Spring 2024: CSCI 6521 Advanced Machine Learning - I
Programming Assignment #1
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1. **In your language, briefly describe why we can use voice features to detect Parkinson's disease. You may use published peer-reviewed literature with appropriate citations.**

- Voice features can serve as valuable indicators for detecting Parkinson's disease (PD) due to the characteristic vocal impairments associated with the condition. PD affects the motor control of muscles, including those involved in speech production, leading to dysphonia, which manifests as changes in vocal attributes such as pitch, loudness, and quality. [1]

  In the context of telemonitoring, voice features can be particularly useful, as demonstrated by Little et al. (2008) [1]. They introduced a new measure, pitch period entropy (PPE), which is robust to uncontrollable confounding effects like noisy acoustic environments and normal variations in voice frequency. By combining traditional harmonics-to-noise ratios with nonstandard methods, including PPE, they achieved a correct classification performance of 91.4% using a kernel support vector machine [1].

  Another study by Little et al. (2007) [2] explored the use of nonlinear recurrence and fractal scaling properties to detect voice disorders, including those associated with PD. They developed two new tools for speech analysis - recurrence and fractal scaling - that address the symptoms of disorder and can distinguish normal from disordered voices with a high degree of accuracy.

  These studies highlight that voice features can effectively detect PD because the disease's impact on the neuromuscular system often leads to measurable changes in speech production that can be captured through acoustic analysis. The use of advanced signal processing and machine learning techniques further enhances the ability to detect these changes and potentially allows for remote monitoring and early detection of PD [1][2].

References:

[1] Little, M. A., McSharry, P. E., Hunter, E. J., Spielman, J., & Ramig, L. O. (2008). Suitability of Dysphonia Measurements for Telemonitoring of Parkinson's Disease. IEEE Transactions on Biomedical Engineering, 56(4), 1015-1022.

[2] Little, M. A., McSharry, P. E., Roberts, S. J., Costello, D. A. E., & Moroz, I. M. (2007). Exploiting Nonlinear Recurrence and Fractal Scaling Properties for Voice Disorder Detection. BioMedical Engineering OnLine, 6, 23.

2. **From the relevant literature (with appropriate citations), describe in your language how the features were extracted or generated from the collected human voice.**

- Voice features can be used to detect Parkinson's disease because the disease often leads to vocal impairments that can be quantified acoustically. PD affects the motor control of muscles, including those involved in speech production, resulting in a condition known as dysphonia which manifests as changes in vocal attributes such as pitch, loudness, and quality, and can be measured using various acoustic parameters.

  In the paper by Little et al. (2008)[1], the authors assessed the value of traditional and nonstandard measures for discriminating healthy individuals from those with PD by detecting dysphonia. They introduced a new measure, pitch period entropy (PPE), which is robust to many uncontrollable confounding effects like noisy acoustic environments and normal, healthy variations in voice frequency. The study found that a combination of nonstandard methods and traditional harmonics-to-noise ratios best separated healthy from PD subjects, achieving a correct classification performance of 91.4% using a kernel support vector machine.

  Another study by Little et al. (2007) [2], explored the use of nonlinear recurrence and fractal scaling properties to detect voice disorders, including those associated with PD. The authors developed two new tools for speech analysis—recurrence and fractal scaling—that address the symptoms of disorder and can distinguish normal from disordered voices with a high degree of accuracy.

  These studies shows that voice features can be effective in detecting PD because the disease's impact on the neuromuscular system often leads to measurable changes in speech production that can be captured through acoustic analysis.

References:

[1] Little, M. A., McSharry, P. E., Hunter, E. J., Spielman, J., & Ramig, L. O. (2008). Suitability of Dysphonia Measurements for Telemonitoring of Parkinson's Disease. IEEE Transactions on Biomedical Engineering, 56(4), 1015-1022.

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3.

	Accuracy (%)	Accuracy (%)	Accuracy (%)
Cross-Validation (CV)	**GDA**	**LDA**	**QDA**
CV1	80.00	86.20	86.20
CV2	70.00	78.57	89.28
CV3	80.00	82.14	82.14
CV4	80.00	96.42	82.14
CV5	80.00	85.71	78.57
CV6	94.74	85.71	82.14
CV7	78.95	82.14	92.85
CV8	84.21	85.71	78.57
CV9	63.16	71.42	75.00
CV10	68.42	71.42	82.14
Average —>	77.95	82.54	82.90

4.

	Balanced Accuracy (%)	Balanced Accuracy (%)	Balanced Accuracy (%)
Cross-Validation (CV)	**GDA**	**LDA**	**QDA**
CV1	78.12	85.71	85.71
CV2	67.03	78.57	89.28
CV3	89.47	82.14	82.14
CV4	81.25	96.42	82.14
CV5	81.25	85.71	78.57
CV6	97.22	85.71	82.14
CV7	79.29	82.14	92.85
CV8	90.00	85.12	76.92
CV9	55.95	69.23	73.58
CV10	67.71	70.76	82.82
Average —>	78.73	82.15	82.61