**Research Paper**

**Abstract:**

The abstract is a summary of the main points of the paper. Here are some key takeaways:

* [The paper proposes a deep learning technique for classifying wheat leaf diseases using a modified ResNet50 (CNN with 50 layers) model1](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C0%7Cdac849a2-dabb-49c1-aa8e-f104449a4236%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22The%20object...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A2%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A35%2C%22highlightText%22%3A%22The%20objective%20of%20our%20work%20is%20to%20ofer%20a%20deep-learning%20model%20for%20identifying%20%5Cr%5Cnwheat%20leaf%20disease.%22%2C%22snippets%22%3A%5B%5D%7D%7D).
* The paper uses a collaborative generative adversarial network to improve the quality of the wheat leaf images and fill in the missing data.
* [The paper adds three layers to the ResNet50 model to enhance its feature extraction and discrimination abilities2](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C1%7Cdac849a2-dabb-49c1-aa8e-f104449a4236%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22These%20laye...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A1%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A23%2C%22highlightText%22%3A%22These%20layers%20are%20inserted%20%5Cr%5Cninto%20the%20ResNet50%20architecture%20for%20accurate%20feature%20extraction%20and%20discrimination.%22%2C%22snippets%22%3A%5B%5D%7D%7D).
* [The paper tests the proposed model on a large wheat disease classification dataset and compares it with other models3](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C2%7Cdac849a2-dabb-49c1-aa8e-f104449a4236%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22Exten%5Cu0002sive...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A1%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A24%2C%22highlightText%22%3A%22Exten%5Cu0002sive%20tests%20are%20carried%20out%20to%20evaluate%20the%20proposed%20model%E2%80%99s%20performance%20on%20photos%20from%20a%20%5Cr%5Cnlarge%20wheat%20disease%20classifcation%20dataset.%22%2C%22snippets%22%3A%5B%5D%7D%7D).
* The paper claims that the proposed model achieves the highest accuracy of 98.44% and can help in accurate and timely detection of wheat leaf diseases.

**Introduction:**

* [The motivation and objective of the study, which is to propose a deep learning-based technique for classifying wheat leaf diseases using a modified ResNet50 convolutional neural network model](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C0%7Ce8dcb720-6558-4fc8-be7e-0326eeed54f5%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22In%20this%20st...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A16%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A15%2C%22highlightText%22%3A%22In%20this%20study%2C%20a%20new%20deep%20transfer%20learning%20model%20%5Cr%5Cnbased%20on%20convolutional%20neural%20networks%20and%20the%20pretrained%20ResNet50%20model%20is%20con%5Cu0002structed%20for%20wheat%20leaf%20disease%20classifcation.%22%2C%22snippets%22%3A%5B%5D%7D%7D)[1](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C0%7Ce8dcb720-6558-4fc8-be7e-0326eeed54f5%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22In%20this%20st...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A16%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A15%2C%22highlightText%22%3A%22In%20this%20study%2C%20a%20new%20deep%20transfer%20learning%20model%20%5Cr%5Cnbased%20on%20convolutional%20neural%20networks%20and%20the%20pretrained%20ResNet50%20model%20is%20con%5Cu0002structed%20for%20wheat%20leaf%20disease%20classifcation.%22%2C%22snippets%22%3A%5B%5D%7D%7D).
* The challenges and limitations of conventional methods for wheat leaf disease detection and diagnosis, such as manual observation, spectral analysis, and traditional image feature extraction methods.
* The advantages and benefits of using deep learning models, especially convolutional neural networks, for wheat leaf disease classification, such as improved accuracy, efficiency, and generalization.
* [The main contribution and novelty of the study, which is to use a pre-trained ResNet50 model as a foundation and modify it by adding convolution, batch normalization, and leaky relu activation layers to enhance its feature extraction and discrimination capabilities](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C1%7Ce8dcb720-6558-4fc8-be7e-0326eeed54f5%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22To%20extract...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A11%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A27%2C%22highlightText%22%3A%22To%20extract%20the%20resilient%20features%20from%20the%20dataset%20images%2C%20three%20layers%20namely%20Convo%5Cu0002lution%2C%20Batch%20Normalization%2C%20and%20Leaky%20relu%20activation%20are%20included%20in%20the%20pre-trained%20%5Cr%5CnResNet50%20model%2C%20as%20illustrated%20in%20Fig.%C2%A03b.%22%2C%22snippets%22%3A%5B%5D%7D%7D)[2](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C1%7Ce8dcb720-6558-4fc8-be7e-0326eeed54f5%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22To%20extract...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A11%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A27%2C%22highlightText%22%3A%22To%20extract%20the%20resilient%20features%20from%20the%20dataset%20images%2C%20three%20layers%20namely%20Convo%5Cu0002lution%2C%20Batch%20Normalization%2C%20and%20Leaky%20relu%20activation%20are%20included%20in%20the%20pre-trained%20%5Cr%5CnResNet50%20model%2C%20as%20illustrated%20in%20Fig.%C2%A03b.%22%2C%22snippets%22%3A%5B%5D%7D%7D).

The structure and organization of the paper, which consists of six sections: introduction, literature review, material and methods, proposed system, experimental results, and conclusion.

**Material and Methods:**

* [The authors used a dataset of 4,500 images of wheat leaves, divided into four classes: leaf rust, crown and root rot, healthy wheat, and wheat loose smut](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C0%7Cc8067d98-38f3-42c5-bc20-be3e6bbf6a54%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22There%20are%20...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A7%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A32%2C%22highlightText%22%3A%22There%20are%20around%204%2C500%20images%2C%20divided%20into%20three%20groups%20of%20wheat%20disease%20%5Cr%5Cnand%20one%20normal%20class.%22%2C%22snippets%22%3A%5B%5D%7D%7D).
* [The authors applied a data imputation technique (a method for retaining the majority of the dataset's data and information by substituting missing data with a different value) based on a collaborative generative adversarial network to estimate the missing data in the dataset and improve the image quality](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C1%7Cc8067d98-38f3-42c5-bc20-be3e6bbf6a54%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22A%20collabor...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A1%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A18%2C%22highlightText%22%3A%22A%20collaborative%20generative%20adversarial%20network%20is%20used%20%5Cr%5Cnas%20an%20image%20imputation%20in%20the%20proposed%20methodology%2C%20allowing%20a%20generator%20and%20discrimina%5Cu0002tor%20network%20to%20properly%20estimate%20the%20missing%20data%20in%20the%20dataset%20using%20the%20residual%20method.%22%2C%22snippets%22%3A%5B%5D%7D%7D).

Note: The authors used a method to fill in the gaps in the dataset and make the images clearer. This method involves two parts: a generator and a discriminator. The generator tries to create realistic images that look like the original ones, but with the missing parts filled in. The discriminator tries to tell apart the real images from the fake ones. By competing with each other, they both improve their skills and produce better results.

* [The authors also performed data augmentation using image transformation to reduce feature space sparsity and create more robust data for classification](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C2%7Cc8067d98-38f3-42c5-bc20-be3e6bbf6a54%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22This%20helps...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A10%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A25%2C%22highlightText%22%3A%22This%20helps%20us%20to%20minimize%20feature%20%5Cr%5Cnspace%20sparsity%20and%20construct%20more%20robust%20data%20for%20classifers.%22%2C%22snippets%22%3A%5B%5D%7D%7D).
* The authors proposed a modified ResNet50 convolutional neural network model for wheat leaf disease classification, which added convolution, batch normalization, and activation Leaky Relu layers to the original ResNet50 architecture.
* The authors evaluated the performance of their model on the test dataset and compared it with other models such as InceptionV3 and DenseNet. [They used metrics such as accuracy, precision, recall, and F1-score to measure the classification results](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=a5e1c7da32e93a89d60978f1c0f50b0bc93f1bbe&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C3%7Cc8067d98-38f3-42c5-bc20-be3e6bbf6a54%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22The%20recall...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A13%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A16%2C%22highlightText%22%3A%22The%20recall%2C%20%5Cr%5Cnaccuracy%2C%20precision%2C%20and%20F1-score%20of%20the%20classifcation%20model%20were%20evaluated.%22%2C%22snippets%22%3A%5B%5D%7D%7D).

**Experimental Result:**

The experimental results section of this paper describes how the proposed model for wheat leaf disease classification was implemented and evaluated using various metrics and datasets. The authors used the Keras and TensorFlow libraries to build and test their model, which was based on a modified ResNet50 architecture. They also applied data imputation and augmentation techniques to enhance the quality and diversity of their training data. The authors compared their model’s performance with other models, such as InceptionV3, DenseNet, and ResNet50, using the Large Wheat Disease Classification Dataset (LWDCD2020). [The results showed that the proposed model achieved the highest accuracy, precision, recall, and F1-score among the compared models, demonstrating its robustness and reliability in classifying wheat leaf diseases1](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=86da5d0437ec2ef870655c4332f87931de2bb5ff&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C0%7C4810e360-812c-4464-9eeb-cd62f28a2c1f%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22The%20recall...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A13%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A16%2C%22highlightText%22%3A%22The%20recall%2C%20%5Cr%5Cnaccuracy%2C%20precision%2C%20and%20F1-score%20of%20the%20classifcation%20model%20were%20evaluated.%22%2C%22snippets%22%3A%5B%5D%7D%7D). The authors also performed cross-validation experiments to verify the consistency of their model’s performance. The results indicated that the proposed model outperformed the other models in all folds of cross-validation. [The authors concluded that their model can effectively classify healthy wheat, leaf rust, crown and root rot, and wheat loose smut, and that it can contribute to the improvement of crop health and yield2](https://edgeservices.bing.com/edgesvc/chat?udsframed=1&form=SHORUN&clientscopes=chat,noheader,udsedgeshop,channelstable,ntpquery,devtoolsapi,udsinwin11,udsdlpconsent,udsfrontload,cspgrd,&shellsig=86da5d0437ec2ef870655c4332f87931de2bb5ff&setlang=en-US&darkschemeovr=1#sjevt%7CDiscover.Chat.SydneyClickPageCitation%7Cadpclick%7C1%7C4810e360-812c-4464-9eeb-cd62f28a2c1f%7C%7B%22sourceAttributions%22%3A%7B%22providerDisplayName%22%3A%22Using%20heal...%22%2C%22pageType%22%3A%22pdf%22%2C%22pageIndex%22%3A1%2C%22relatedPageUrl%22%3A%22file%253A%252F%252F%252FC%253A%252FUsers%252FLENOVO%252FDownloads%252Fwheat%252520disease%252520detection.pdf%22%2C%22lineIndex%22%3A16%2C%22highlightText%22%3A%22Using%20healthy%20wheat%2C%20leaf%20rust%2C%20crown%2C%20root%20rot%2C%20and%20%5Cr%5Cnwheat%20loose%20smut%20as%20research%20objects%2C%20this%20study%20proposes%20a%20deep%20learning-based%20technique%20%5Cr%5Cnfor%20classifying%20wheat%20leaf%20diseases.%22%2C%22snippets%22%3A%5B%5D%7D%7D).