Web application to D-Scoring approach

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1 Introduction

The purpose of this guide is to introduce the methodology of D-Scoring using specially developed Web application. It uses the DScoring package under R, available at https://github.com/amitko/DScoring.git. The concepts behind this approach are presented in [1].

The starting screen of the system is presented on Figure 1. It consists of three main areas:

- 1. Menu tabs with different aspects of DScoring test assessment
- 2. Left Pannel organized in different tabs, it contains different parameters and fields for data input and settings.
- 3. Right Pannel the required results are presented. The Download button can be used to export the presented results in a csv file.

2 Test assessment

The first step of test assessment is to define the used RFM model. The default value (the most common case) is RFM2. After that the file with person's response has to be uploaded. This file should be in csv format, with header row. The columns should represent items and the rows - different persons. The value in the row i + 1, column j, should be 1 if the person i answers correctly on item j and 0 otherwise. The upload process is presented on Figure 2.

Figure 1: Starting window

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D-Scoring Classical Latent Equating DIF Diagnostics		
Model	Load item data	
Select model	🛓 Download	
BFM1 BFM2		
RFM3		
Item access only		
Browse No file selected		
Item Scores		
item deitas		
Person D-scores		
BEM norameters		
ICC		

Figure 2: Uploading file

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D-Scoring Classical Latent Equating DIF Diagnostics		
Model	Load item data	
Select model	🛓 Download	
RFM1 RFM2		
O REM3		
Item scores csv		
Browse item_score.csv		
Upload complete		
Item Scores		
Item deltas		
Person D-scores		
RFM parameters		
ICC		

After uploading the file, its processing is started. Depending on the size of the file it may take some time. After the file is processed the status **Processed** is presented in the Left Pannel and the ICC of first item is presented (Figure 3).

Figure 3: File is processed



Pressing Item Scores in the Left Pannel, the uploaded data is presented in the table on the Right Pannel. The label of the columns are taken from the first row of the file. In the table only the first 10 rows of the data are presented. Next cases can be accessible on the next pages. The whole file can be downloaded using Download button. See Figure 4.

●●● □ ~ < >				No	t Secure -	– webapp.i	r-statistics	s.net										
D-Scoring Classical Latent Equating DIF	Diagnostics																	
Model		Processe	d															
Select model		Show 1	0 ‡ ¢	entries											Searc	hc		
O BEM1		3	co 🗄	X0.1 🗄	X0.2 🔅	X0.3 🗄	X0.4 🔅	X1 0	X0.5 🗄	X0.6 🔅	X0.7 🗄	X0.8 🔅	X0.9 0	X0.10 🗄	X0.11 0	X0.12 0	X0.13 🗄	X0.14
RFM2 RFM3		1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
		2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Itom accrea any		3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
item scores csv		4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Browse Item_score.csv Upload complete		5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Item Scores		7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Item deltas		9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Person D-scores		Showing	1 to 10	of 2,982	entries							Pre	vious	1 2	3 4	5	299	Next
		🛓 Dow	nload															
RFM parameters																		
ICC		2 -															000	
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		entorma											1	- 0				
		0.6										0	-					
		0.4 0.4									0 0							

Figure 4: Item scores

The estimated item deltas can be accessed by pressing the Item deltas button in the Left Pannel (Figure 5). On the right the corresponding values of the item delta are presented. The first column shows the estimated delta value while the second column is the corresponding standard error (se) of the estimate.

••• • • • • • •	Not Secure — webapp.ir-statistics.net	
D-Scoring Classical Latent Equating DIF Diagnostics		
Model	Processed	
Select model	Show 10 ‡ entries	Search:
O BEM1	delta	à
O RFM2	4	0.000000010101010000
O RFM3	0.3906/800496311	2 0.00028594649161228
	2 0.63715627095908	\$ 0.0002/1/94452454/96
Item scores csv	3 0.28303152246814	2 0.000254056450679345
Browse Item score.csv	4 0.45238095238095	2 0.000296030351273735
Upfoed complete	5 0.57075788061703	5 0.000272626865930614
	6 0.23641851106639	8 0.000245012462610822
Item Scores	7 0.30348759221998	7 0.000263019744951397
	8 0.36653252850435	a 0.000269788815059769
Item deltas	9 0.42471495640509	7 0.000280703251231948
	10 0.55835010060362	2 0.000295982940967161
Person D-scores	Showing 1 to 10 of 20 entries	Previous 1 2 Next
	± Download	
BEM parameters		
ni ni paranietera		
ICC	2 -	
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		a a a
	- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	0

Figure 5: Item deltas

Estimated person's D-scores can be shown by pressing the Person D-scores (see Figure 6) button in the Left Pannel. The data presented on the Right Pannel consist of estimated person's D-score, the maximul reliability D-score (see [2]), estimated true score and standard error of estimated D-score.

Figure 6: Person D-Scores

aroung manual and county on					
Model	Processed				
Select model	Show 10 \$	entries		Sear	sh:
BFM1		D-score 0	MaxReliabilityScore	TrueScore	s
RFM2 RFM3	1	0.0244100895036615	0.0497514267299095	0.0224934741068385	0.09017468069072
	2	0.0244100895036615	0.0497514267299095	0.0224934741068385	0.09017468069072
	3	0.0244100895036615	0.0497514267299095	0.0224934741068385	0.09017468069072
Item scores csv	4	0.0261413015251978	0.0538117587165867	0.0241527658618159	0.09342601697666
Browse item_score.csv	5	0.0261413015251978	0.0538117587165867	0.0241527658618159	0.09342601697666
Upiced complete	6	0.0261413015251978	0.0538117587165867	0.0241527658618159	0.09342601697666
Item Scores	7	0.0261413015251978	0.0511719164925433	0.0241527658618159	0.09342601697666
	8	0.0261413015251978	0.0511719164925433	0.0241527658618159	0.09342601697666
Item deltas	9	0.0261413015251978	0.0511719164925433	0.0241527658618159	0.09342601697666
	10	0.0261413015251978	0.0511719164925433	0.0241527658618159	0.09342601697666
Person D-scores	Showing 1 to 1	0 of 2,982 entries		Previous 1 2 3 4	5 299 Ne
	± Download				
BFM rerematere					
66					
					0 0 0
	- 08 -			A-0-0	
	e perfor			8	

The data from the current test are fitted to the choosen RFM model. The fit parameters are presented by pressing RFM parameters button on the Left Pannel (see Figure 7). The presented data consist of estimated item parameters and their standard errors as well as of a MAD of the estimated fit.

The item characteristic curve for the specific item can be shown chosing the item from the ICC list box (Figure 8). The plot can be exported with right click.

Figure 7: ICC

•• •• • •		Not Secure — webs	pp.ir-statistics.net	5 0		<u>ڻ</u> +
D-Scoring Classical Latent Equating DIF Diagno	istics					
Model	Processe	d				
Select model	Show 1	0 ‡ entries			Search:	
O BEM1		b 🗄	s ÷	SE b 🗄	SE s 🗄	MA
O RFM2	1	0.571702734638349	1.21372968395074	0.00748071446125299	0.047459011980558	0.02188358338830
	2	0.620219174220645	1.20900505579729	0.0130505224677006	0.0844839880854146	0.0376686975262
	3	0.227766247282768	0.972609597282137	0.00900302300388267	0.0491229333894702	0.02469522918279
Item scores csv	4	0.423320325545251	1.13335949821983	0.0201811324449934	0.114037038667614	0.0379844207774
Browse Item_score.csv	5	0.554194632124798	1.14908886586351	0.00885547622871754	0.0508178535893093	0.02634571760967
Upload complete	6	0.182558503218907	0.983035688699752	0.00927815317655069	0.0580301193227645	0.0282354665945
Ham Seams	7	0.257576102457128	1.05342768650562	0.0199152151902869	0.117503887302984	0.0432727852191
item scores	8	0.329928105836283	1.11274935734335	0.0131864814174064	0.0772743340483854	0.0340658341410
Item rieltos	9	0.394307441991236	1.11100410291213	0.010713978831285	0.0593920705216741	0.02764857571082
Item Genas	10	0.536236995534687	1.23298225905104	0.00822714742294993	0.0530631726260883	0.0262749144205
Person D-scores	Showing	1 to 10 of 20 entries			Prev	ious 1 2 N
	≛ Dov	nload				
RFM parameters						
ICC						
1	•				~	0 0 0
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	ę 6'			0		

Figure 8: RFM fit

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RFM1		b \oplus	s 0	SE_b 0	SE_s ¢	MAD
RFM3	1	0.571702734638349	1.21372968395074	0.00748071446125299	0.047459011980558	0.021883583388306
	2	0.620219174220645	1.20900505579729	0.0130505224677006	0.0844839880854146	0.037668697526288
tom scores osy	3	0.227766247282768	0.972609597282137	0.00900302300388267	0.0491229333894702	0.024695229182797
tem scores csv	4	0.423320325545251	1.13335949821983	0.0201811324449934	0.114037038667614	0.037984420777484
Browse item_score.csv	5	0.554194632124798	1.14908886586351	0.00885547622871754	0.0508178535893093	0.026345717609672
	6	0.182558503218907	0.983035688699752	0.00927815317655069	0.0580301193227645	0.028235466594593
Item Scores	7	0.257576102457128	1.05342768650562	0.0199152151902869	0.117503887302984	0.043272785219114
	8	0.329928105836283	1.11274935734335	0.0131854814174064	0.0772743340483854	0.034065834141004
Item deltas	9	0.394307441991236	1.11100410291213	0.010713978831285	0.0593920705216741	0.027648575710826
	10	0.536236995534687	1.23298225905104	0.00822714742294993	0.0530631726260883	0.02627491442050
RFM parameters						
ICC	2.4					
1	* 8 ⁻				-0-	-0-0-
1	0.8				8 8	
2	o.6			_	a de	
3	4 COLE			200		
4	9 G			0		
6	- 5 cpap		0 0			
7	۵	0-0-0-	-0			
0	8 -	0				
		0.0	0.2 0.	4 0.6	0.8	1.0
				D-score		

The item parameters as well as a person parameters are accessible from the second tab of Latent (Figure 9).

3 Estimation of the latent model

Figure 9: Latent parameters

••• •	0	Not Secure — webapp.ir-statistics.net	0 C	©∆+©
D-Scoring Classical Latent Equating	DIF Diagnostics			
Estimate RFM2		≟ Download		
Item parameters				
D-scores ID from:				
1	۲			
to: 30	٢			

Latent item parameters can be shown via button Item parameters (Figure 10). The estimated item parametes, according the chossen RFM model are presented as well as their standard errors (SE). The last column of the table contains the estimated mean absolute difference (MAD) between observed item performance and the one predicted by the model.

Figure 10: Latent item parameters

●● □□ < >			Not Secure — web	app.ir-statistics.net			
-Scoring Classical Latent Equating	DIF Diagnostics						
Estimate RFM2		Processing					
		Show 10	+ entries			Search:	
Item parameters			b \div	s 0	SE_b 🗄	SE_8 0	MAD
		1	0.541995153837975	1.22590522713779	0.00896656840667096	0.05480712989707	0.029392849547286
D-scores ID from:		2	0.589757433381007	1.25828710317192	0.00919524485122512	0.0563495096882345	0.043028052095058
1	٥	3	0.200849176261066	0.944177859707176	0.0105633584296909	0.0511860366386172	0.02983804959775
to:		4	0.393498713178111	1.10899943156852	0.00898183673862981	0.0517059913797506	0.04477466245263
30	۲	5	0.5221269744761	1.19161709803222	0.00901855281416418	0.0537473091934119	0.0350469784824
		6	0.151575305364802	0.907092320321793	0.0106525671809942	0.0523166153130803	0.034984805760507
		7	0.227321670237561	0.992089785602621	0.0101421716483506	0.0515933082508676	0.0495240385893
		8	0.303662351098483	1.11697281967093	0.00902461101063804	0.0530029454648695	0.03861152137765
		9	0.362962919958937	1.07285359087573	0.00923404202745183	0.0510925804242414	0.037927740581777
		10	0.507219267662575	1.23393015834071	0.00865767038643132	0.0546954894090809	0.033932657763181
		Showing 1 to	ad			Previ	ous 1 2 Nex

The estimated person parameters can be accessed by the button D-scores. The proposed methodology is explayned in [3]. As the calculation of their values is computably intensive, only the specified range ID from - to of person ID (rows in the data file) are processed. For example, if one wants to precess the first 150 persons (rows) in the data file, one should input values 1 and 150 in these fields. The result is presented on Figure 11. The first column consists the persen ID (row number), so if the data file is large, different bunches of it can be processed separately and the results can be combined together based on this column. The second and third column are the estimeted D-Score and its standard error.

Figure 11: Latent person parameters

••• •••				Not Secure — webapp.ir-statistics.net		
D-Scoring Classical La	ent Equating	DIF	Diagnostics			
Estimate RFM2				Processed		
				Show 10 ‡ entries		Search:
Item parameters				ID ÷	D-Score 🗄	SE 🕸
Descores				1	0.0348786730879521	0.034487991532753
ID from:				2	0.0348786730879521	0.034487991532753
1			0	3	0.0348786730879521	0.034487991532753
to:				4	0.037019333526843	0.0355284473367537
30			٥	5	0.037019333526843	0.0355284473367537
				6	0.037019333526843	0.0355284473367537
				7	0.0376866312916555	0.0358471870971038
				8	0.0376866312916555	0.0358471870971038
				9	0.0376866312916555	0.0358471870971038
				10	0.0376866312916555	0.0358471870971038
				Showing 1 to 10 of 30 entries		Previous 1 2 3 Next

4 Test equating

One of the main advantages of the used methodology is the ability to equate the results of different test forms, administrated on different populations (see [5]). For that purpose, the item deltas for the base test (the test to which the current test is equated) should be provided as well as the set of comon items between the two tests (Figure 12).

Figure 12: Test Equating

••• • • < > • • •	Not Secure — webapp.ir-statistics.net	5 a	⊕ ∆ + ©
D-Scoring Classical Latent Equating DIF Diagnostics			
Base test			
Base test deltas	Lownload		
Browse No file selected			
Common itoms			
Browse No file selected			
Base test deltas			
Common items			
Hescaing constants			
Rescaled item deltas			
Equated D-scores			

The base test item deltas should be provided in a $\tt csv$ file as a one column with a header row, for example

```
"delta"
0.146036509127282
0.623155788947237
0.706426606651663
0.295073768442111
0.60190047511878
0.695923980995249
.
```

The file should be uploaded in the field Base test deltas, (see Figure 13).

Figure 13: Base test deltas

••• • • < > • •	Not Secure — webapp.ir-statistics.net	• •	• ዕ + ©
D-Scoring Classical Latent Equating DIF Diagnostics			
Base test			
Base test deltas	± Download		
Browse base_test_deltas.csv Upload complete			
Common items			
Browse No file selected			
Base test deltas			
Common items			
Rescaling constants			
Rescaled item deltas			
Equated D-scores			

The common item should be provided in a csv file with two columns. The first one indicates the number of the item i the base test which is equivalent to the number of the item in the current test, presented in the second column.

For example, the following file

3,5 7,9 4,6 7,3

shows that item 3 from the base test is equivalent to item 5 in the current test under processing, item 7 in the base test corresponds to item 9 in the current and so on. The file should be uploaded in field Common items (Figure 14).

Figure 14: Common items

••• •• • •	Not Secure — webapp.ir-statistics.net	5 0	© ∆ + ©
D-Scoring Classical Latent Equating DIF Diagnostics			
Base test	L Download		
Base test deltas			
Common items			
Browse common_Rems.csv Upload complete			
Base test deltas			
Common items			
Rescaling constants			
Equated D-scores			

The loaded base test deltas and common items can be inspected with the corresponding buttons, see Figure 15 and Figure 16.

Figure 15: Base test deltas inspected

Scoring Classical Latent Equating DIF Diagnosti	3	
Base test	Show 10 + ontrine	
Base test deltas		Search:
Browse base_test_deltas.csv	-	0.1460255001772
Upload complete	2	0.62315578894723
Common items	3	0.70642660665166
Browse common_items.csv	4	0.29507376844211
Upload complete	5	0.601900475118
	6	0.6959239809952
Base test deltas	7	0.53238309577394
Common Name	8	0.333333333333
Common nems	9	0.30132533133283
Rescaling constants	10	0.53463365841460
	Showing 1 to 10 of 20 entries	Previous 1 2 Nex
Rescaled item deltas	2. Download	
Equated D-scores		

Figure 16: Common items inspected

••• • • • • • •	Not Secure — webapp.ir-statistics.net	5 a	⊕ ± ©
D-Scoring Classical Latent Equating DIF Diagnostics			
Base test			
Base test deltas	Show 10 ¢ entries		Search:
Browse base_test_deltas.csv		base_test \Rightarrow	target_test 🖗
Upload complete	1	3	5
Common itema	2	7	9
	4	4	6
Browse common_nems.csv Upload complete	Showing 1 to 4 of 4 entries		Previous 1 Next
	L Download		
Base test deltas			
Common items			
Rescaling constants			
Rescaled item deltas			
Frontie Down			
Equated D-scores			

Equating constant A and B are presented on Figure 17. The current test item deltas, rescaled on the scale of the base test are available trough button Rescaled item deltas (Figure 18). The equated person's D-score can be shown by Equated D-score button (Figure 19).

Figure 17: Equating constants

●●●	Not Secure — webapp.ir-statistics.net		
D-Scoring Classical Latent Equating DIF Diagnostics			
Base test			
Base test deltas	Show 10 C entries		Search:
Browse base_test_deltas.csv		A ‡	B ‡
Upload complete	1	1.09546150453018	0.380355613278923
Common items	Showing 1 to 1 of 1 entries		Previous 1 Next
Browse common_items.csv			
Upload complete			
Base test deltas			
Common items			
Rescaling constants			
Percenter item delter			
Equated D-scores			

Figure 18: Rescaled Item deltas

●●● □ ~ < > □ □	Not Secure — webapp.ir-statistics.net	
D-Scoring Classical Latent Equating DIF Diagnostics		
Provide		
Base test deltes	Show 10 ¢ entries	Search:
Dase lest dellas		delta 👳
Browse base_test_deltas.csv Upload complete		0.740785545916134
		0.779740858607732
Common items		0.408338718003483
Browse common_items.csv		0.607799435033578
Upload complete		0.723023765217142
Receited deltes		0.345931427047872
Dase test dellas		0.434704089828645
Common items		0.512001405504469
Common normal		0.578093114998259
Rescaling constants		0.711815262210012
	Showing 1 to 10 of 20 entries	Previous 1 2 Next
Rescaled item deltas	2 Download	
Equated D-scores		

Figure 19: Equated person score

●●● □ ← く >		Not Secure — webapp.ir-statistics.net		
D-Scoring Classical Latent Equating DIF	Diagnostics			
Rose test				
Page test deltas	s	how 10 ¢ entries	Search	12
Dase lest dellas				D-score
Browse Dase_test_dertas.csv Upload complete		1		0.0278668072607407
		2		0.0278668072607407
Common items		3		0.0278668072607407
Browse common_items.csv		4		0.0297048905516202
Upload complete		5		0.0297048905516202
Base test deltas		-		0.0297048905516202
		7		0.0297048905516202
Common Items		•		0.0297048905516202
		10		0.0297048905516202
Rescaling constants	-	ihowing 1 to 10 of 2.982 entries	Previous 1 2 3 4	5 299 Next
		± Download		
Rescaled item deltas				
Equated D-scores				

5 Differential item functioning

Differential item functioning of the items in the current test can be studyed by DIF tab of the application (Figure 20). Detailed description of the methodology and the interpretation of the results can be found in [4]. The focal and reference group should be indicated by the csv five with a focal indicator (Figure 21). This file should contain one column with value for every person in the test indicating whether he belongs to the focal (value 1) or reference group (value 0). So the file consists of one single column with zeros and ones.

The resulted DIF sttistics can be shown by button **Statistics** and the result is presented on Figure 22. If there is a statistically significant DIF for a specific item, the corresponding value in the column DIF will be 1.

••• • • •		Not Secure — webapp.ir-statistics.net	
D-Scoring Classical Latent Equating DIF	Diagnostics		
Differential Item Functionning	± Dou	hoad	
Browse No file selected			
Statistics			

Figure 20: DIF

Figure 21: Focal indicator

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D-Scoring Classical Latent Equating DIF Diagnostics			
Differential Item Functionning			
Focal group indicator	≛ Download		
Browse focal.csv Uplead complete			
Contraction -			
STRUSTICS			

Figure 22: DIF Statistics

••• Ш • < >			Not S	ecure — webapp.ir-statistics.net			
D-Scoring Classical Latent Equating DI	F Diagnostics						
Differential item Functionning		Processed					
Focal group indicator		Show 10	+ entries			Se	arch:
Browse focal.csv			DIF φ	Fistat 🗄	Ep.value 💠	T.stat 💠	T.p.value 🗄
Upload complete		1	0	0.847166986440312	0.652569817936443	0.647456754193342	0.519822922480802
		2	0	0.847223090992994	0.652699277835749	0.380696185704196	0.704782432739176
Stansucs		3	0	1.18149807477563	0.650761230877802	3.39742606936345	0.00121728981071635
		4	0	0.980044812943164	0.956342666830288	-0.121984900348257	0.903318665641013
		5	0	0.94345762893316	0.874406269972706	-0.147251822413905	0.883427370596292
		6	0	1.36319095121778	0.401020538818918	-0.661417202436105	0.51093648934548
		7	0	1.12948198069101	0.740959376462496	-1.34801733105386	0.182738949172584
		8	0	1.01934454355592	0.958500359286474	0.0774326827388898	0.938537008864479
		9	0	1.01230329736255	0.973506791183635	-1.3536947309192	0.18091152679625
		10	0	0.810226461029587	0.567989885039078	0.0250964708941926	0.980062210797747
		Showing 1 to	ad	S			Previous 1 2 Next

6 Test diagnostics

A basic test diagnostics can be acheived by 'Item-Person map' available at the tab Diagnostic, presented on Figure 23. The result is presented on

Figure 24. The bars, labled as 'deltas', represent the distribution of the item difficulties, while the bars labeled as 'D-score' represents the distribution of the estimated D-score of the persons.

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Figure 23: Diagnostics





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