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International Workshop on Information Management and Media Science (IWIMMS 2024)

Generative AI for ESG Data Analytics and Sustainability Innovation

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Publications Chair, The IEEE International Conference on Information Reuse and Integration for Data Science (IEEE IRI 2007-)

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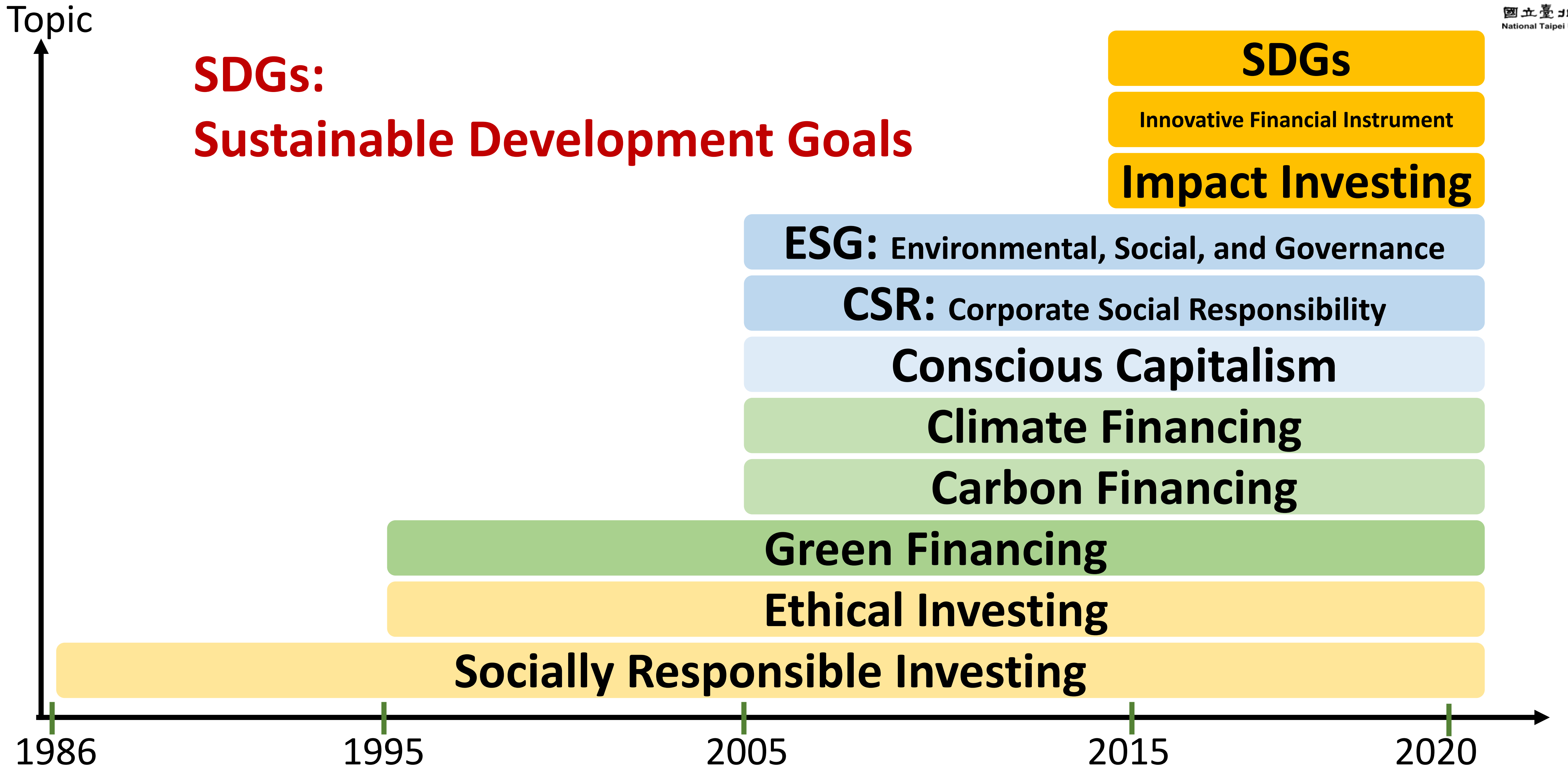
Outline

- Overview of ESG
  - Environmental, Social, Governance
- Challenges in ESG Data Analytics
  - Fragmented, Unstructured, Diverse
- Generative AI as a Solution
  - Synthesis, Reporting, and Prediction
- Sustainability Innovation

Evolution of Sustainable Finance Research



Source: Kumar, S., Sharma, D., Rao, S., Lim, W. M., & Mangla, S. K. (2022). Past, present, and future of sustainable finance: Insights from big data analytics through machine learning of scholarly research. Annals of Operations Research, 1-44.

Sustainable Development Goals (SDGs)

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Source: https://sdgs.un.org/goals

Sustainable Development Goals (SDGs) and 5P

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National Taipei University

Partnership

Peace

Prosperity

People

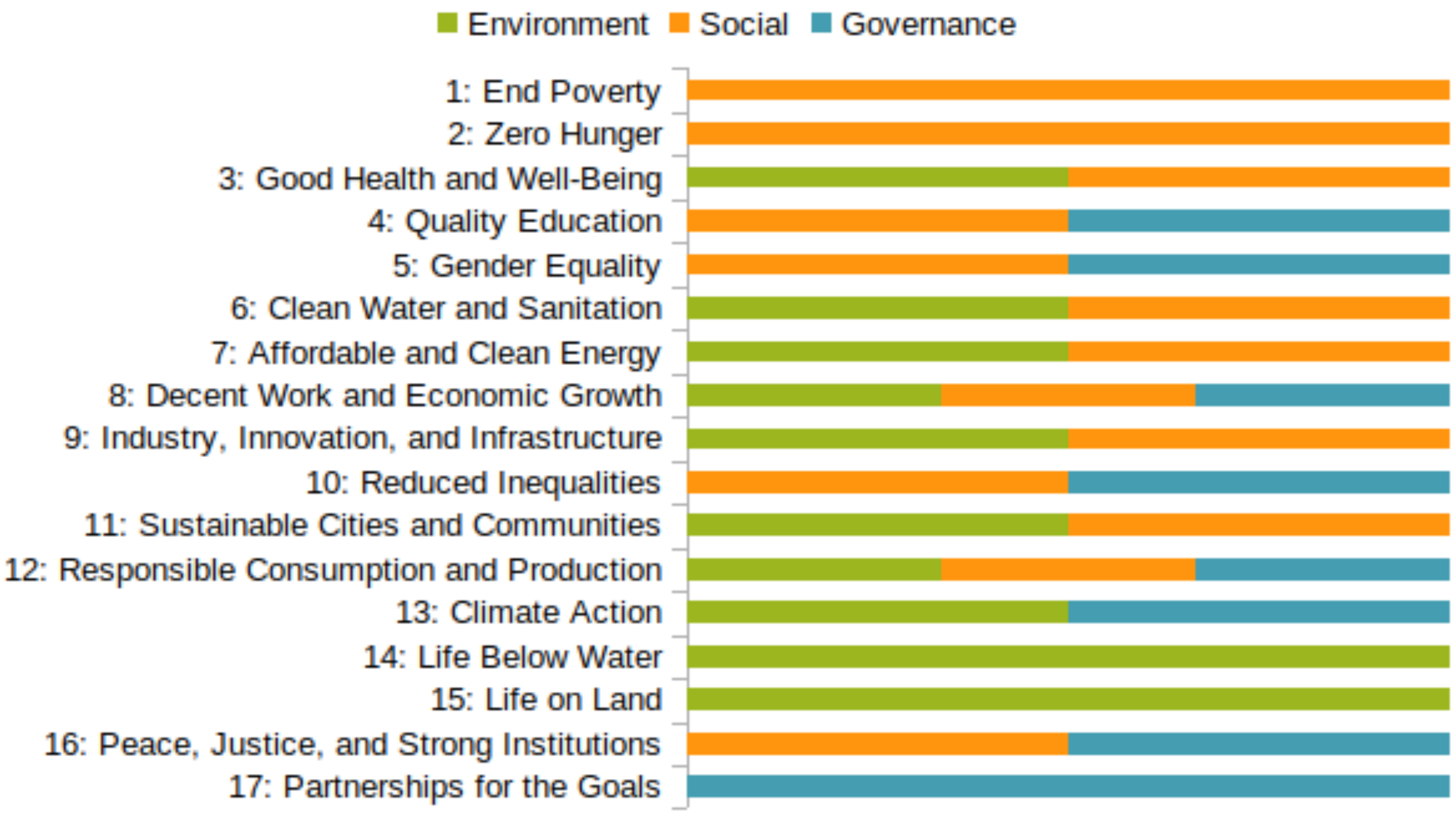
Planet

Source: Folke, Carl, Reinette Biggs, Albert V. Norström, Belinda Reyers, and Johan Rockström. "Social-ecological resilience and biosphere-based sustainability science."Ecology and Society 21, no. 3 (2016).

ESG to 17 SDGs

Source: Henrik Skaug Sætra (2021) "A Framework for Evaluating and Disclosing the ESG Related Impacts of AI with the SDGs." Sustainability 13, no. 15 (2021): 8503.

ESG to 17 SDGs



Source: https://sustainometric.com/esg-to-sdgs-connected-paths-to-a-sustainable-future/

Net-Zero Transformation

- **Ambition**
  - Aligned to achieving global net zero by no later than 2050 & to limit warming to 1.5°C
- **Governance**
  - Accountability driven from the top
- **Strategy**
  - Embedded and aligned net zero into company strategy
- **Enterprise**
  - Key operating model changes in support of transformation
- **Supply chains**
  - Transformed net zero supply chains
- **Innovation**
  - Developed innovation and technologies to deliver net zero
- **Finance**
  - Financing the net zero transformation
- **Transparency**
  - Communicating action
- **Engagement**
  - Enhancing the pace and scale of net zero action

Source: https://www.pwc.com/us/en/services/esg/library/building-blocks-for-net-zero-transformation.html

ESG Challenges and Opportunities

- Challenges
  - Fragmented and unstructured ESG data.
  - Lack of standardization and transparency.
  - Timeliness of data availability.
- Opportunities
  - Rising demand for actionable ESG insights.
  - Innovation in sustainable solutions and policies.
  - Generative AI as a tool for transformation.

Generative AI

Powering
Digital Sustainability
Transformation

Generative AI-Driven ESG Report Generation Technology

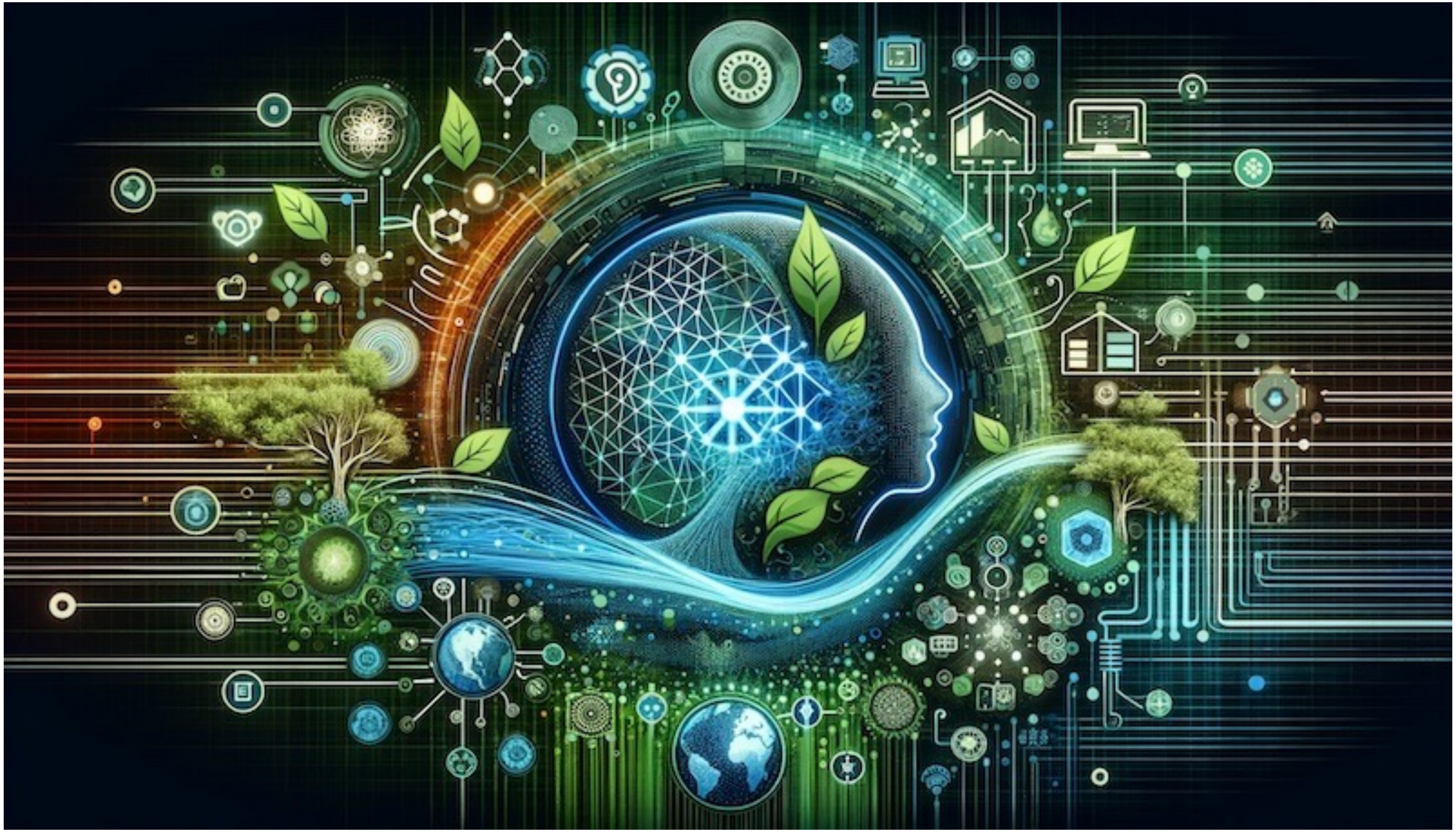
Industrial Technology Research Institute (ITRI),
Fintech and Green Finance Center (FGFC, NTPU),
NTPU-113A513E01, 2024/03/01~2024/12/31

Sustainability and ESG Data Analytics

Generative AI for ESG Data Analytics

- Data Integration and Enrichment:
  - Synthesizing structured and unstructured ESG data.
- Automated Reporting and Insight Generation:
  - Tailored ESG reports and insights for stakeholders.
- Scenario Modeling and Forecasting:
  - Simulating potential risks and opportunities.
- Addressing Bias and Ensuring Accountability:
  - Transparent, fair, and ethical AI deployment.

Generative AI and LLMs for Sustainability and ESG Data Analytics



Sustainability Innovation with Generative AI

- Sustainable Product Design:
  - Eco-friendly designs minimizing waste and energy.
- Policy Formulation and Implementation:
  - AI-driven simulations for effective policies.
- Stakeholder Engagement and Awareness:
  - Communicating ESG strategies with compelling AI-driven visuals.

Generative AI for ESG Rating and Reporting Generation

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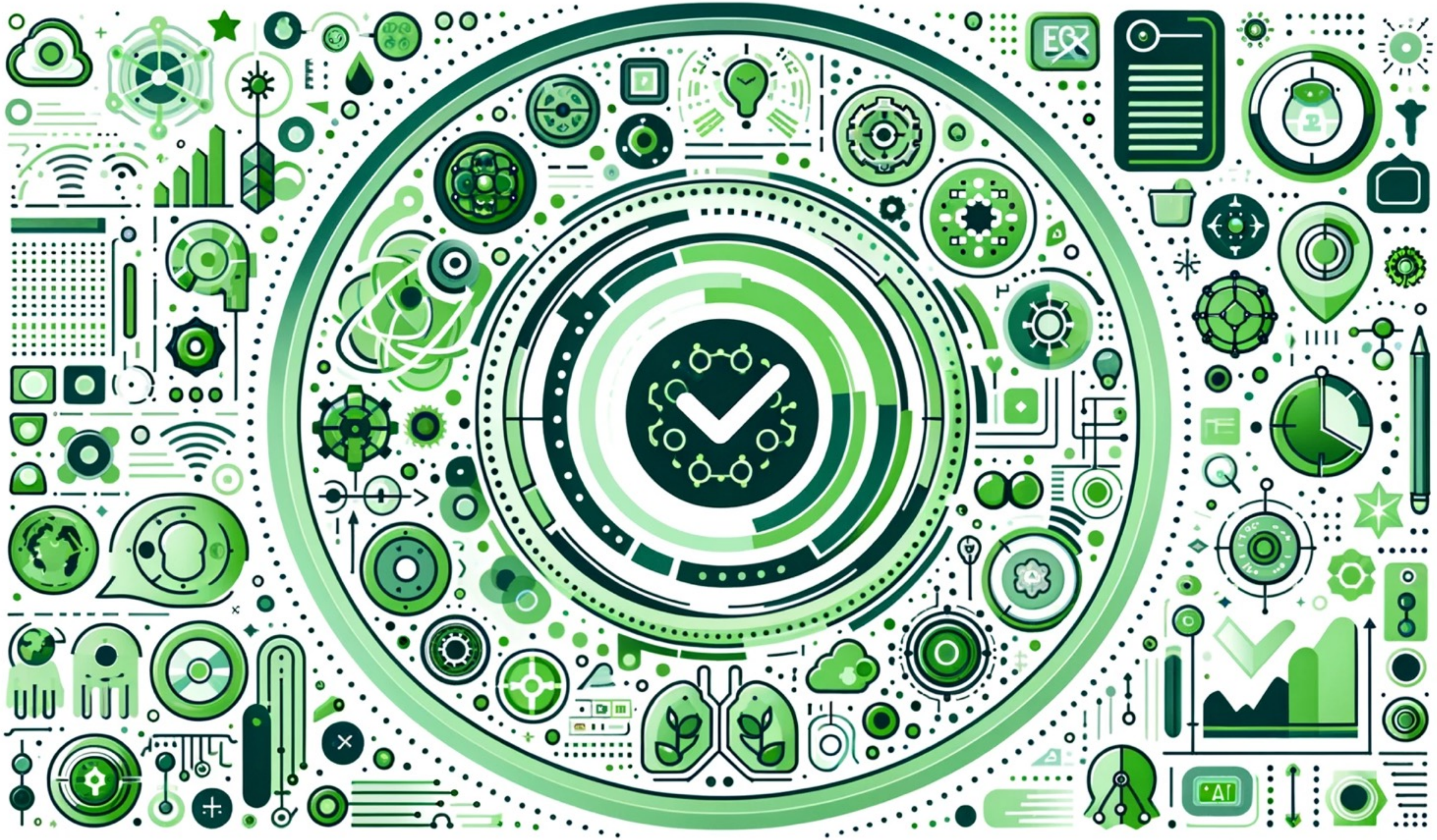

Future Directions

- Integrating blockchain, IoT, and digital twins.
- Democratizing AI tools for all stakeholders.
- Promoting collaboration among experts and communities.

Conclusion

- Generative AI is transforming ESG analytics and sustainability innovation.
- Collaboration among researchers, policymakers, and innovators is key.
- Generative AI to build a sustainable future.

NTCIR

2022

IMNTPU at the NTCIR-16 FinNum-3 Task: Data Augmentation for Financial Numclaim Classification

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2022

IMNTPU Dialogue System Evaluation at the NTCIR-16 DialEval-2 Dialogue Quality and Nugget Detection

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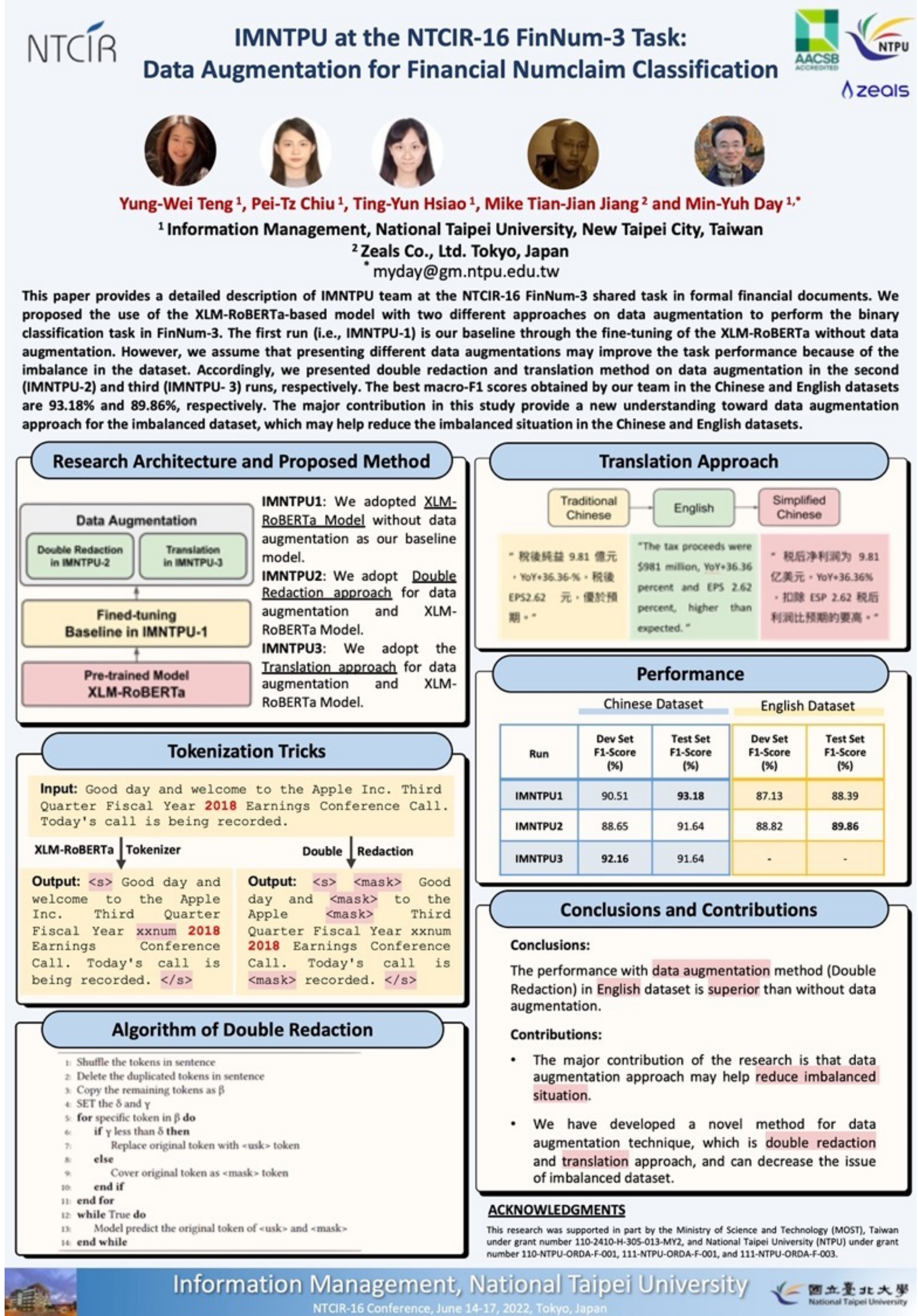
NTCIR

2022

NTCIR-16 Best Poster Presentation Award

NTCIR-16 FinNum-3



NTCIR

IMNTPU at the NTCIR-16 FinNum-3 Task: Data Augmentation for Financial Numclaim Classification

AACSB ACCREDITED NTPU zeals

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This paper provides a detailed description of IMNTPU team at the NTCIR-16 FinNum-3 shared task in formal financial documents. We proposed the use of the XLM-RoBERTa-based model with two different approaches on data augmentation to perform the binary classification task in FinNum-3. The first run (i.e., IMNTPU-1) is our baseline through the fine-tuning of the XLM-RoBERTa without data augmentation. However, we assume that presenting different data augmentations may improve the task performance because of the imbalance in the dataset. Accordingly, we presented double redaction and translation method on data augmentation in the second (IMNTPU-2) and third (IMNTPU- 3) runs, respectively. The best macro-F1 scores obtained by our team in the Chinese and English datasets are 93.18% and 89.86%, respectively. The major contribution in this study provide a new understanding toward data augmentation approach for the imbalanced dataset, which may help reduce the imbalanced situation in the Chinese and English datasets.

Research Architecture and Proposed Method

Data Augmentation

Double Redaction in IMNTPU-2

Translation in IMNTPU-3

Fined-tuning Baseline in IMNTPU-1

Pre-trained Model XLM-RoBERTa

IMNTPU1: We adopted XLM-RoBERTa Model without data augmentation as our baseline model.

IMNTPU2: We adopt Double Redaction approach for data augmentation and XLM-RoBERTa Model.

IMNTPU3: We adopt the Translation approach for data augmentation and XLM-RoBERTa Model.

Tokenization Tricks

Input: Good day and welcome to the Apple Inc. Third Quarter Fiscal Year 2018 Earnings Conference Call. Today's call is being recorded.

XLM-RoBERTa | Tokenizer

Output: <s> Good day and welcome to the Apple Inc. Third Quarter Fiscal Year xxnum 2018 Earnings Conference Call. Today's call is being recorded. </s>

Double | Redaction

Output: <s> <mask> Good day and <mask> to the Apple <mask> Third Quarter Fiscal Year xxnum 2018 Earnings Conference Call. Today's call is <mask> recorded. </s>

Algorithm of Double Redaction

1: Shuffle the tokens in sentence
2: Delete the duplicated tokens in sentence
3: Copy the remaining tokens as β
4: SET the δ and γ
5: **for** specific token in β **do**
6: **if** γ less than δ **then**
7: Replace original token with <usk> token
8: **else**
9: Cover original token as <mask> token
10: **end if**
11: **end for**
12: **while** True **do**
13: Model predict the original token of <usk> and <mask>
14: **end while**

Translation Approach

Traditional Chinese → English → Simplified Chinese

" 稅後純益 9.81 億元，YoY+36.36-%，稅後 EPS2.62 元，優於預期。"

"The tax proceeds were $981 million, YoY+36.36 percent and EPS 2.62 percent, higher than expected."

" 税后净利润为 9.81 亿美元，YoY+36.36%，扣除 ESP 2.62 税后利润比预期的要高。"

Performance

	Chinese Dataset		English Dataset	
Run	Dev Set F1-Score (%)	Test Set F1-Score (%)	Dev Set F1-Score (%)	Test Set F1-Score (%)
IMNTPU1	90.51	**93.18**	87.13	88.39
IMNTPU2	88.65	91.64	88.82	**89.86**
IMNTPU3	**92.16**	91.64	-	-

Conclusions and Contributions

Conclusions:

The performance with data augmentation method (Double Redaction) in English dataset is superior than without data augmentation.

Contributions:

- The major contribution of the research is that data augmentation approach may help reduce imbalanced situation.
- We have developed a novel method for data augmentation technique, which is double redaction and translation approach, and can decrease the issue of imbalanced dataset.

ACKNOWLEDGMENTS

This research was supported in part by the Ministry of Science and Technology (MOST), Taiwan under grant number 110-2410-H-305-013-MY2, and National Taipei University (NTPU) under grant number 110-NTPU-ORDA-F-001, 111-NTPU-ORDA-F-001, and 111-NTPU-ORDA-F-003.

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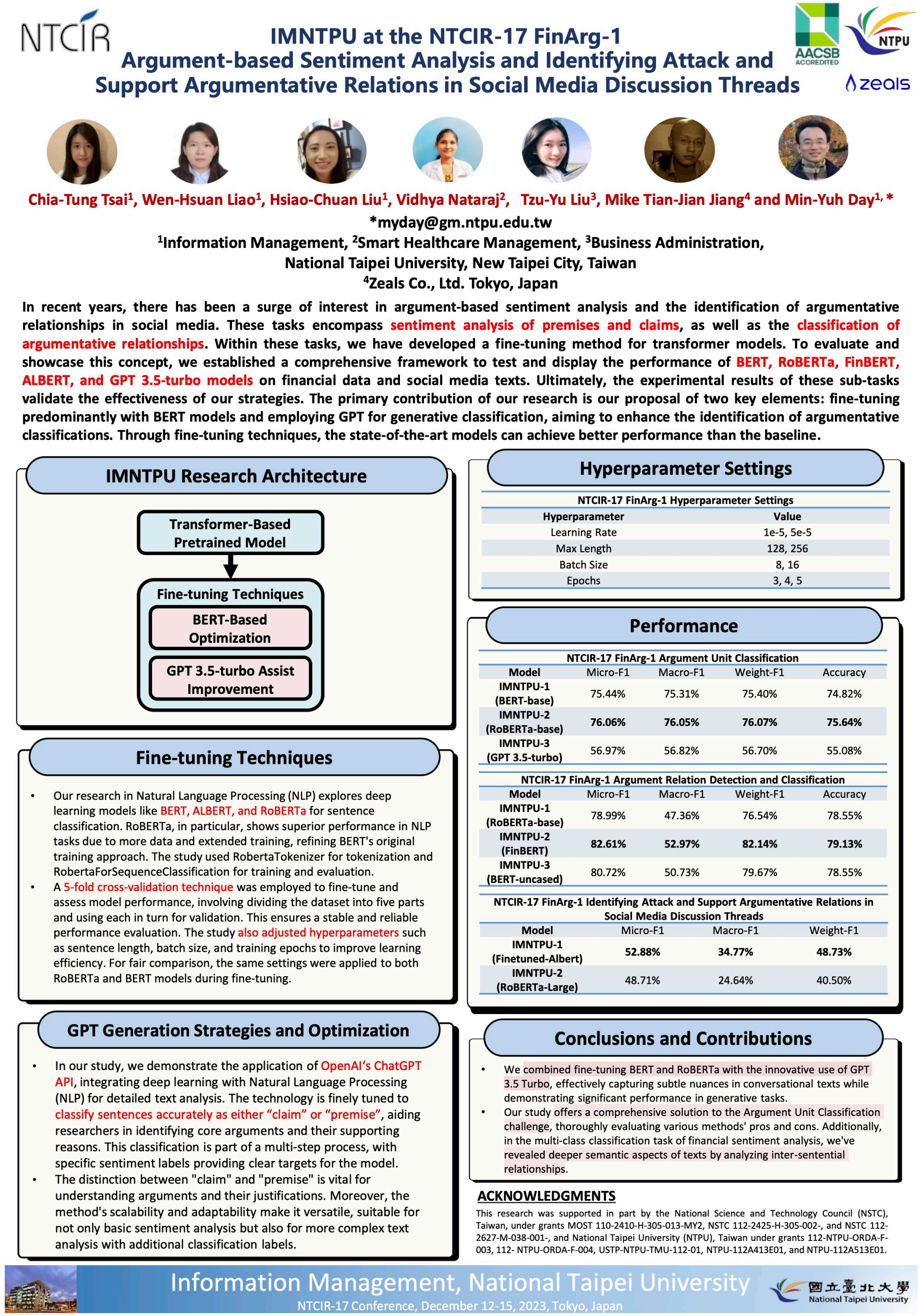
NTCIR-17 Best Poster Presentation Award

NTCIR-17 FinArg-1



IMNTPU at the NTCIR-17 FinArg-1 Argument-based Sentiment Analysis and Identifying Attack and Support Argumentative Relations in Social Media Discussion Threads

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In recent years, there has been a surge of interest in argument-based sentiment analysis and the identification of argumentative relationships in social media. These tasks encompass sentiment analysis of premises and claims, as well as the classification of argumentative relationships. Within these tasks, we have developed a fine-tuning method for transformer models. To evaluate and showcase this concept, we established a comprehensive framework to test and display the performance of BERT, RoBERTa, FinBERT, ALBERT, and GPT 3.5-turbo models on financial data and social media texts. Ultimately, the experimental results of these sub-tasks validate the effectiveness of our strategies. The primary contribution of our research is our proposal of two key elements: fine-tuning predominantly with BERT models and employing GPT for generative classification, aiming to enhance the identification of argumentative classifications. Through fine-tuning techniques, the state-of-the-art models can achieve better performance than the baseline.

IMNTPU Research Architecture

Transformer-Based Pretrained Model

Fine-tuning Techniques

BERT-Based Optimization

GPT 3.5-turbo Assist Improvement

Fine-tuning Techniques

- Our research in Natural Language Processing (NLP) explores deep learning models like BERT, ALBERT, and RoBERTa for sentence classification. RoBERTa, in particular, shows superior performance in NLP tasks due to more data and extended training, refining BERT's original training approach. The study used RobertaTokenizer for tokenization and RobertaForSequenceClassification for training and evaluation.
- A 5-fold cross-validation technique was employed to fine-tune and assess model performance, involving dividing the dataset into five parts and using each in turn for validation. This ensures a stable and reliable performance evaluation. The study also adjusted hyperparameters such as sentence length, batch size, and training epochs to improve learning efficiency. For fair comparison, the same settings were applied to both RoBERTa and BERT models during fine-tuning.

GPT Generation Strategies and Optimization

- In our study, we demonstrate the application of OpenAI's ChatGPT API, integrating deep learning with Natural Language Processing (NLP) for detailed text analysis. The technology is finely tuned to classify sentences accurately as either "claim" or "premise", aiding researchers in identifying core arguments and their supporting reasons. This classification is part of a multi-step process, with specific sentiment labels providing clear targets for the model.
- The distinction between "claim" and "premise" is vital for understanding arguments and their justifications. Moreover, the method's scalability and adaptability make it versatile, suitable for not only basic sentiment analysis but also for more complex text analysis with additional classification labels.

Hyperparameter Settings

NTCIR-17 FinArg-1 Hyperparameter Settings

Hyperparameter	Value
Learning Rate	1e-5, 5e-5
Max Length	128, 256
Batch Size	8, 16
Epochs	3, 4, 5

Performance

NTCIR-17 FinArg-1 Argument Unit Classification

Model	Micro-F1	Macro-F1	Weight-F1	Accuracy
IMNTPU-1 (BERT-base)	75.44%	75.31%	75.40%	74.82%
IMNTPU-2 (RoBERTa-base)	**76.06%**	**76.05%**	**76.07%**	**75.64%**
IMNTPU-3 (GPT 3.5-turbo)	56.97%	56.82%	56.70%	55.08%

NTCIR-17 FinArg-1 Argument Relation Detection and Classification

Model	Micro-F1	Macro-F1	Weight-F1	Accuracy
IMNTPU-1 (RoBERTa-base)	78.99%	47.36%	76.54%	78.55%
IMNTPU-2 (FinBERT)	**82.61%**	**52.97%**	**82.14%**	**79.13%**
IMNTPU-3 (BERT-uncased)	80.72%	50.73%	79.67%	78.55%

NTCIR-17 FinArg-1 Identifying Attack and Support Argumentative Relations in Social Media Discussion Threads

Model	Micro-F1	Macro-F1	Weight-F1
IMNTPU-1 (Finetuned-Albert)	**52.88%**	**34.77%**	**48.73%**
IMNTPU-2 (RoBERTa-Large)	48.71%	24.64%	40.50%

Conclusions and Contributions

- We combined fine-tuning BERT and RoBERTa with the innovative use of GPT 3.5 Turbo, effectively capturing subtle nuances in conversational texts while demonstrating significant performance in generative tasks.
- Our study offers a comprehensive solution to the Argument Unit Classification challenge, thoroughly evaluating various methods' pros and cons. Additionally, in the multi-class classification task of financial sentiment analysis, we've revealed deeper semantic aspects of texts by analyzing inter-sentential relationships.

ACKNOWLEDGMENTS

This research was supported in part by the National Science and Technology Council (NSTC), Taiwan, under grants MOST 110-2410-H-305-013-MY2, NSTC 112-2425-H-305-002-, and NSTC 112-2627-M-038-001-, and National Taipei University (NTPU), Taiwan under grants 112-NTPU-ORDA-F-003, 112- NTPU-ORDA-F-004, USTP-NTPU-TMU-112-01, NTPU-112A413E01, and NTPU-112A513E01.

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2023

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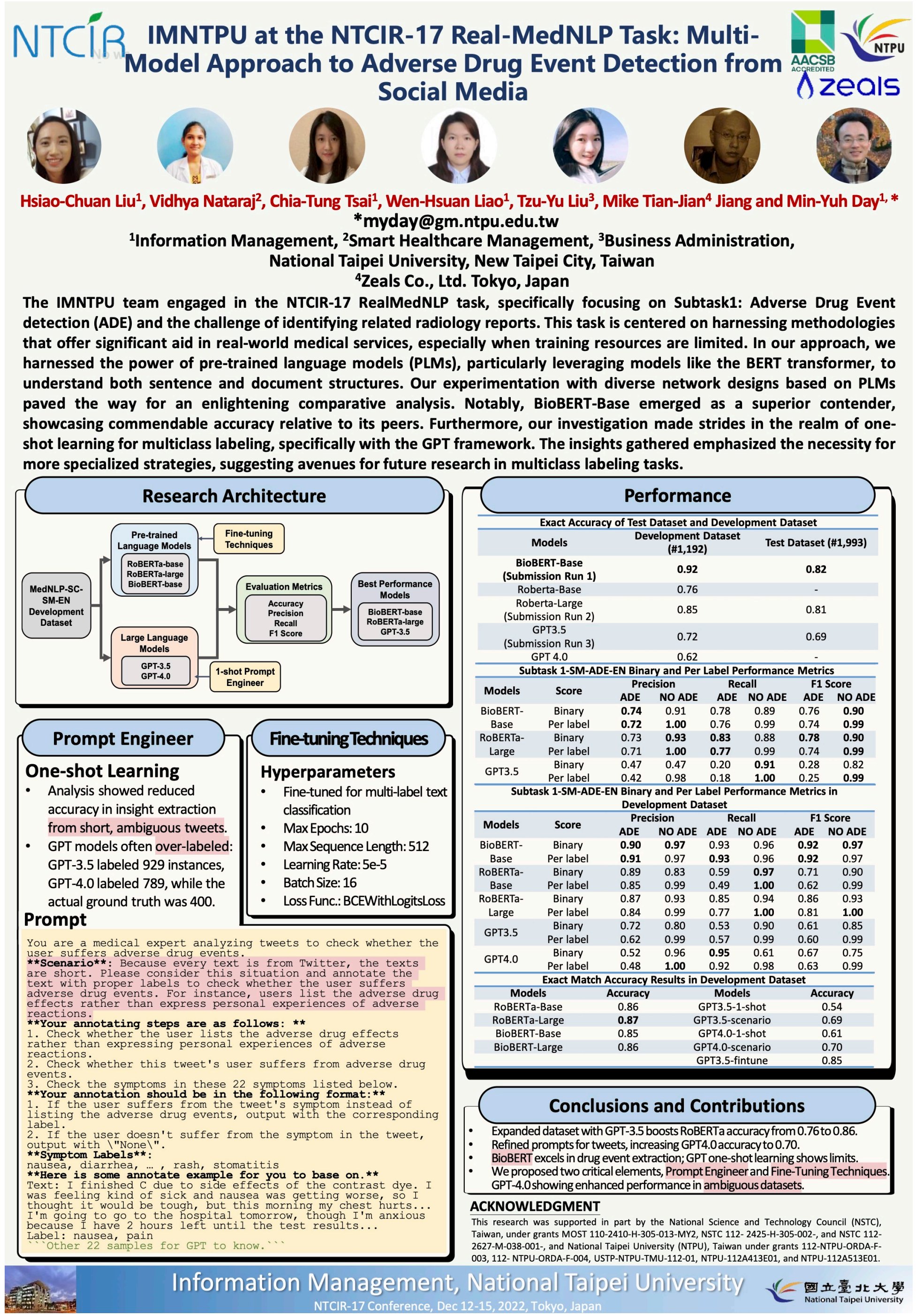
NTCIR-17 Real MedNLP



Generative AI in Multimodal Cross-Lingual Dialogue System for Inclusive Communication Support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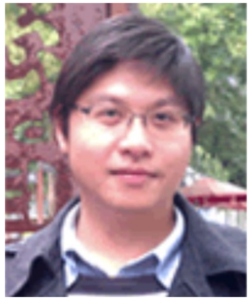
Yue-Shan Chang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2024
Smart City Large Language Model Agent System


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Fintech Green Finance for Carbon Market Index, Corporate Finance, and Environmental Policies (金融科技綠色金融於碳市場指標與公司環境策略)

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Summary

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- Challenges in ESG Data Analytics
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- Generative AI as a Solution
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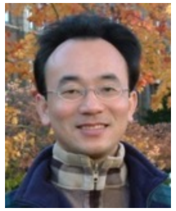
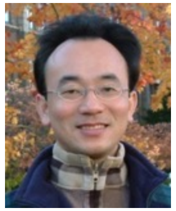


Acknowledgments: Research Projects

1. **Fintech Green Finance for Carbon Market Index, Corporate Finance, and Environmental Policies.**
   Carbon Emission Sentiment Index with AI Text Analytics
   - NTPU, 113-NTPU_ORDA-F-003, 2023/01/01~2024/12/31
2. **Digital Support, Unimpeded Communication: The Development, Support and Promotion of AI-assisted Communication Assistive Devices for Speech Impairment (2/3).**
   Multimodal Cross-lingual Task-Oriented Dialogue System for Inclusive Communication Support
   - NSTC 113-2425-H-305-002-, 3 Years (2023/05/01-2026/04/30) Year 1: 2024/05/01~2025/04/30
3. **Research on speech processing, synthesis, recognition, and sentence construction of people with language disabilities. Multimodal Cross-lingual Task-Oriented Dialogue System**
   - NTPU, 113-NTPU_ORDA-F-004, 2023/01/01~2025/12/31
4. **Metaverse AI Multimodal Cross-Language Task-Oriented Dialogue System**
   - ATEC Group, Fintech and Green Finance Center (FGFC, NTPU), NTPU-112A413E01, 3 Years (2023/05/01~2026/04/30)
5. **Generative AI-Driven ESG Report Generation Technology**
   - Industrial Technology Research Institute (ITRI), Fintech and Green Finance Center (FGFC, NTPU), NTPU-113A513E01, 2024/03/01~2024/12/31
6. **Establishment and Implement of Smart Assistive Technology for Dementia Care and Its Socio-Economic Impacts (3/3). Intelligent, individualized and precise care with smart AT and system integration**
   - NSTC, 113-2627-M-038-001-, 2024/08/01~2025/07/31
7. **Prospective longitudinal study on peri-implant bone loss associated with peri-implantitis**
   - USTP (NTPU, TMU), USTP-NTPU-TMU-113-03, 2024/01/01~2024/12/31

https://web.ntpu.edu.tw/~myday/cindex.htm#projects



Acknowledgments: IFIT Lab Members

Intelligent Financial Innovation Technology, IFIT Lab, IM, NTPU

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Q & A

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