesian assumes $p = .75$ if first item correct or $p = .25$ if first item incorrect. Ability measure if answer item correct should be 1.1 logits above this item difficulty. Therefore….

$$\text{Item variance} = 1 / .75 \times .25 = 5$$

After administering $L$ items, ability estimate should approximate:

$$B_n = \left[ \sum (D_i + 1.1) + \sum (D_i - 1.1) \right] / L_n$$

Standard error should approximate:

$$\text{SE} (B_n)^2 = \left[ \sum (D_i + 1.1)^2 + \sum (D_i - 1.1)^2 \right] / L_n (L_n - 1) + 5 / L_n$$

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CAT Example

Program Files

<table>
<thead>
<tr>
<th>File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCCAT.EXE</td>
<td>Executable PROGRAM</td>
</tr>
<tr>
<td>PCCAT.CRL</td>
<td>Control File</td>
</tr>
<tr>
<td>PCCAT.IPA</td>
<td>Item Parameter File</td>
</tr>
<tr>
<td>SAMPLE.DAT</td>
<td>Examinee Data File</td>
</tr>
</tbody>
</table>

Stopping Rule (Select a or b)

a. SE = .30 (requires minimum of 60 items)
b. 20 Items (requires SE = 0 to work)

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CAT Example

Control File

&CONTROL
TITLE='CAT SE STOPPING RULE'
FMT='(11X,60I1//)'
NI=60
NCB=3
NP=200
MAXI=20
BOTSV=-2.76
TOPSV=2.92
SDMIN=0.30
PARMFN='SSI89.IPA'
DATAFN='SAMPLE.DAT'
AUDITFN='SSI89.AUD'
THETAFN='SSI89.THE'
/

Data Format
Number of items in bank
Number of step values
Number of persons
Maximum Items to Give
Lowest step value
Highest step value
Standard Error Cutoff
Item Parameter File
Examinee Responses
Audit Response Trail
Ability, SE, Items taken

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Cat Example

Item Parameter File

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>-0.436</td>
<td>-0.014</td>
<td>0.435</td>
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<tr>
<td>-0.437</td>
<td>0.027</td>
<td>0.362</td>
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<tr>
<td>-0.669</td>
<td>0.010</td>
<td>0.708</td>
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<tr>
<td>-0.003</td>
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<td>0.794</td>
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<td>-0.032</td>
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<td>0.066</td>
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<td>-1.814</td>
<td>-1.213</td>
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<tr>
<td>-2.103</td>
<td>-1.621</td>
<td>-0.798</td>
</tr>
</tbody>
</table>

(etc.)

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CAT Example

Examinee Data File

-2.3393850
0010000000013000000010000000101001300000100000002110000000000000000
0000000000000000000000000000000010021002000110110010110202100001131
131010322110100122101201110000000010102210100000021001121000000001012000000
000022230102
0.3090126
3220320230003312113223332103320112211123102321221211211013220100000100101001
100022300101022000110030000100100020001010003330133332333333333333323332333
333233132333333333323332330201103333321010310132233333000000033133330011
020033322332
(etc.)
## CAT Example

### Examinee Output File

<table>
<thead>
<tr>
<th>Person</th>
<th>Theta</th>
<th>SE</th>
<th>Items Taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-2.143</td>
<td>.303</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
<td>.439</td>
<td>.295</td>
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<tr>
<td>4</td>
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<td>10</td>
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<td>17</td>
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</tbody>
</table>

(etc.)
Computer Adaptive Testing

PROGRAM AVAILABILITY

- Programs are available on the internet (www.rasch.org)
  - UCAT Program manual and source code
  - SECURE Program encrypts and decrypt data files
- Programs are available commercially
  - Computer Adaptive Technologies
  - Assessment Systems Corporation
- Write your own