

Supplement

Data Augmentation for Small-Scale Raman Spectroscopy Dataset in Breast Cancer Cell Classification

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Table S1. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when augmented size is 20.

| Augmented_20 | Accuracy | Precision | Recall | F1 score |
|-----------------|--------------|--------------|--------------|--------------|
| Blur | 93.20%±1.27% | 93.67%±1.02% | 93.20%±1.27% | 93.24%±1.26% |
| Gaussian | 93.25%±1.21% | 93.60%±1.09% | 93.25%±1.21% | 93.26%±1.23% |
| Scaling | 91.70%±3.11% | 91.87%±3.05% | 91.70%±3.11% | 91.68%±3.14% |
| GAN | 93.85%±1.93% | 94.27%±1.53% | 93.85%±1.93% | 93.84%±1.92% |

Table S2. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when augmented size is 50.

| Augmented_50 | Accuracy | Precision | Recall | F1 score |
|-----------------|--------------|--------------|--------------|--------------|
| Blur | 94.30%±0.98% | 94.47%±0.95% | 94.30%±0.98% | 94.33%±0.97% |
| Gaussian | 93.65%±2.70% | 93.97%±2.48% | 93.65%±2.70% | 93.73%±2.63% |
| Scaling | 89.90%±2.18% | 90.03%±2.14% | 89.90%±2.18% | 89.90%±2.19% |
| GAN | 94.10%±2.42% | 94.41%±2.26% | 94.10%±2.42% | 94.15%±2.38% |

Table S3. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when augmented size is 200.

| Augmented_200 | Accuracy | Precision | Recall | F1 score |
|-----------------|--------------|--------------|--------------|--------------|
| Blur | 91.85%±1.05% | 92.07%±0.98% | 91.85%±1.05% | 91.87%±1.03% |
| Gaussian | 95.35%±1.83% | 95.62%±1.67% | 95.35%±1.83% | 95.42%±1.76% |
| Scaling | 91.10%±0.91% | 91.27%±0.88% | 91.10%±0.91% | 91.11%±0.90% |
| GAN | 90.35%±2.17% | 90.69%±2.01% | 90.35%±2.17% | 90.41%±2.11% |

Table S4. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when augmented size is 500.

| Augmented_500 | Accuracy | Precision | Recall | F1 score |
|---------------|--------------|--------------|--------------|--------------|
| Blur | 93.55%±0.99% | 93.72%±0.96% | 93.55%±0.99% | 93.58%±0.98% |

| | | | | |
|-----------------|--------------|--------------|--------------|--------------|
| Gaussian | 94.55%±3.06% | 94.87%±2.78% | 94.55%±3.06% | 94.63%±2.94% |
| Scaling | 90.10%±1.33% | 90.25%±1.30% | 90.10%±1.33% | 90.12%±1.32% |
| GAN | 87.95%±3.22% | 88.37%±2.97% | 87.95%±3.22% | 88.04%±3.21% |

Table S5. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when training set size per class is 1.

| 1 | Accuracy | Precision | Recall | F1 score |
|----------------------|-----------------|-----------------|-----------------|-----------------|
| Original data | 20.00% ± 0.00% | 4.00% ± 0.00% | 20.00% ± 0.00% | 6.67% ± 0.00% |
| Blur | 58.00% ± 7.12% | 62.20% ± 6.55% | 58.00% ± 7.12% | 55.61% ± 6.53% |
| Gaussian | 70.90% ± 2.73% | 72.79% ± 3.43% | 70.90% ± 2.73% | 67.89% ± 3.49% |
| Scaling | 44.65% ± 4.75% | 47.85% ± 6.24% | 44.65% ± 4.75% | 40.92% ± 3.93% |
| GAN | 47.95% ± 12.69% | 53.26% ± 13.25% | 47.95% ± 12.69% | 44.33% ± 13.21% |

Table S6. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when training set size per class is 2.

| 2 | Accuracy | Precision | Recall | F1 score |
|----------------------|----------------|-----------------|----------------|-----------------|
| Original data | 20.00% ± 0.00% | 4.00% ± 0.00% | 20.00% ± 0.00% | 6.67% ± 0.00% |
| Blur | 69.45% ± 9.09% | 71.44% ± 9.45% | 69.45% ± 9.09% | 65.85% ± 11.09% |
| Gaussian | 72.70% ± 6.09% | 76.14% ± 4.65% | 72.70% ± 6.09% | 71.33% ± 7.58% |
| Scaling | 56.30% ± 6.51% | 63.92% ± 6.88% | 56.30% ± 6.51% | 53.40% ± 6.72% |
| GAN | 58.25% ± 9.90% | 62.22% ± 16.75% | 58.25% ± 9.90% | 51.68% ± 12.11% |

Table S7. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when training set size per class is 5.

| 5 | Accuracy | Precision | Recall | F1 score |
|----------------------|--------------|--------------|--------------|--------------|
| Original data | 58.90% \pm | 53.01% \pm | 58.90% \pm | 53.66% \pm |
| | 35.69% | 44.85% | 35.69% | 43.04% |
| Blur | 86.20% \pm | 86.82% \pm | 86.20% \pm | 85.99% \pm |
| | 4.78% | 4.67% | 4.78% | 4.99% |
| Gaussian | 87.95% \pm | 88.59% \pm | 87.95% \pm | 87.91% \pm |
| | 2.24% | 2.24% | 2.24% | 2.34% |
| Scaling | 84.60% \pm | 85.09% \pm | 84.60% \pm | 84.16% \pm |
| | 7.37% | 7.32% | 7.37% | 8.36% |
| GAN | 83.90% \pm | 84.17% \pm | 83.90% \pm | 83.71% \pm |
| | 9.58% | 9.42% | 9.58% | 9.79% |

Table S8. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when training set size per class is 20.

| 20 | Accuracy | Precision | Recall | F1 score |
|----------------------|--------------|--------------|--------------|--------------|
| Original data | 94.80% \pm | 94.98% \pm | 94.80% \pm | 94.80% \pm |
| | 1.39% | 1.32% | 1.39% | 1.40% |
| Blur | 95.20% \pm | 95.48% \pm | 95.20% \pm | 95.20% \pm |
| | 1.08% | 1.02% | 1.08% | 1.08% |
| Gaussian | 95.05% \pm | 95.16% \pm | 95.05% \pm | 95.03% \pm |
| | 2.56% | 2.42% | 2.56% | 2.58% |
| Scaling | 93.60% \pm | 93.85% \pm | 93.60% \pm | 93.58% \pm |
| | 1.76% | 1.75% | 1.76% | 1.77% |
| GAN | 95.15% \pm | 95.26% \pm | 95.15% \pm | 95.15% \pm |
| | 0.60% | 0.60% | 0.60% | 0.60% |

Table S9. The classification accuracy, precision, recall and F1 score obtained on the same test set after training with the original dataset and the four augmented datasets when training set size per class is 40.

| 40 | Accuracy | Precision | Recall | F1 score |
|----------------------|--------------|--------------|-----------------------|--------------|
| Original data | 96.80% \pm | 96.88% \pm | 96.80% \pm 0.65% | 96.81% \pm |

| | | | | |
|-----------------|--------------|--------------|--------------|--------------|
| | 0.65% | 0.63% | | 0.64% |
| Blur | 97.55% \pm | 97.59% \pm | 97.55% \pm | 97.55% \pm |
| | 0.65% | 0.60% | 0.65% | 0.64% |
| Gaussian | 97.25% \pm | 97.30% \pm | 97.25% \pm | 97.25% \pm |
| | 0.31% | 0.28% | 0.31% | 0.30% |
| Scaling | 96.20% \pm | 96.30% \pm | 96.20% \pm | 96.21% \pm |
| | 0.93% | 0.84% | 0.93% | 0.92% |
| GAN | 97.35% \pm | 97.42% \pm | 97.35% \pm | 97.36% \pm |
| | 0.55% | 0.55% | 0.55% | 0.54% |