PORTFOLIO

Lei Ying

01
Affective Computing

02
Human AI Interaction
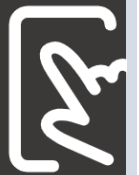
03
Social Computing

04
Interaction Design

- **Emotion Recognition: LDM-EEG (EEG)**

- **Emotion and Personality Recognition: OPO-FCM & EFCM (facial)**

- **Negative Emotion Regulation: Mind Catcher**

EMOTION RECOGNITION

LDM-EEG (EEG)

LDM-EEG: A Lightweight EEG Emotion Recognition Method Based on Dual-stream Structural Scaling and Multiple Attention Mechanisms.

Computer Science. 2023. (Chinese Core Journey)

<u>Ying Lei</u>, Feng Liu

Background: EEG emotion recognition is a multi-channel time-series signal classification problem with high complexity, high information density, and massive data.

Motivation: In order to achieve optimal accuracy and performance of EEG emotion recognition with fewer computational parameters while maintaining the existing classification accuracy, we propose a lightweight network (LDM-EEG) based on dual-stream structural scaling and multiple attention mechanisms.

Algorithm Design: The network takes the time-space and frequency-space maps constructed based on the differential entropy features of EEG signals as the input, processes the two features separately using a symmetric dual-stream structure, achieves lightweighting through a novel parameter-saving residual module and a network scaling mechanism, and enhances the model feature aggregation capability using a novel channel-time/frequency-space multiple attention mechanism and a post-attention mechanism.

Results: The experimental results show that the accuracy of the model is 95.18% with significantly reduced number of parameters, which achieves the optimal result in the domain. Further, about 50 times reduction in the number of parameters is achieved with slightly lower accuracy than the existing models.

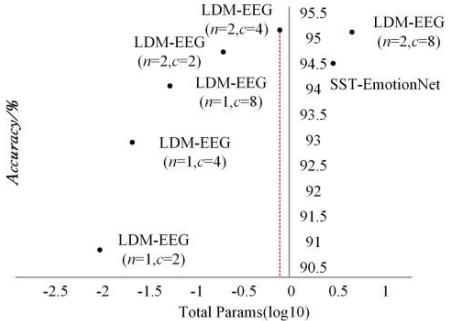**My Contribution:** conceptualization, algorithm, writing.

Framework of Algorithm Design
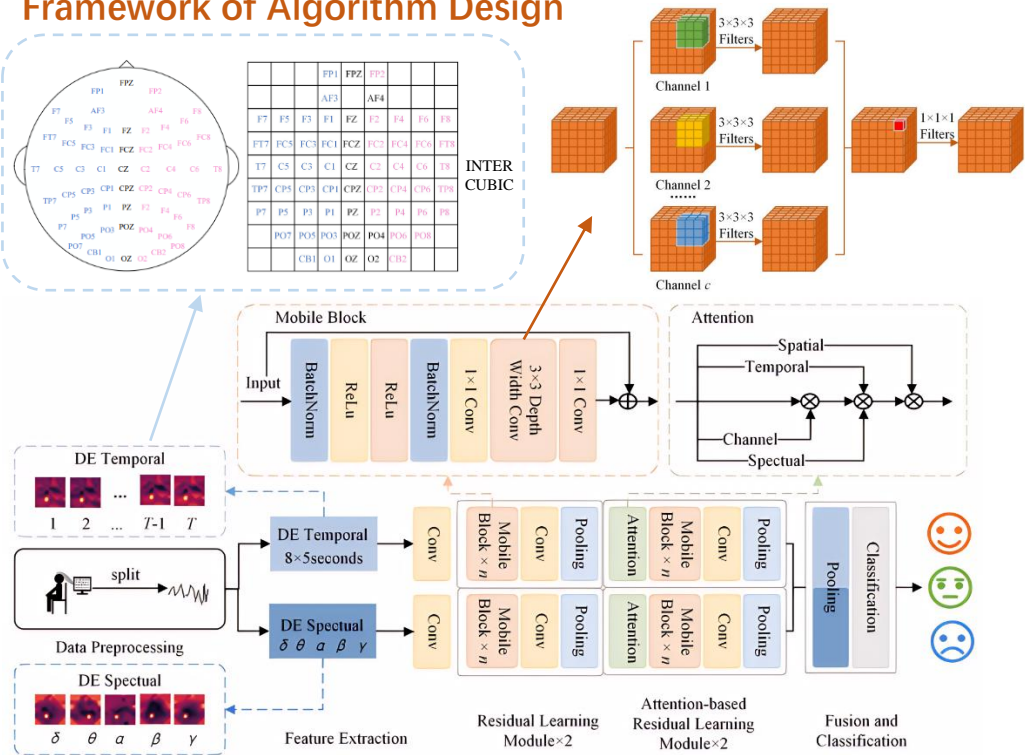
Main Results of Experiments

Model	ACC	STD
SVM[53]	83.99	9.72
GSCCA[54]	82.96	9.95
DBN[4]	86.08	8.34
DGCNN[6]	90.40	8.49
BiDANN[55]	92.38	7.04
BiHDM[56]	93.12	6.06
R2G-STNN[22]	93.38	5.96
RGNN[7]	94.24	5.95
SST-EmotionNet*[8]	94.52	2.21
LDM-EEG(Ours)	**95.18**	**2.13**

EMO & PERSONALITY RECOGNITION

OPO-FCM & EFCM (facial)

OPO-FCM: A Computational Affection Based OCC-PAD-OCEAN Federation Cognitive Modeling Approach

IEEE Transactions on Computational Social Systems. 2022. (JCR Q1)

Feng Liu, Han-Yang Wang, Si-Yuan Shen, Xun Jia, Jing-Yi Hu, Jia-Hao Zhang, Xi-Yi Wang, Ying Lei, et al.

Background: Recently, it is difficult to integrate the deep cross-fertilization and interpretable cognitive modeling methods from the basic theory of emotional psychology with deep learning and other algorithms.

Motivation and Algorithm Design: To address this problem, a cognitive model, namely, a computational affection-based OCC-PAD-OCEAN federation cognitive modeling (OPO-FCM), is constructed. It integrates the VGG-facial action coding system (FACS)-OCC model based on fer2013 expression features and the OCC-pleasure-arousal-dominance (PAD)-openness, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN) fusion of the basic theory of emotional psychology.

Results: By constructing this model and performing formal proof algorithms, it is shown that the OPO-FCM can acquire expression features in video streams, complete the acquisition of expression features in videos by training a deep neural network, map expressions to the PAD emotion space through the established expression–basic emotions–emotion space mapping relationship, and finally complete the mapping of the average emotion over a period time. The information of personality space is obtained through it. Finally, the experimental simulation of the model is conducted, and the results show that the average accuracy of the valid tested personalities is 79.56%.
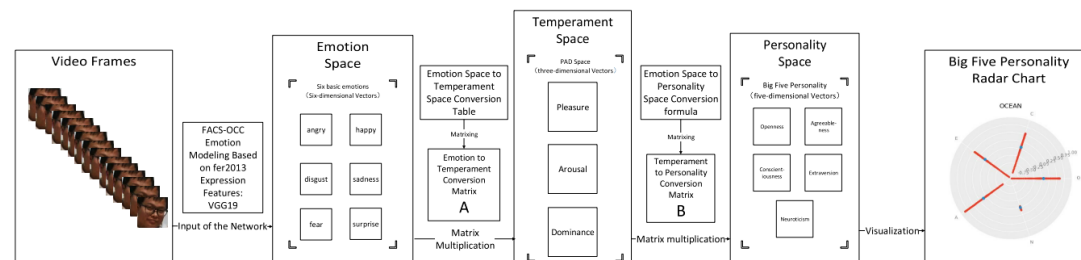
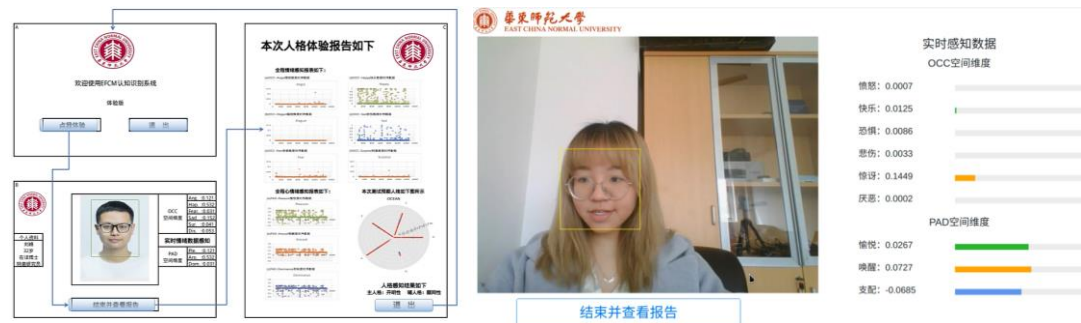**My Contribution:** Software Develop – EFCM website, displayed in WAIC 2021.

Algorithm: OPO-FCM Cognitive Model Processing
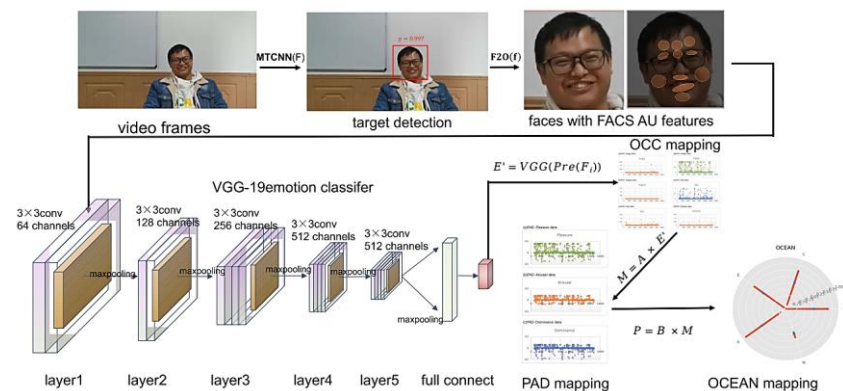
Data Processing: Raw-Emotion-Temperament-Personality

EFCM: Real-time Emotion and Personality Recognition System

NEGATIVE EMOTION REGULATION

Mind Catcher

Mind Catcher - Affective Computing based Edge-side Music Therapy System

China National-level Undergraduate Innovation Project & National Key Field Funding. 2021-2022.

Ying Lei (leader), Jiaqi Ruan, Shuaya Xu, Yihao Zhou, Fangrui Cui.

Background: Surveys have shown that drivers driving with negative emotions account for up to 70% of the total number of crashes. Negative emotions like anger can lead to aggressive driving behaviour, and frustration / sadness can reduce attention levels and thus increase the rate of error in locating road elements.

Motivation – Music Therapy: Aiming to regulate drivers' negative emotion, we explored the potential of 'AI+Music Therapy' to achieve real-time intervention, in face with the lack of traditional professional services. e.g., research suggests that calming music can relax and relieve drivers of stress during demanding driving; - **Advancements in Technology:** facial expression recognition and intelligent cockpit development both provide opportunities for music-driver interaction. **Our goal** is to enhance safe driving by utilizing an in-vehicle music adjustment system based on affective computing to alleviate negative emotions.

System: an AI driven interaction system (sensor, server, application) using music therapy and affective computing to regulate negative emotion in driving. Main research includes: music theory research & music library construction; face detection & emotion recognition algorithm; IoT; UI design & software development.

Function: The system can analyze and display the driver's emotions in real time and play specially chosen healing music to regulate negative emotion, thus improving safety while driving.
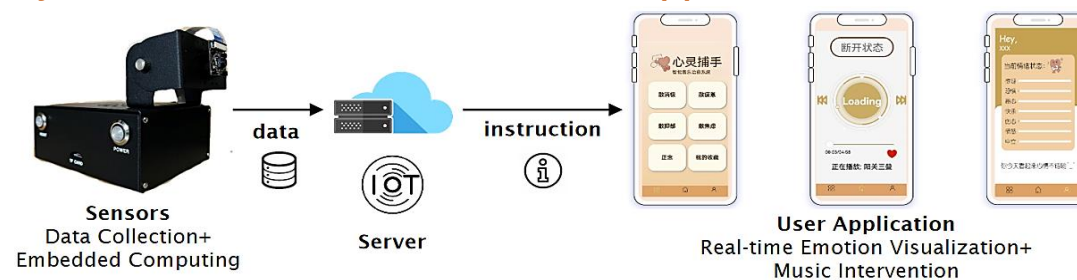
My Contribution: conceptualization, algorithm, UI design and software development.

Algorithm: Face Detection and Emotion Recognition
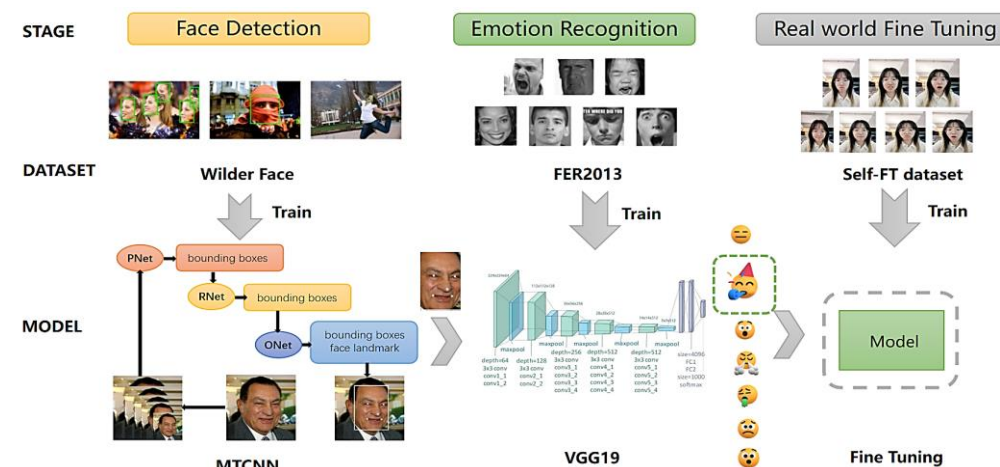
System Architecture: Sensor, Server, Application

Demo: Setup-Negative Emotion Detection-Music Regulation

- **AI-Assisted Decision-Making**

  - Promote Appropriate Trust

  - Calibrate Self-Confidence

- **Human Centered AI for Child Safety Education**

AI-ASSISTED DECISION MAKING

Promote Appropriate Trust

Who Should I Trust: AI or Myself? Leveraging Human and AI Correctness Likelihood to Promote Appropriate Trust in AI-Assisted Decision-Making

Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI 2023)

Shuai Ma, Ying Lei, Xinru Wang, Chengbo Zheng, Chuhan Shi, Ming Yin, and Xiaojuan Ma.

Research Gap: In AI-assisted decision-making, it is critical for human decision-makers to know when to trust AI and when to trust themselves. However, prior studies calibrated human trust only use AI confidence indicating AI's correctness likelihood (CL) but ignored humans' CL, hindering optimal team decision-making.
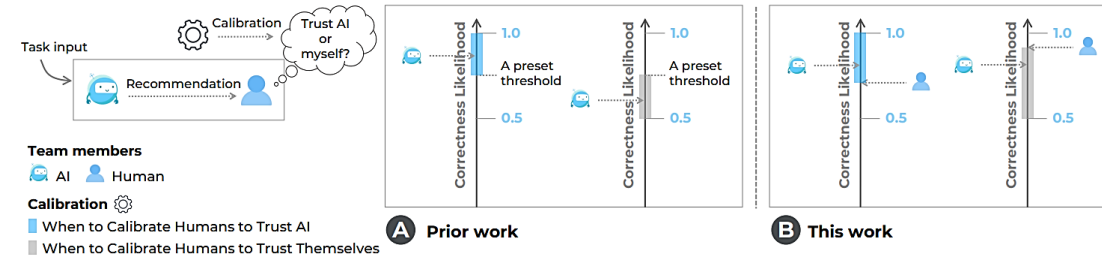
Our Work: To mitigate this gap, we proposed to promote humans' appropriate trust based on the CL of both sides at a task-instance level. We first modeled humans' CL by approximating their decision-making models and computing their potential performance in similar instances.

User Study: We demonstrated the feasibility and effectiveness of our model via two preliminary studies. Then, we proposed three CL exploitation strategies to calibrate users' trust explicitly/implicitly in AI-assisted decision-making process. Results from a between-subjects experiment (N=293) showed that CL exploitation strategies promoted more appropriate human trust in AI, compared with only using AI confidence. We further provided practical implications for more human-compatible AI-assisted decision-making.
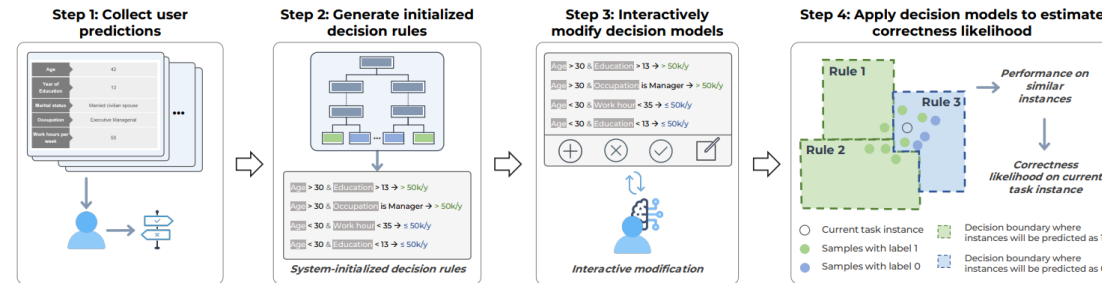
My Contribution: conceptualization, methodology-design & develop & validation (user study), UI-design & software develop.
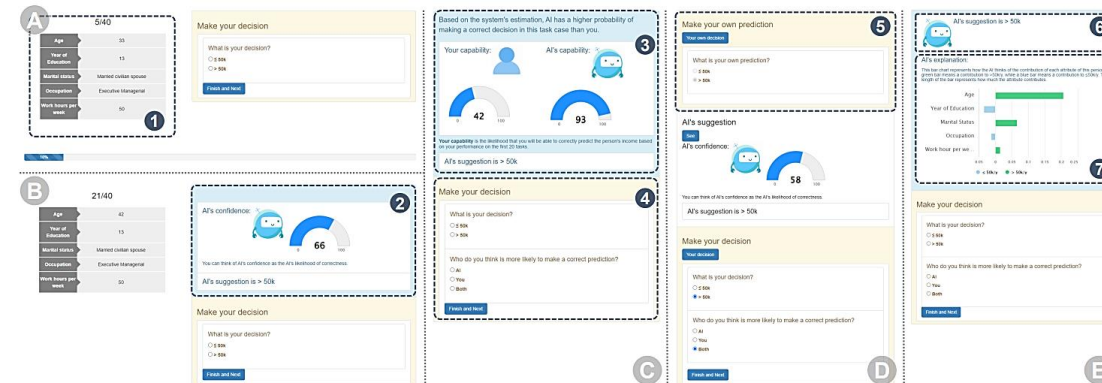
Difference between Prior Work and Ours

Team members
🚗 AI   👤 Human

Calibration ⚙
▮ When to Calibrate Humans to Trust AI
▮ When to Calibrate Humans to Trust Themselves

Ⓐ **Prior work**   Ⓑ **This work**

The Human Capability Modeling Process (four steps)

Step 1: Collect user predictions

Step 2: Generate initialized decision rules

Step 3: Interactively modify decision models

Step 4: Apply decision models to estimate correctness likelihood

Explainable and Adaptive Interfaces to Promote Trust in AI

AI-ASSISTED DECISION MAKING

Are You Really Sure? Understanding the Effects of Human Self-Confidence Calibration in AI-Assisted Decision Making

(To Appear) Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems (CHI 2024)

Shuai Ma, Xinru Wang, Ying Lei, Chuhan Shi, Ming Yin, and Xiaojuan Ma.

Motivation & Main Work: In AI-assisted decision-making, achieving appropriate human reliance on AI is crucial but often challenging. This paper investigates this problem from a human perspective by introducing a novel concept, "human self-confidence calibration". We begin by proposing an analytical framework to highlight the importance of calibrated human self-confidence.

User Study: In our first user study (N=94), we explore the intricate link between human self-confidence and their reliance on AI suggestions. We then introduce three calibration mechanisms, rooted in decision-making and cognitive science theories. In our second study (N=232), we compare these mechanisms' impacts on human self-confidence and task experience. Subsequently, we investigate its effects on AI-assisted decision-making in our third study (N=125).

Findings: self-confidence calibration promotes humans' more rational behaviors and more appropriate reliance, resulting in improved human-AI team performance compared to a baseline without calibration. This research offers a human-centric perspective on the issue of appropriate reliance in human-AI collaboration.

My Contribution: conceptualization, UI-design & software develop.

Calibrate Self-Confidence

A Space of Defining Incorrect AI/Self-reliance
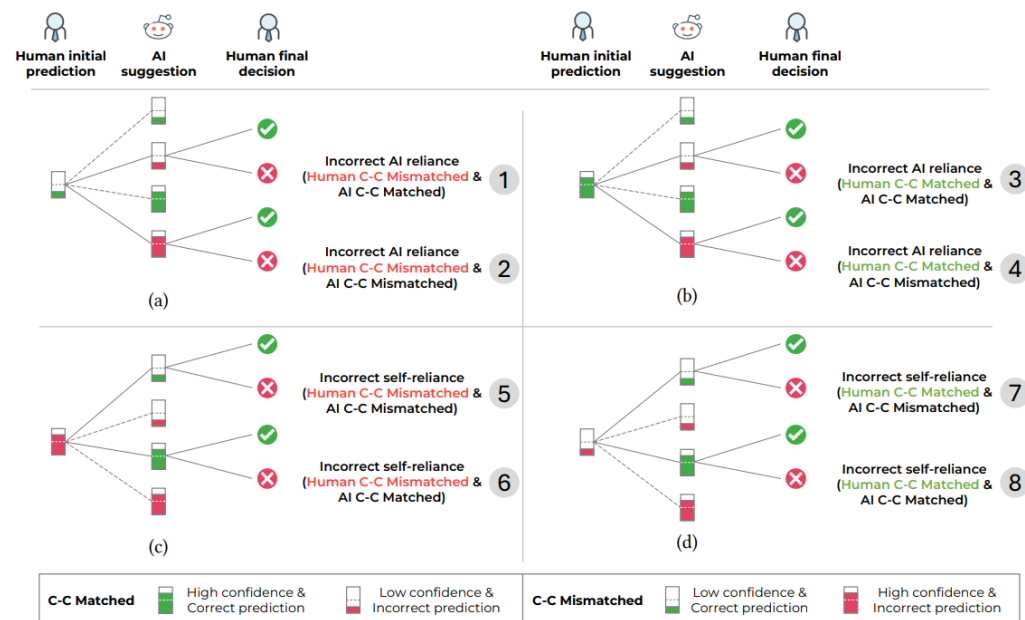
Four Calibration Strategies & Adaptive Interfaces
(think the opposite, think in bets, feedback-real time /-post hoc)

HCAI FOR CHILD SAFETY EDUCATION

Interactive Storytelling Agents

Interactive Storytelling Agents for Child Safety Education: Design, Implementation and Evaluation

Bachelor Thesis (B.Eng. in Computer Science and Technology at ECNU) 2023

Ying Lei.

Motivation: Based on the importance of child safety education and the current challenges, we aims to use Human Centered AI to build an interactive storytelling agent for child safety education as a means to overcome the challenges in child safety education, improving the quality of child safety education and guarding the healthy growth of children.

Main Work: Firstly, we analyze the current situation of child safety education and user needs through a formative study, and proposed a solution of integrating child safety education into an interactive storytelling agent. Secondly, we constructed a corpus of children's safety knowledge through a semi-automated approach, and built a safety knowledge matching and safety question and answer (QA) dataset based on FairytaleQA. Thirdly, we designed a GPT-3 based external safety knowledge augmented fairytale safety question and answer generation (QAG) method and verified the effectiveness of the model through experiments. Finally, we evaluate the overall effectiveness of the method through a user study, using both interviews and questionnaires to collect users' evaluations and feedback. The results show that users gave positive evaluations of the method, showing its strengths and potential in all dimensions. At the same time, users also offered some suggestions for improvement, which provide directions for future research.

My Contribution: conceptualization, formative study, corpus/dataset construction, algorithm-design & develop & validation, user study.

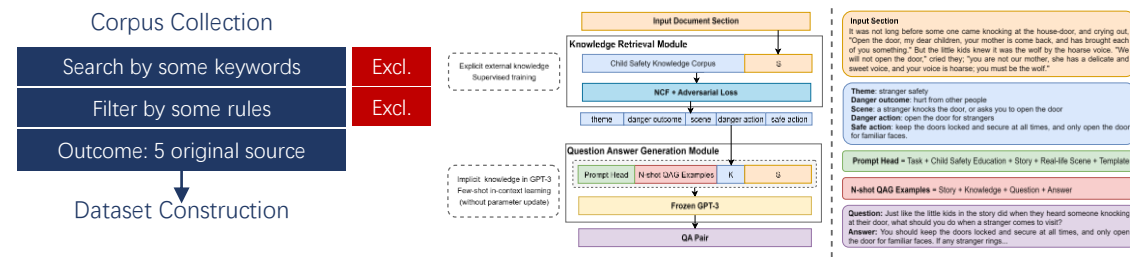## From Fairytales to Real life Safety Education in Storytelling

Step1: Formative Study - Design Principles

- Integrate safety education into real-life situations for children.
- Provide children with simple and tangible scenarios or imaginative spaces for easy understanding.
- Develop agents for child safety education to support parents' limited awareness, knowledge, and time.

Solution: Bring Safety Education to Storytelling

Step2: Dataset Construction

Corpus Collection

Search by some keywords	Excl.
Filter by some rules	Excl.
Outcome: 5 original source	

Dataset Construction

Step3: Knowledge Retrieval & QAG Algorithms

Step4: User Evaluation

User Preference of Baseline and Ours
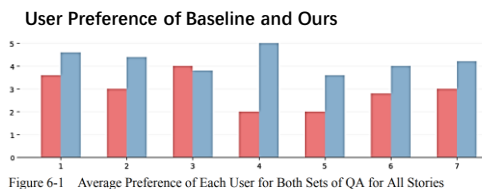
Figure 6-1   Average Preference of Each User for Both Sets of QA for All Stories

Educational Dimension
- Knowledge Expertise
- Reality Relevance
- Reality Universality
- Knowledge Comprehensiveness

Figure 6-3   Average Scores of All Users for Both Sets of QA of All Stories on the Technical Dimension

Users' Scores on Our Design Usefulness, Future Use, ect.

Technical Dimension
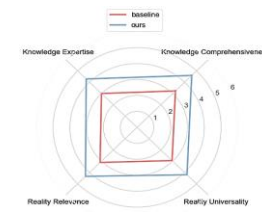- QA Readability
- Knowledge Relevance
- Question Relevance
- Answer Relevance

Figure 6-5   Average Scores of all users on Each dimension of the Fairy Tale based Child Safety Education   Figure 6-4   Average Scores of All Users for Both Sets of QA of All Stories on the Child Safety Education Dimension

- **Computer Supported Cooperative Work (CSCW), ICT**

  - Social Connection and Support for Late-life Migrants

  - Solidarity Movement in Communities

CSCW, ICT

Late-life Migration

Unpacking ICT-supported Social Connections and Support of Late-life Migration:
From the Lens of Social Convoys

(To Appear) Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems (CHI 2024)

Ying Lei, Shuai Ma, Yuling Sun.

Research Gap & Main Work: Migration and aging-related dilemmas have limited opportunities for late-life migrants to rebuild social connections and access support. While ICT has provided a new paradigm of social connection for migrants and older adults, little is known about the experiences of late-life migrants suffering from both Migration and aging-related dilemmas. This paper reports a qualitative study of ICT-mediated social connections and support of late-life migrants.

Findings & Discussion: Drawing on social convoy model, we pay specific attention to the dynamic changes of late-life migrants' social convoy, support roles each convoy plays, functions ICT plays in this evolution, as well as the encountered challenges and expectations of our participants regarding ICT-supported social convoys. Based on these findings, we deeply unpack the social connections and support of late-life migrants through the lens of social convoys and ICT's involvement. We end by providing design implications for future ICT-based social supporting systems for late-life migrants.

My Contribution: conceptualization, data collection & analysis, writing-draft & review.

Ecology of Social Convoys in Late-life Migration
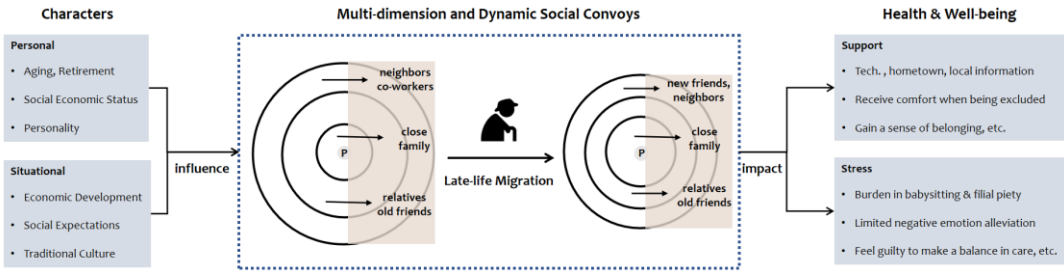
Finding 1: Structure and Transitions of Older Drifters' Convoys
Finding 2: Support Roles of Different Convoy Members
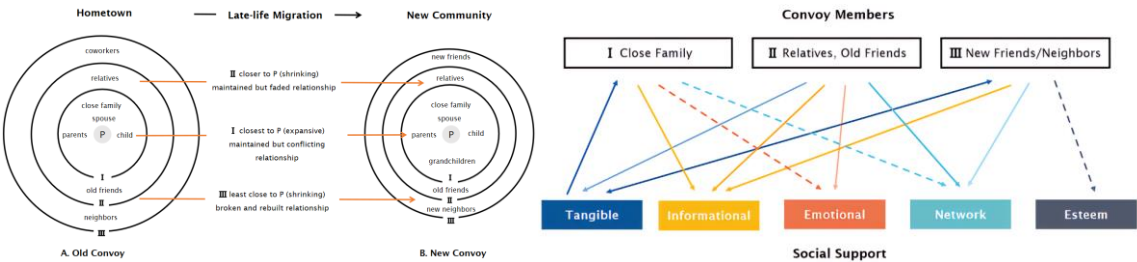
Finding 3: Roles of ICT in Older Drifters' Convoy

Finding 4: Perceived Challenges and Expectations of ICT

CSCW, ICT

Solidarity Movement

Community Group Buying as a Form of Solidarity Movement: Collaborations, Governance, and Sustainability

(Under Review) Proceedings of the Computer Supported Cooperative Work & Social Computing (CSCW 2024)

Yuling Sun, Ray LC, Ying Lei, Jiali Liu, Xiaojuan Ma, Liang He.

Background: People in communities can take active, cooperative actions to achieve common goals as a response to crises. These pervasive solidarity movements have drawn increased attention in HCI and CSCW, contributing to studies of ICT-mediated crisis response.

Method & Findings: Our study focuses on Community Group Buying (CGB), a specific case of city-wide solidarity movement. Drawing from a qualitative research in Shanghai during the pandemic response, including on-site fieldwork and semi-structured interviews with 17 participants, we provide a systematic examination of CGB in Shanghai, reporting its infrastructuring process and infrastructure.

Discussion: We conclude by proposing a set of design recommendations for supporting more effective, extensible, and sustainable collective behaviors in the form of neighbourhood-based solidarity movement.
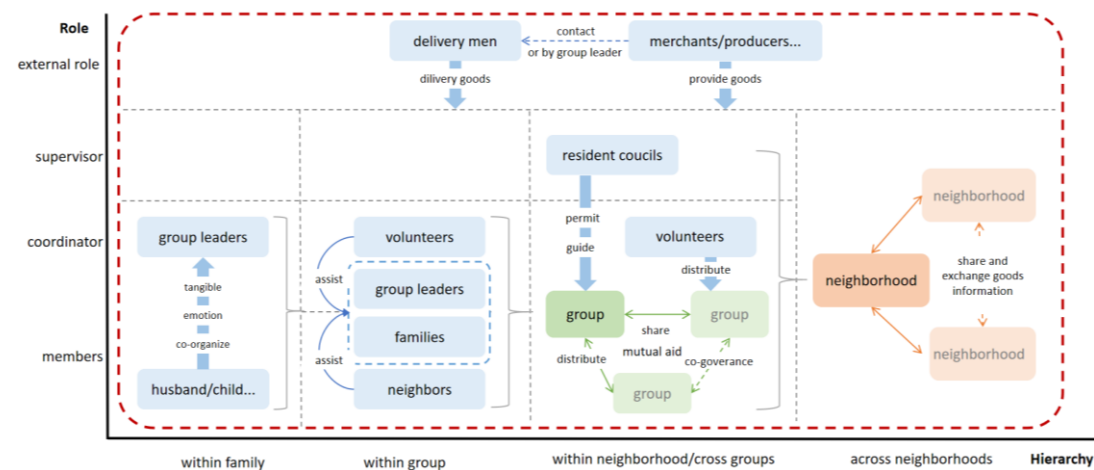
My Contribution: conceptualization, data collection & analysis, writing-draft & draw.

The Overview of Neighborhood-based CGB Process
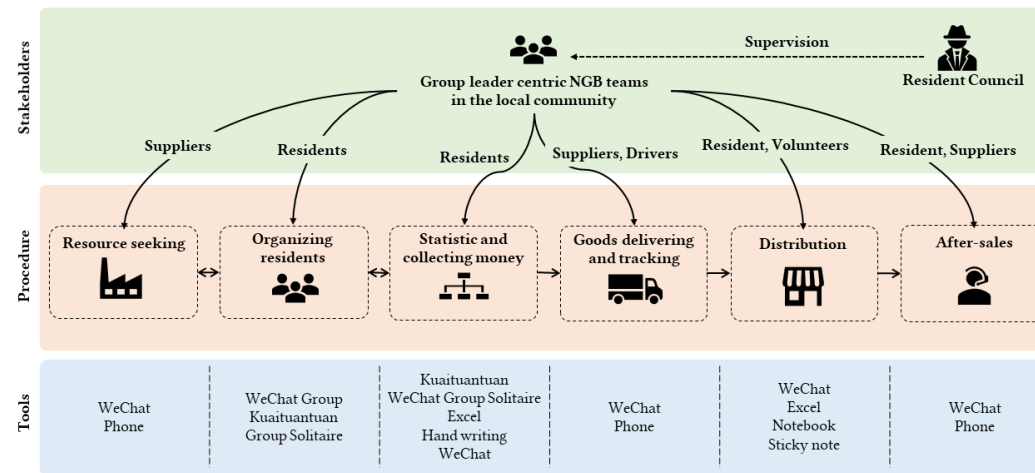
Group Leader Centric Multi-Hierarchical Collaborative Networks

- **Interaction Design in Virtual Reality (VR)**

  - Restraining Finger Enslaving to Improve Mid-air Typing

INTERACTION DESIGN IN VR

Design for Mid-air Typing

Restraining Finger Enslaving to Improve Mid-air Typing: from a Neuro-mechanical Perspective

(Manuscript) Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems (CHI 2024)

Hechuan Zhang, Xuewei Liang, Ying Lei, Yanjun Chen, Zhenxuan He, Yu Zhang, Lihan Chen, et al.

Background: Typing in mid-air is considered intuitive but problematic due to finger enslaving caused by biomechanical constraints in the periphery, resulting in involuntary coactivation among adjacent fingers when one finger movement in the air.

Main Work: To address this issue, we propose restricting finger enslaving and evaluate the accuracy of motor sequence generation to reveal the potential of dexterous fingers for mid-air input.

User Study: In a sequential finger tapping task, there was a significant decrease error in motor sequence with finger enslaving restrained, indicating that finger enslaving affects users' sequence generation ability in typing tasks. To further understand the impact on user experiences due to finger enslaving, functional Near Infrared Spectroscopy (fNIRS) was utilized to observe cortical changes in mid-air typing with and without finger enslaving restrained. The results revealed depressed excitability in both the primary motor cortex and supramarginal gyrus within Wernicke's area when restraining finger enslaving, resulting in reduced motor control consumption.

My Contribution: user study-design & conduct, data analysis, writing-draft & draw.

Design of wearable device and Principle of braking structure
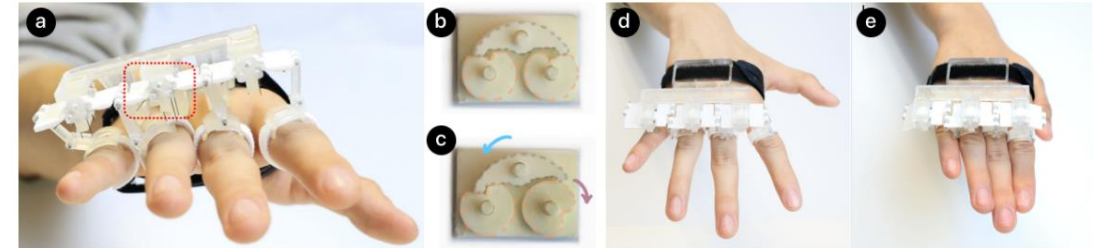
Restraining finger coactivation improve the finger sequence generation and reduce the motor control load (Exp 1&2)

- C1: Left Hand Without Wearing indeFinger
- C2: Left Hand with Wearing indeFinger
- C3: Right Hand Without Wearing indeFinger
- C4: Right Hand with Wearing indeFinger