

Automated human-level diagnosis of dysgraphia using a consumer tablet

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CoWriter Project

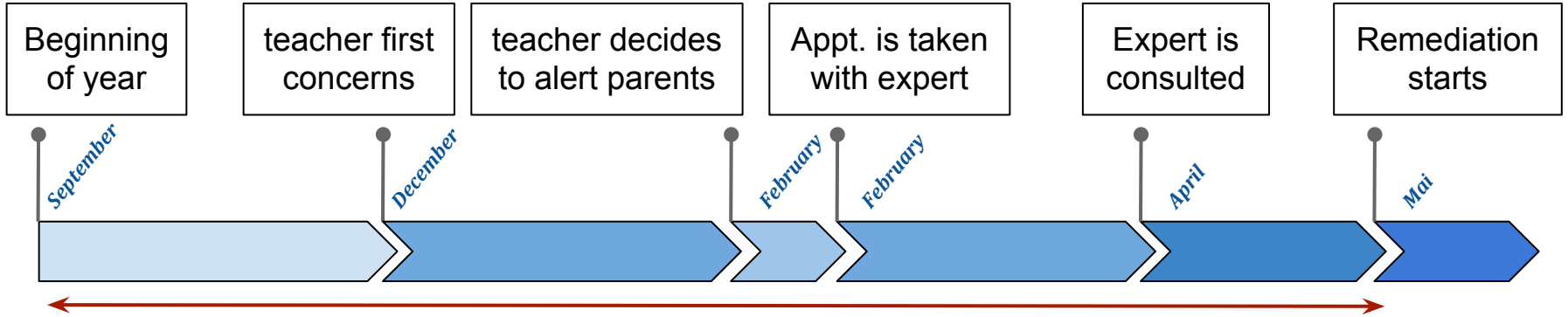
Learning by Teaching

Extrinsic Motivation

Protégé Effect



Diagnosis timeline



child accumulate problems, self-esteem drops down, ...



BHK Test

This is
the best
I can do

le petit cheval gambader

CRITÈRES											TOTAL
1. Ecriture grande						→					
2. Inclinaison de la marge vers la droite						→					
	Phrases	1	2	3	4	5	→				
3. Lignes non planes							→				
4. Mots serrés							→				
5. Ecriture chaotique							→				
6. Liens interrompus entre les lettres							→				
7. Téléscopages							→				
8. Variation dans la grandeur des lettres troncs							→				
9. Hauteur relative incorrecte							→				
10. Distorsion des lettres							→				
11. Formes de lettres ambiguës							→				
12. Lettres retouchées							→				
13. Hésitations et tremblements							→				
Score Total											

Limitations of the BHK



Subjective

Relies on **human judgement.**

Small (60%) inter-raters agreement.



Time consuming

Takes 5 minutes to pass the test, and around **15 minutes** to score it.



Costly

Expert needs to be trained to acquire the **expertise** for grading.

Grading takes time



Neglect informations

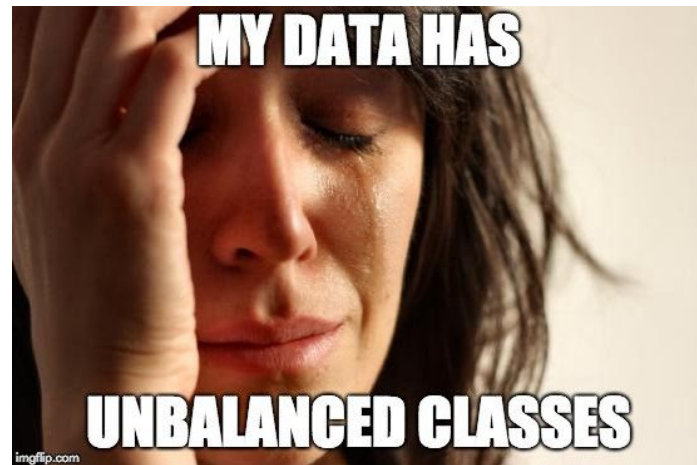
Test done on paper: all the **dynamic, pressure, tilt** aspects of handwriting are **not perceivable.**

Datasets

242 *TD* children versus 56 *D* children

- *Training set* —70% of *TD dataset* and 70% of *D dataset*.
- *Testing set* —30% of *TD dataset* and 30% of *D dataset*.

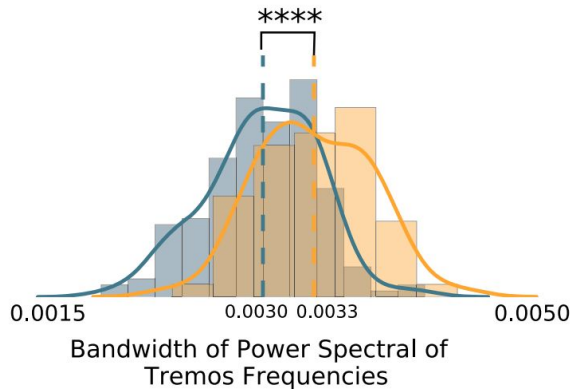
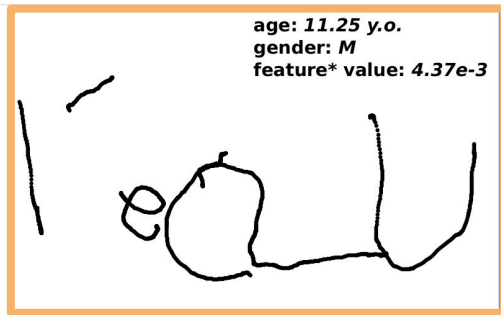
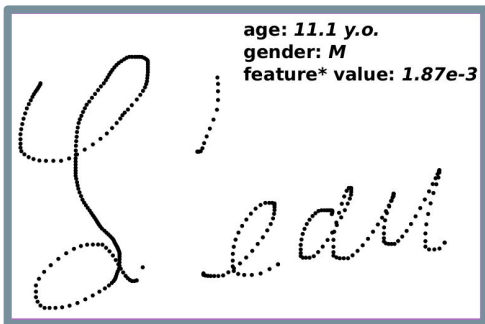
A k -fold cross-validation (with $k = 25$) on a Random Forest classifier was performed in order to test our model.

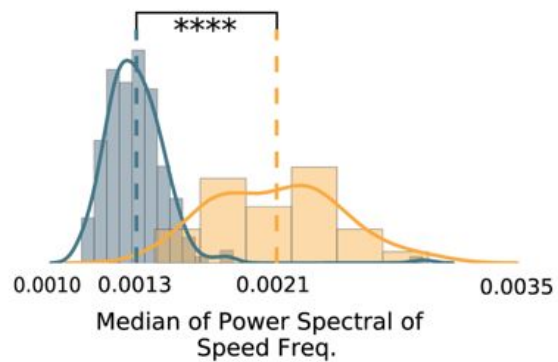
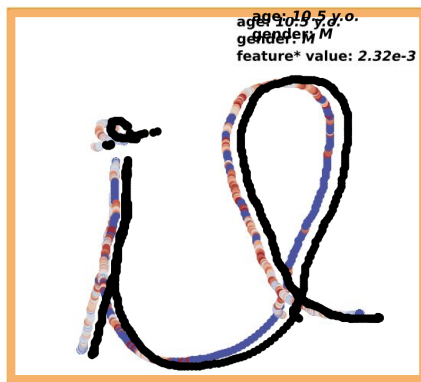
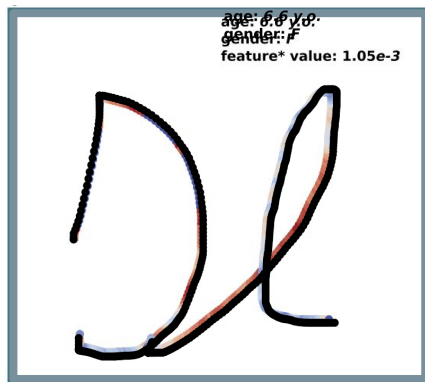


Features extraction

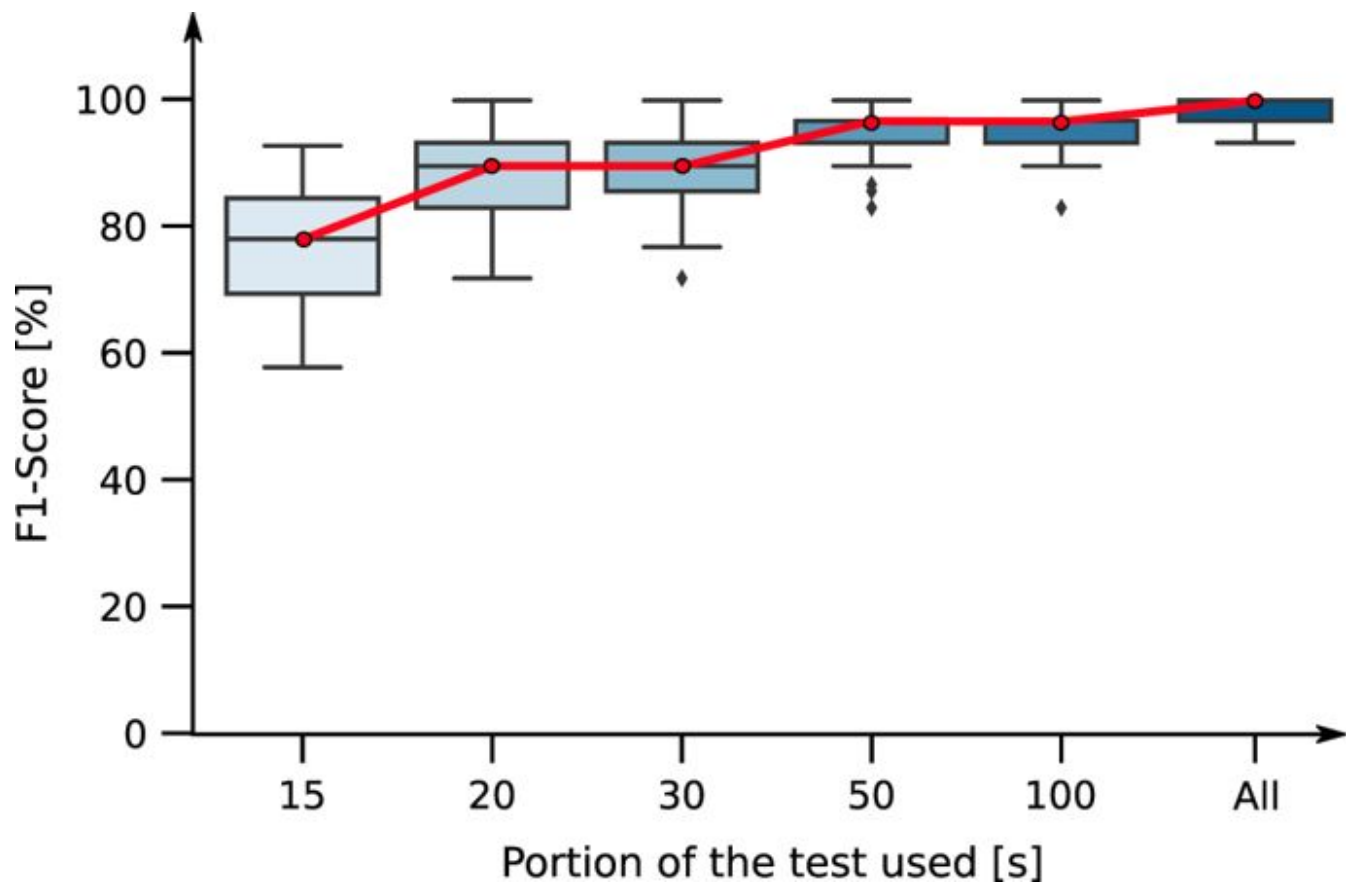
- *Static features*—purely geometric characteristics of a written text.
- *Kinematic features*—dynamics of handwriting path.
- *Pressure features*—characteristics of the pressure recorded between the pen tip and the tablet surface.
- *Tilt features*—characteristics of the pen tilt.







F1-score of 97%



Most Discriminative features

- The most important features used by the Artificial Intelligence to diagnose dysgraphia sorted.

Table 2. The most important features found by the Random Forest model, using Gini importance as a metric

Rank	Category	Name	Importance (Std.) [%]
1	Kinematic	Median of Power Spectral of Speed Frequencies	15.71 (9.06)
2	Kinematic	Bandwidth of Speed Frequencies	12.08 (8.00)
3	Pressure	Mean Speed of Pressure Change	9.81 (6.52)
4	Static	Space Between Words	7.45 (6.73)
5	Tilt	Distance to Mean of Speed of Tilt-X Change Frequencies	6.07 (4.30)
6	Kinematic	Distance to Mean of Speed Change Frequencies	5.18 (4.73)
7	Tilt	Bandwidth of Speed of Tilt-X Change Frequencies	4.10 (4.64)
8	Tilt	Median of Power Spectral of Tilt-Y Change Frequencies	2.97 (3.33)

We report the ranks, feature categories, and their importance averaged for the 25 folds and the standard deviation of importance over all folds

Only one of this feature can potentially be extracted with a pen/paper test !

Current and Future Work

Test on different script

Build tools for adaptive handwriting training

Kazakhstan adopts new version of Latin-based Kazakh alphabet

BY ELYA ALTYNSARINA in NATION on 26 FEBRUARY 2018

ASTANA – President Nursultan Nazarbayev amended his Oct. 26, 2017 decree concerning the transition of the Kazakh alphabet from Cyrillic to Latin script, which if kept, would have put into effect a Latin-script alphabet with 32 letters including nine characters with apostrophes. The new amendment replaces the apostrophes with diacritic signs and digraphs. The deadline to complete the switch remains 2025.

The following is the new version of the alphabet introduced by the amendment.

#	Letter	Cyrillic version	#	Letter	Cyrillic version
1	A a	[a]	17	Ń ń	[н]
2	Á á	[ə]	18	O o	[o]
3	B b	[b]	19	Ó ó	[ə]
4	D d	[d]	20	P p	[п]
5	E e	[e]	21	Q q	[к]
6	F f	[f]	22	R r	[р]
7	G g	[r]	23	S s	[c]
8	Ć ć	[ɸ]	24	T t	[т]
9	H h	[x], [h]	25	U u	[ʏ]
10	I i	[i]	26	Ú ú	[y]
11	I ı	[и], [й]	27	V v	[в]
12	J j	[ж]	28	Y y	[ы]
13	K k	[к]	29	Ý ý	[ʏ]

Thank you



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Doctorant ISIR*



K. Zolna



C. Jolly

UGA

Common tests to diagnose dysgraphia

		Age range	Test duration [min]	Scoring duration [min]	Language	Dynamic of handwriting	Pressure	Tilt	Speed
Ajuriaguerra	350	6–12	2	5	French	✗	✓	✗	✓
BHK	837	6–12	5	10	Multi-language	✗	✗	✗	✓
BHK-teenager	471	12–18	5	10	Multi-language	✗	✗	✗	✓
DASH	546	9–16	20	10	English	✗	✗	✗	✓