

Intrinsic Feature Importance

The intrinsic feature importance refers to the inherent ranking of features based on their contribution to the model's predictive performance. We applied regression models to predict the MDS-UPDRS Total, Part I, II, and III scores using multimodal data. Feature importance was assessed based on the models' internal mechanisms (e.g., coefficient values or feature weights) or via post-hoc evaluation methods such as the MI algorithm.

Random forest regressor (RFR), being an ensemble method, evaluates feature importance by measuring the decrease in impurity (e.g., Gini impurity or variance) across all the decision trees in the forest. Features that contribute more significantly to reducing the model's prediction error are ranked higher in importance. Least absolute shrinkage and selection operator (LASSO), being a regularization technique, automatically selects relevant features by shrinking the coefficients of less important ones to zero. However, Lasso does not provide feature importance in the same way as tree-based models like RFR, though the coefficients can give some insight into feature relevance.

The full lists of ranked features for MDS-UPDRS Total, Parts I, II, and III are below.

Table 1. Features importance rating by the random forest regressor and LASSO based on all modalities.

UPDRS Total		UPDRS Part I		UPDRS Part II		UPDRS Part III	
Feature	Score	Feature	Coefficients	Feature	Coefficients	Feature	Score
T10_PC2	0.08	SF-36 (mental)	0.24	SF-36 (total)	0.29	6MWT	0.11
6MWT	0.07	Forward walking_PC3	0.23	Mini-BEST	0.19	LANK_PC6	0.05
RELB_PC4	0.06	SF-36 (total)	0.17	T10_PC2	0.17	RELB_PC1	0.04
RELB_PC1	0.06	T10_PC6	0.03	LANK_PC3	0.14	LELB_PC5	0.04
Backward walking_PC7	0.04	BMI	0.01	LANK_PC6	0.05	5STST	0.04
Mini-BEST	0.04	T10_PC2	0.01	6MWT	0.03	T10_PC2	0.04
LELB_PC4	0.03			RELB_PC4	0.03	LELB_PC1	0.04
SF-36 (physical)	0.03			T10_PC4	0.01	RANK_PC3	0.03
5STST	0.03					LELB_PC4	0.03
LELB_PC6	0.03					T10_PC5	0.03
PSIS_PC6	0.03					PSIS_PC1	0.03
PSIS_PC1	0.03					Backward walking_PC7	0.03
LANK_PC4	0.03					LANK_PC1	0.03
T10_PC5	0.03					LANK_PC5	0.03
SF-36 (total)	0.02					Turning_PC6	0.03
T10_PC4	0.02					PSIS_PC6	0.03
Turning_PC6	0.02					RANK_PC2	0.02
PSIS_PC5	0.02					Mini-BEST	0.02
IPAQ	0.02					Grip strength_R	0.02
SF-36 (mental)	0.02					Body weight	0.02
LANK_PC3	0.02					PSIS_PC5	0.02
Age	0.02					RANK_PC1	0.02
LELB_PC3	0.02					LELB_PC8	0.02

RANK_PC3	0.02					Grip strength_L	0.02
LELB_PC1	0.02					NQ	0.02
Forward walking_PC3	0.02					RANK_PC5	0.02
Body weight	0.02					LELB_PC6	0.02
Height	0.02					Height	0.02
T10_PC3	0.02					Forward walking_PC3	0.02
Turning_PC5	0.02					T10_PC1	0.02
SPPB	0.02					Turning_PC2	0.02
Grip strength_R	0.02					SF-36 (total)	0.02
NQ	0.01					SF-36 (physical)	0.02
LANK_PC2	0.01					SF-36 (mental)	0.02
Turning_PC1	0.01					RANK_PC4	0.02
						BMI	0.02
						LANK_PC2	0.01
						SPPB	0.01
						Turning_PC1	0.01

Demographics
 Physical function and lifestyle
 Gait parameters in motion analysis systems
 Gait parameters in wearable sensors

Table 2. Features importance rating by the random forest regressor and LASSO based on physical function and lifestyle modalities.

UPDRS Total		UPDRS Part I		UPDRS Part II		UPDRS Part III	
Feature	Score	Feature	Coefficients	Feature	Coefficients	Feature	Score
6MWT	0.18	SF-36 (total)	0.21	SF-36 (total)	0.16	6MWT	0.16
Mini-BEST	0.11	SF-36 (mental)	0.20	Mini-BEST	0.15	5STST	0.12
IPAQ	0.10	SPPB	0.06	SF-36 (physical)	0.12	Grip strength_R	0.12
SF-36 (physical)	0.09			Grip strength_L	0.09	Grip strength_L	0.11
5STST	0.09			5STST	0.09	NQ	0.11
SF-36 (total)	0.08			SF-36 (mental)	0.08	SF-36 (physical)	0.10
Grip strength_L	0.06			IPAQ	0.08	SF-36 (total)	0.10
SF-36 (mental)	0.06			6MWT	0.08	SF-36 (mental)	0.10
Grip strength_R	0.05			Grip strength_R	0.07	SPPB	0.08
NQ	0.05			NQ	0.05		
SPPB	0.05			SPPB	0.04		

Table 3. Features importance rating by the random forest regressor and LASSO based on gait parameter's PCs in motion analysis systems modalities.

UPDRS Total		UPDRS Part I		UPDRS Part II		UPDRS Part III	
Feature	Score	Feature	Coefficients	Feature	Score	Feature	Score
Backward walking_PC7	0.22	Forward walking_PC3	0.23	Backward walking_PC4	0.31	Turning_PC6	0.23
Turning_PC6	0.22			Forward walking_PC3	0.25	Backward walking_PC7	0.21
Forward walking_PC3	0.21			Turning_PC2	0.23	Turning_PC2	0.20
Turning_PC1	0.18			Turning_PC1	0.22	Forward walking_PC3	0.19
Turning_PC5	0.18					Turning_PC1	0.17

Table 4. Features importance rating by the random forest regressor and LASSO based on gait parameter's PCs in wearable sensors modalities.

UPDRS Total		UPDRS Part I		UPDRS Part II		UPDRS Part III	
Feature	Score	Feature	Score	Feature	Score	Feature	Score
T10_PC2	0.12	T10_PC2	0.10	T10_PC2	0.08	T10_PC2	0.08
RELB_PC4	0.10	T10_PC6	0.08	RANK_PC1	0.08	LANK_PC6	0.08
RELB_PC1	0.09	LELB_PC2	0.08	RELB_PC1	0.07	RELB_PC1	0.08
PSIS_PC1	0.08	LELB_PC1	0.08	LANK_PC1	0.06	RANK_PC3	0.06
LELB_PC4	0.06	LANK_PC5	0.07	LANK_PC3	0.05	T10_PC5	0.06
PSIS_PC6	0.06	LELB_PC6	0.07	PSIS_PC1	0.05	LELB_PC5	0.06
LELB_PC6	0.06	RANK_PC1	0.07	PSIS_PC6	0.05	LELB_PC1	0.06
LANK_PC4	0.06	LELB_PC8	0.07	LELB_PC6	0.05	PSIS_PC1	0.06
T10_PC5	0.05	T10_PC1	0.07	LANK_PC4	0.05	LELB_PC4	0.05
RANK_PC3	0.05	RELB_PC3	0.07	PSIS_PC5	0.04	PSIS_PC6	0.05
LELB_PC3	0.05	PSIS_PC1	0.07	LELB_PC1	0.04	RANK_PC2	0.05
LELB_PC1	0.05	PSIS_PC4	0.06	RELB_PC4	0.04	LANK_PC1	0.04
LANK_PC3	0.05	RANK_PC3	0.06	T10_PC4	0.04	LANK_PC5	0.04
PSIS_PC5	0.05	LELB_PC3	0.05	T10_PC6	0.04	RANK_PC5	0.04
T10_PC4	0.04			PSIS_PC4	0.04	PSIS_PC2	0.04
LANK_PC2	0.03			T10_PC3	0.04	T10_PC1	0.04
				LELB_PC2	0.04	PSIS_PC5	0.03
				LANK_PC6	0.03	LELB_PC8	0.03
				LELB_PC3	0.03	LELB_PC6	0.03
				LELB_PC7	0.03	LANK_PC2	0.02
				T10_PC5	0.03		
				PSIS_PC2	0.03		