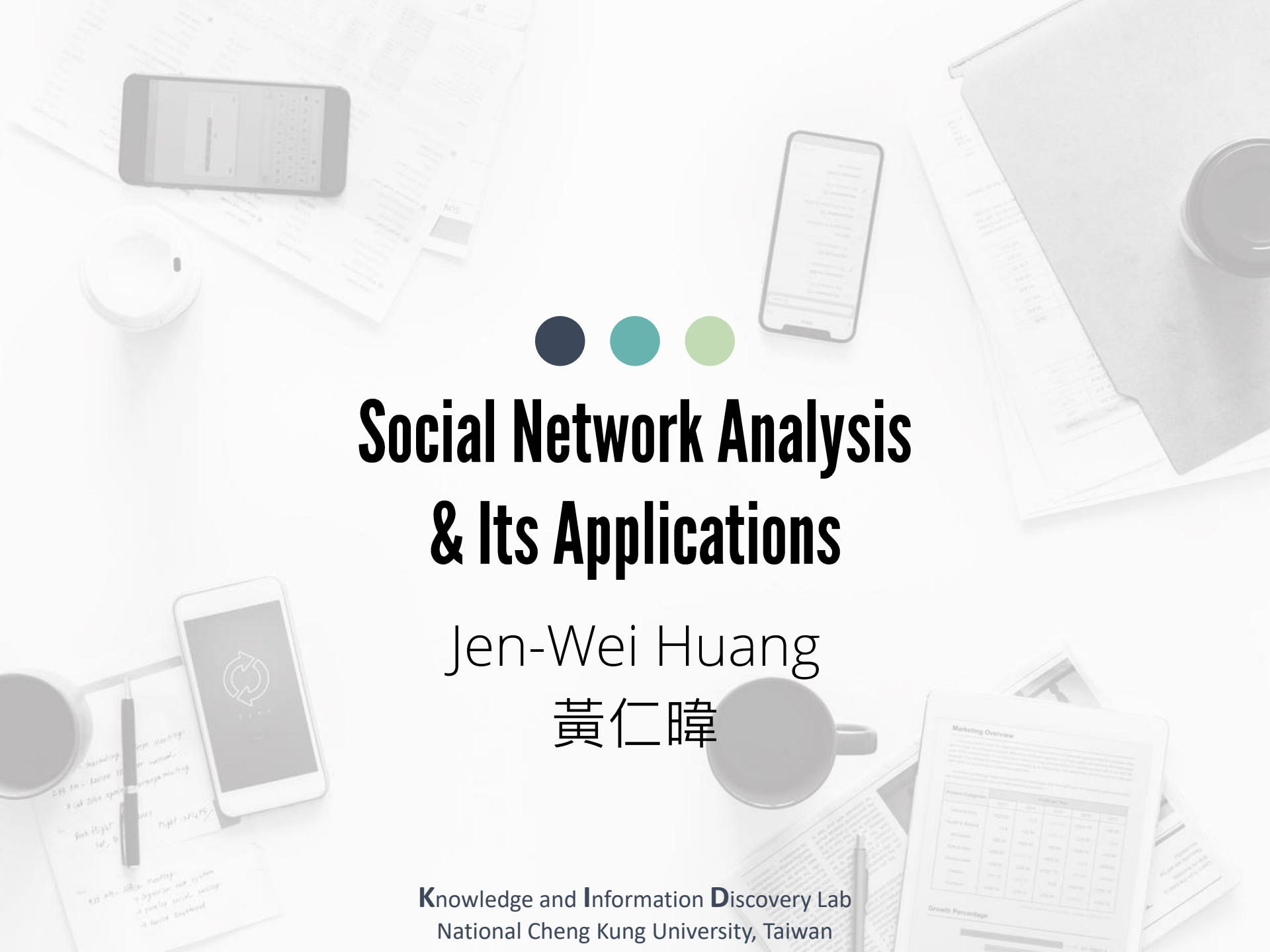




Social Network Analysis & Its Applications

Jen-Wei Huang
黃仁暉

Knowledge and Information Discovery Lab
National Cheng Kung University, Taiwan



ABOUT ME



- Jen-Wei Huang (黃仁暉)
- Dept. of Electrical Engineering,
National Cheng Kung University
- Email: jwhuang (AT) mail.ncku.edu.tw
- **KID Lab**
<https://kid.ee.ncku.edu.tw/>



About Me

- IEEE CIS Website committee member
- Director of Taiwan Association of Artificial Intelligence
- Was:
 - IEEE CIS Member Activities committee member
 - IEEE CIS Website Administrator
 - IEEE Tainan Section CIS Chapter Secretary
 - Lecturer of IEEE CIS Summer School
 - Visiting Scholar @ University of Illinois at Chicago
 - Visiting Scholar @ IBM Almaden Research Center



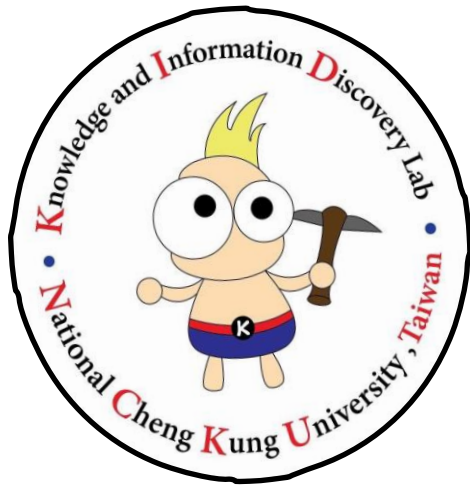
About Me

- **TAAI 中華民國人工智慧學會理事**
- NCKU 多媒體生醫資訊及電子研究中心
Consulting Expert
- 財團法人商業發展研究院 雲嘉南區域智庫中心
Consulting Expert
- 經濟部工業局 AI與數據創新專家顧問團
Consulting Expert



Knowledge and Information Discovery Lab

DATA MINING / MACHINE LEARNING / AI



- Data Mining & Database System
 - Social network analysis
 - Spatial temporal data mining
 - Big data analysis
- Multimedia Information Retrieval
 - Image search and recommendation
 - Voice classification (incl. signal processing)
 - Text mining
- Fintech & Bio-medical Data Analysis



Ongoing Projects

- QQAQ: Air quality index prediction and analysis
- Infant crying analysis
- SinaPac: Personalized banking
- BreezeCenter: Intelligent shopping
- Oath(Yahoo): Recommendation via item and network embedding
- LARC@SMU, Singapore: Next trip prediction / Job transfer pattern using SNA
- Telexpress: AI-enhanced Customer Service Chatbot
- Digital Economy: Human-machine co-learning



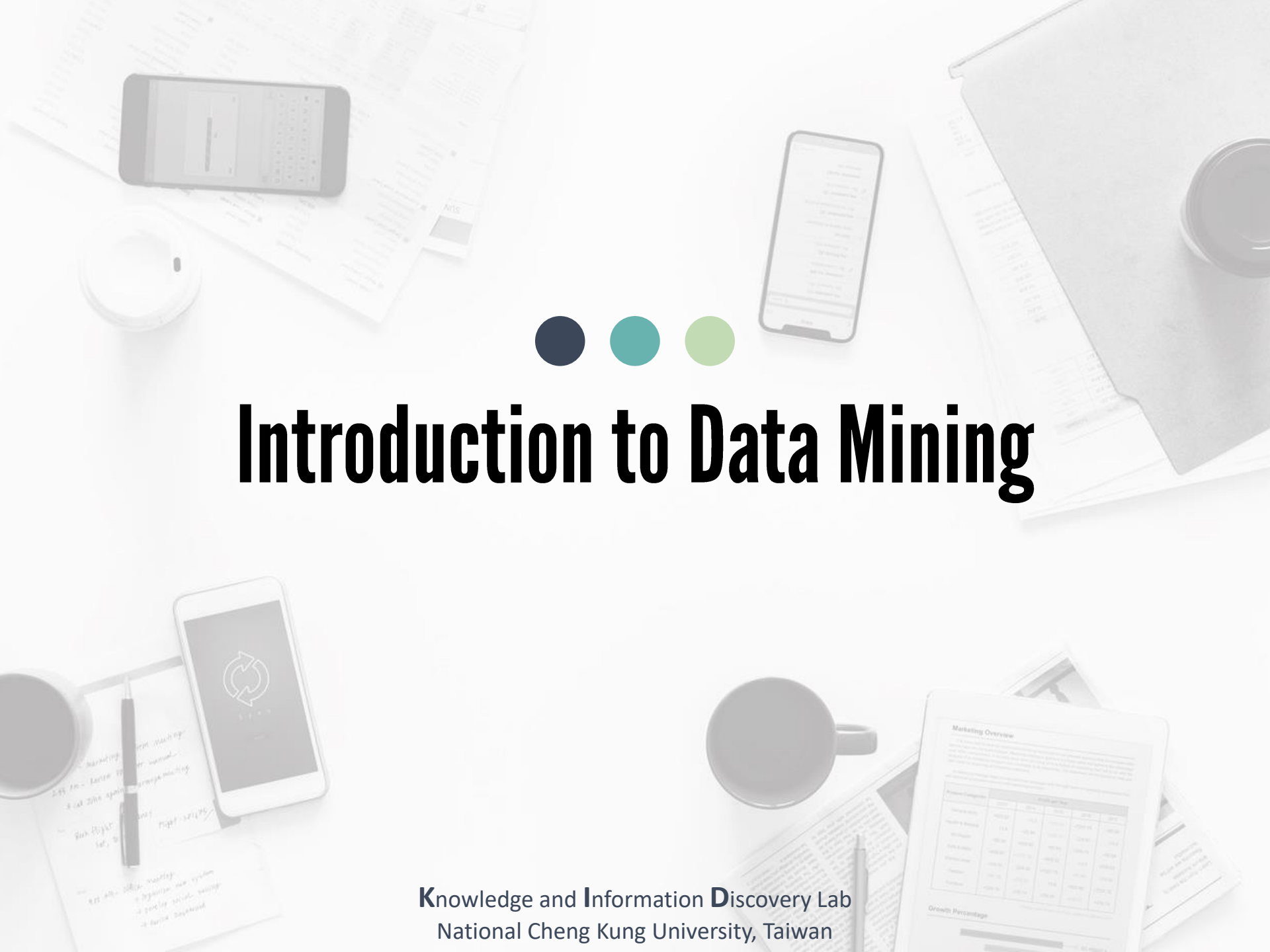
Ongoing Projects

- 教育部人工智慧技術及應用人才培育計畫
- 教育部人工智慧教育議題配合高中領域教學實施示例計畫
- 教育部智慧聯網技術與應用人才培育計畫
 - 智慧空間聯盟
 - 移動通訊網路時空間資料探勘與應用實例
 - 智慧製造聯盟
 - 工業數據異常偵測關鍵技術
- 科技部: some research projects



Previous Projects

- TSMC: Multi-scale control chart classification
- SinoPac: Personal wealth report
- SinoPac: Credit report generation
- ASE: File security classification and prediction
- ASE: Email security classification and prediction
- Ill: Security event detection and monitoring system
- MOST: 10+ projects
- Others



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Introduction to Data Mining

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What is Data Mining

- Knowledge Discovery from Data
- Extraction of interesting, non-trivial, implicit, previously unknown and potentially useful patterns or knowledge from huge amount of data



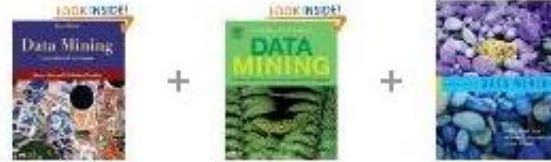


Data Mining Processes

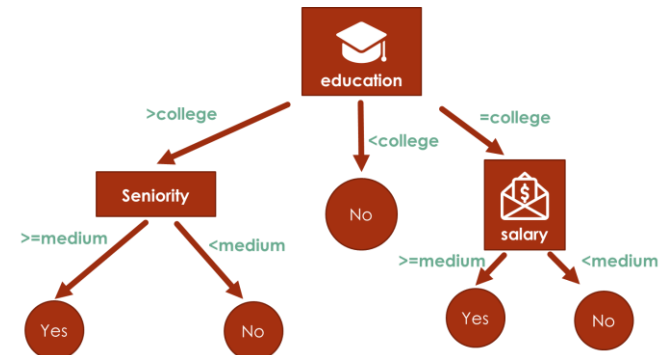
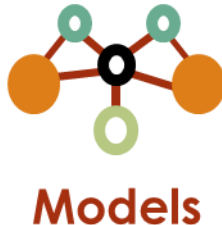
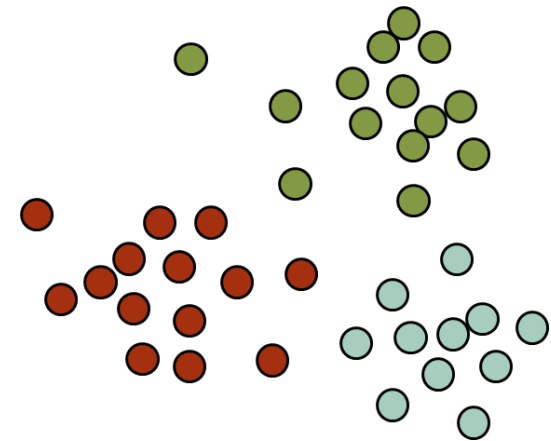
• Data collection • Data cleaning • Data integration	Preprocessing
• Data warehousing • Data selection	Exploration
• Pattern evaluation • Knowledge discovery	Data Mining
• Information presentation • Decision making	Post processing

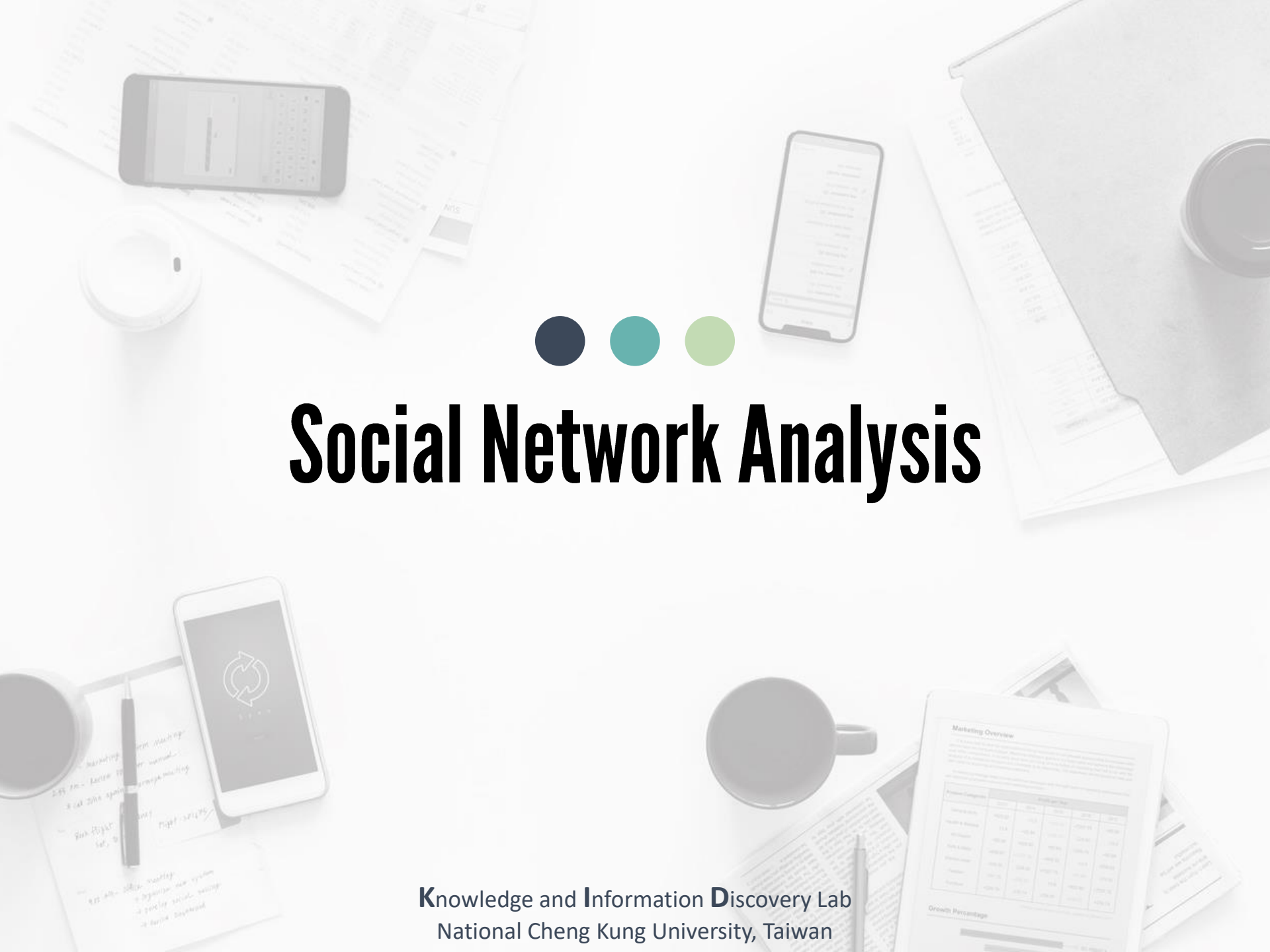
What does Data Mining Do?

- Association
 - $A \rightarrow B$
- Clustering
 - $\{AB\}, \{CDE\}, \{F\}$
- Classification
 - $A:Y, B:N, C:Y, D:Y, E:N, F:Y$
- Etc.



<https://www.amazon.com/>





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Social Network Analysis

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Social Networking

- Social networking websites allow users to establish their own personal communities or social networks based on relationships of friends.



<http://www.facebook.com/>



<http://twitter.com/>



Social Network Analysis

SNA

- Community detection
- Social influence analysis
- Social recommendation
- Link analysis / prediction
- Topic detection / tracking



Community Detection

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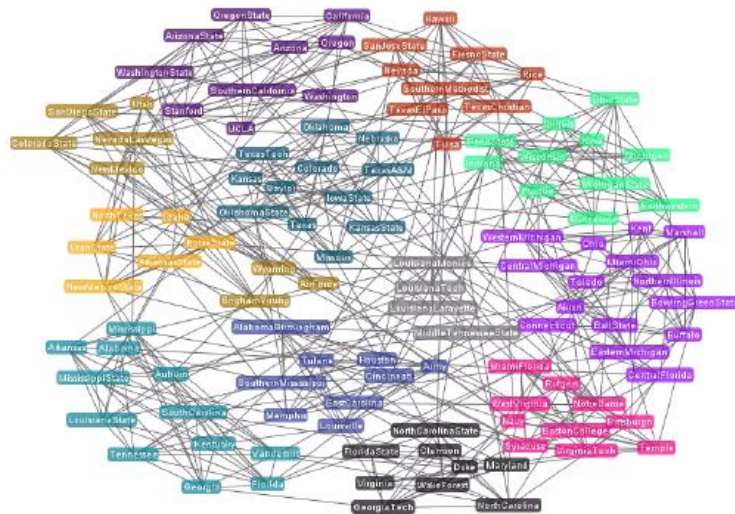
Community Detection

- Community structure
 - Strong internal node to node connections
 - Weaker external connections

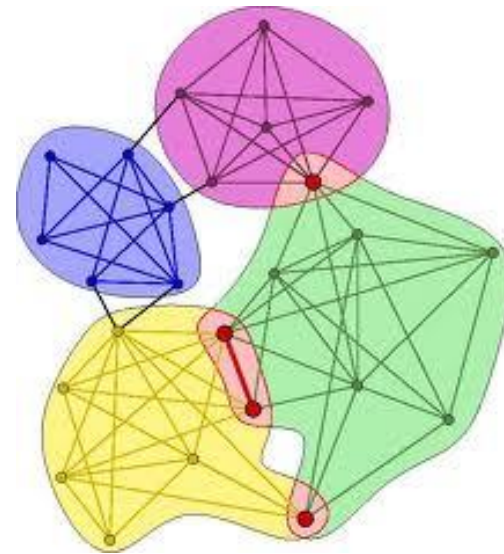


Community Detection

- **Community detection** in a network is the gathering of network vertices into groups in such a way that nodes in each group are **densely connected inside** and **sparser outside**.



Non-overlapped communities

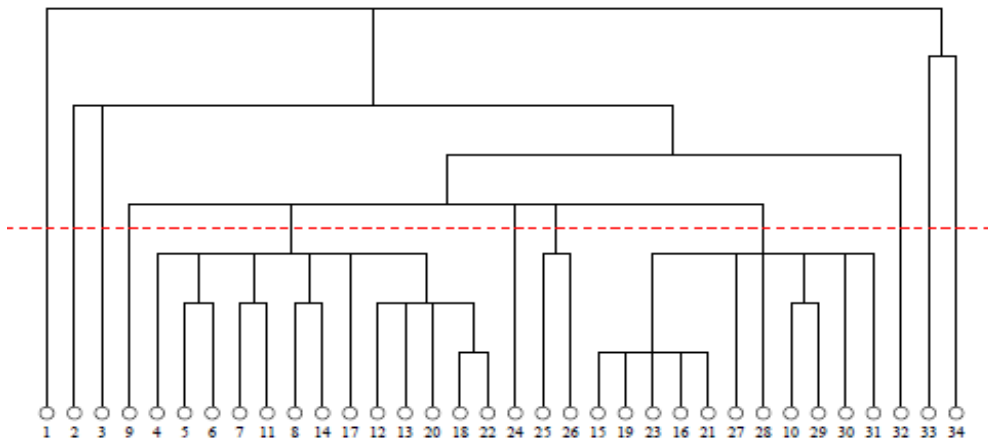


Overlapped communities

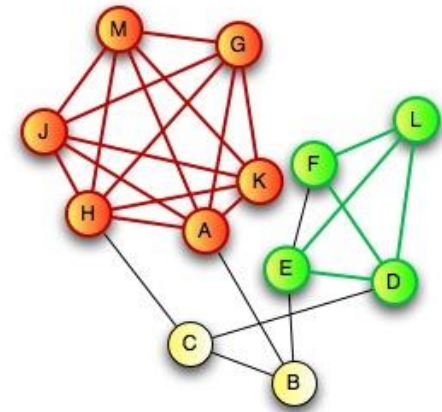


Community Detection Algorithms

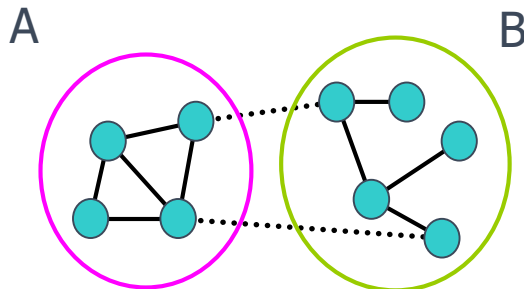
- Hierarchical Clustering techniques



- Clique-based algorithm



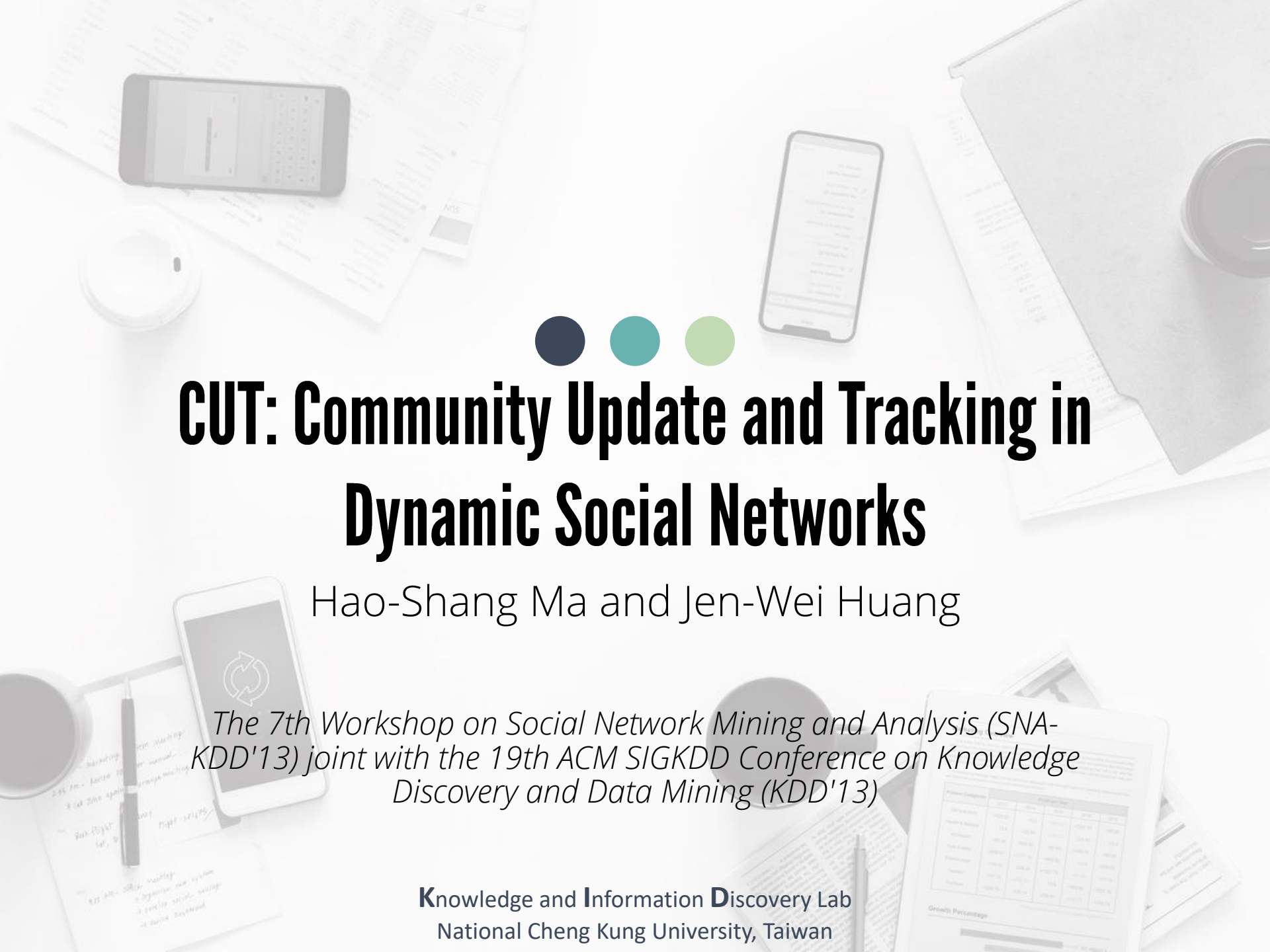
- Edge removal (by betweenness)



- Newman Fast algorithm

Optimizing Modularity

$$Q = \sum_i (e_{ii} - a_i^2)$$



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CUT: Community Update and Tracking in Dynamic Social Networks

Hao-Shang Ma and Jen-Wei Huang

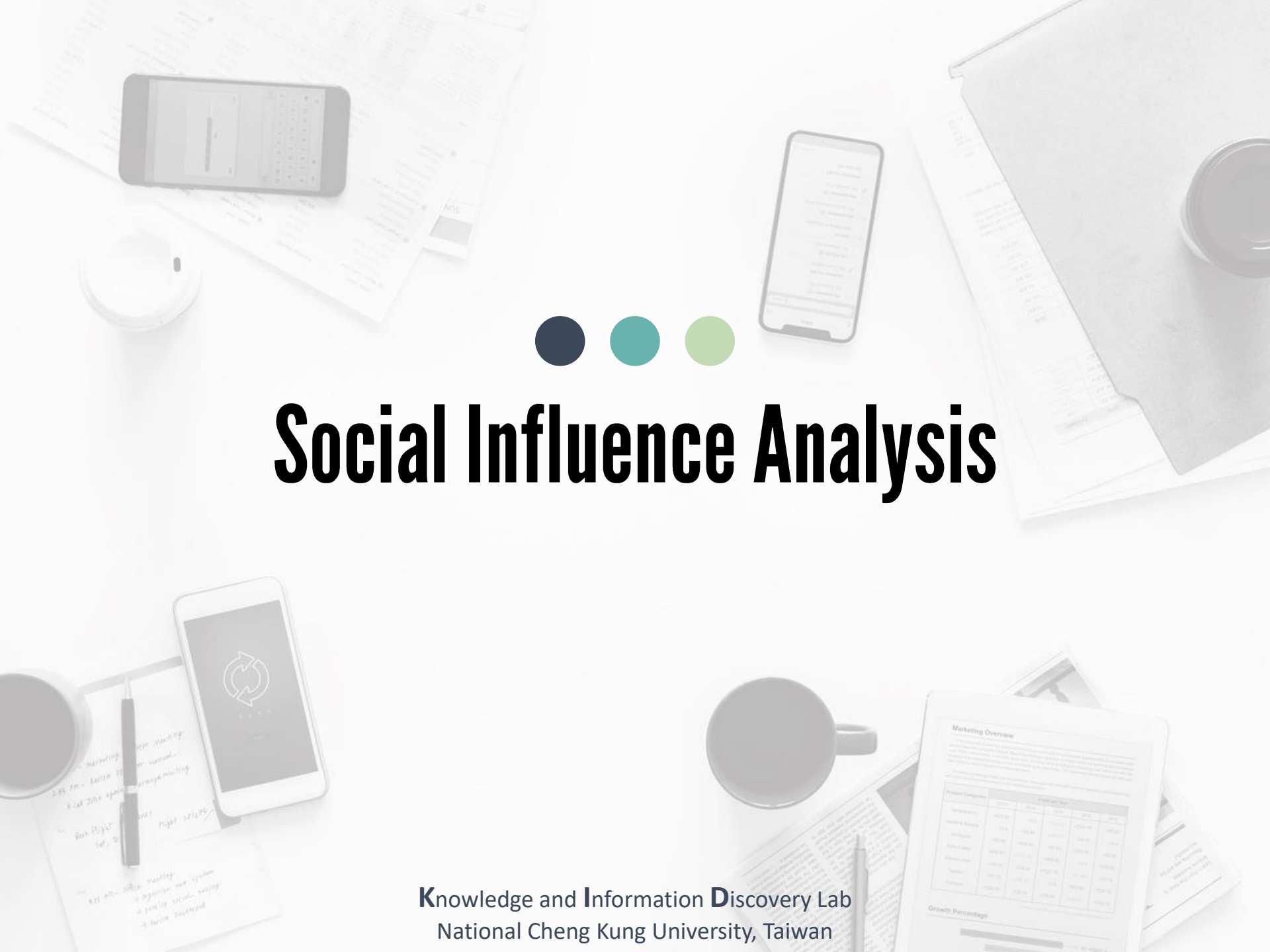
The 7th Workshop on Social Network Mining and Analysis (SNA-KDD'13) joint with the 19th ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD'13)

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National Cheng Kung University, Taiwan



Introduction

- Social networks are always **changing with the time**.
- We want to quickly and efficiently identify the community structures of a network at every timestamp.
- Updating the network structure **by tracking previously known information** instead of recalculating the relationships of all nodes and edges in the networks.



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Social Influence Analysis

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National Cheng Kung University, Taiwan



Information Spread

- Social network plays a fundamental role as a medium for the spread of information among members.
 - daily life, photos
 - opinion, ideas





Social Influence Analysis

- **Social influence** occurs when one's emotions, opinions, or behaviors are affected by others.



Social influential network

- A social network is modeled as a graph $G = \{V, E\}$, where V is the set of nodes, and E is the set of edges.
- Social influence is a directional effect from node A to node B.



Social Influence Analysis

Interesting Topics

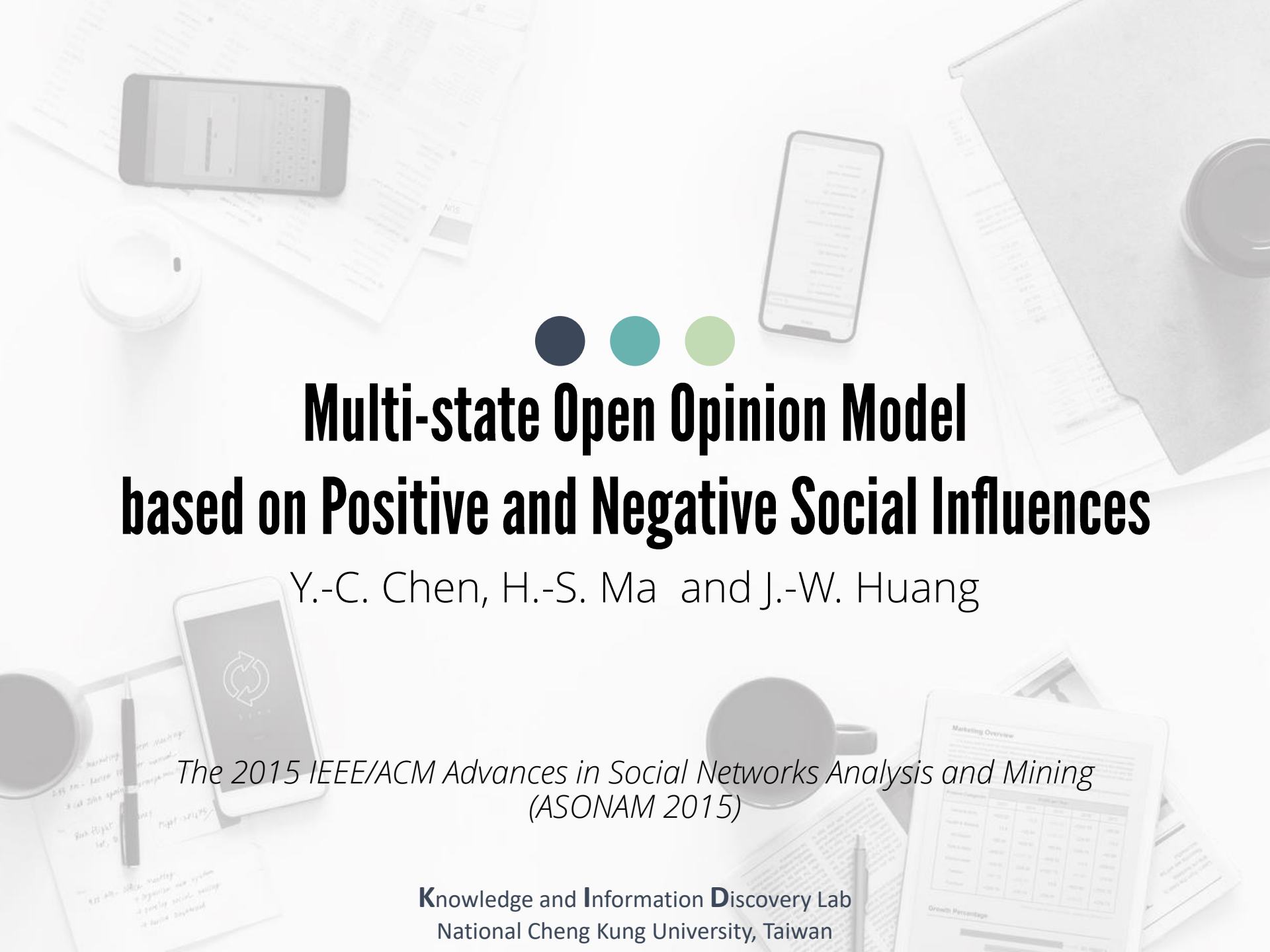
- Modeling the influence diffusion
- Influence maximization problem
- Top influential nodes
- Emerging Topics





Viral Marketing

- Direct marketing takes the “word-of-mouth” effects to significantly increase profits.
- Minimize marketing cost and more generally maximize profit.
- Find a small number of influential users to adopt a new product, and subsequently trigger a large cascade of further adoptions.



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Multi-state Open Opinion Model based on Positive and Negative Social Influences

Y.-C. Chen, H.-S. Ma and J.-W. Huang

*The 2015 IEEE/ACM Advances in Social Networks Analysis and Mining
(ASONAM 2015)*

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Traditional Models

- Traditional social influence models all categorize nodes into active and inactive states.
 - Active state: Node has been influenced, and has the influential power to affect others.
 - Inactive state: Node has not received enough influence to be an active node, and thus has cannot influence others.



Difficulties of Previous Models

- Previous models only consider the possibility of positive influence or negative influence separately.
- If nodes have been influenced and become active, these nodes could not return to the inactive state.
- Most of models do not take the time decay effect into account.



MOO Model

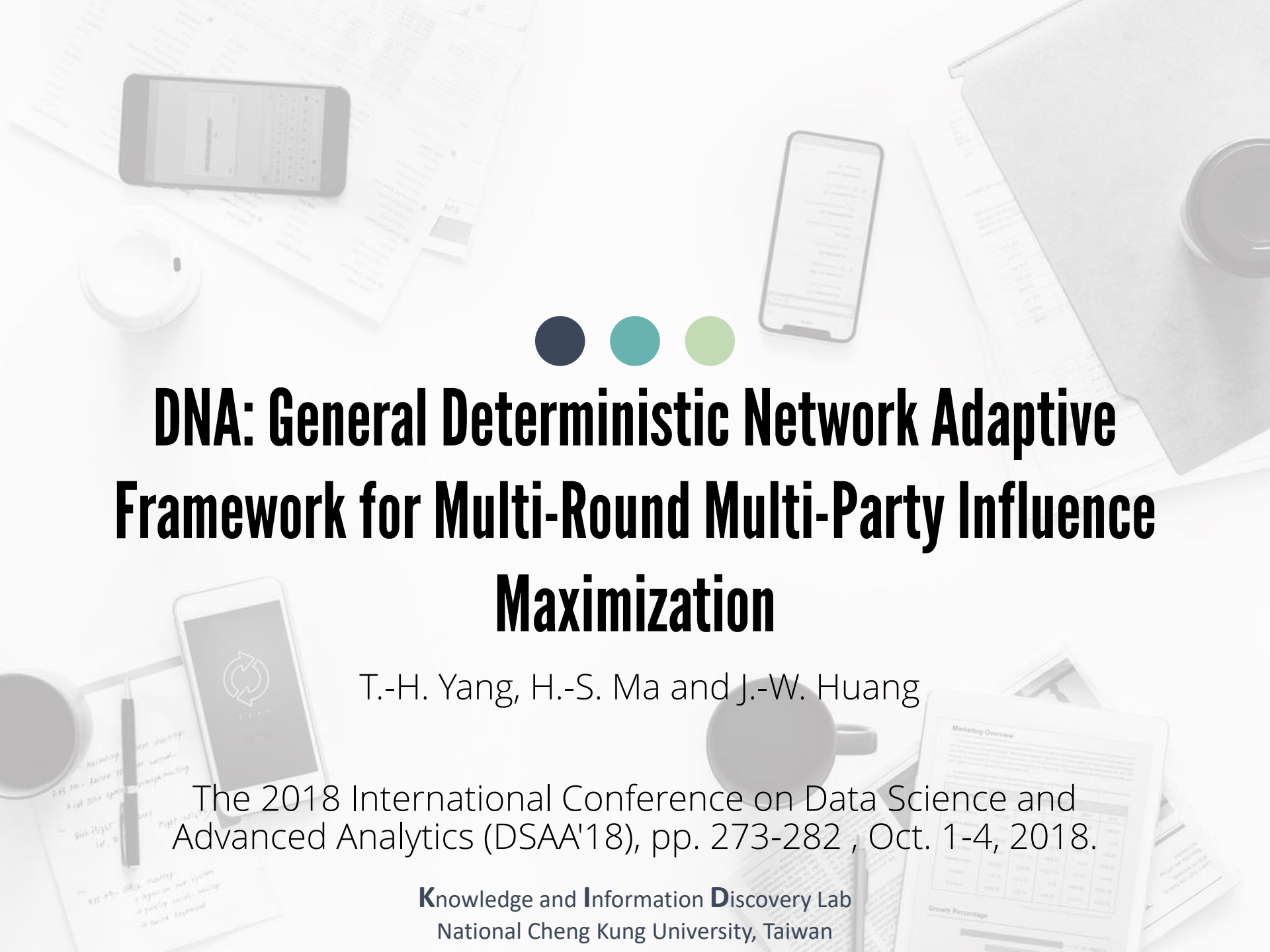
- We propose a Multi-state Open Opinion model, a.k.a, MOO model.
 - We design multiple states of opinions with state threshold table.
 - Nodes in different states can change their states.
 - An influence diffusion process considers positive and negative influences at the same time.
 - The inflence includes the time decay effect.



識別線上社群網路之 Top-k重要影響者

沈家譽, 馬豪尚, 簡志佳, 辛韋呈
吳永斌, 黃仁暉, 葉信延

*Proc. of Conference on Technologies and Applications of Artificial
Intelligence, 2014*



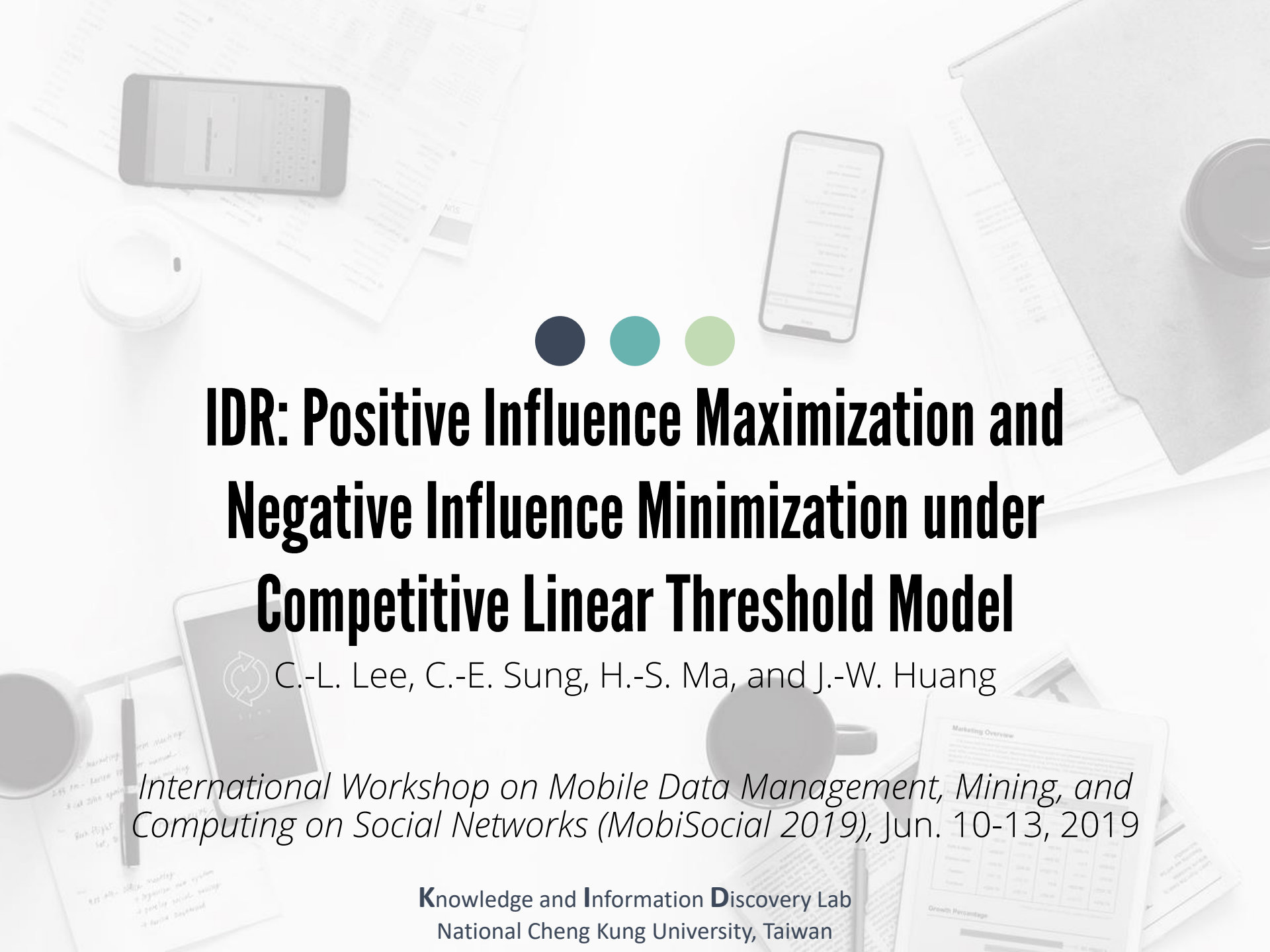
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DNA: General Deterministic Network Adaptive Framework for Multi-Round Multi-Party Influence Maximization

T.-H. Yang, H.-S. Ma and J.-W. Huang

The 2018 International Conference on Data Science and Advanced Analytics (DSAA'18), pp. 273-282 , Oct. 1-4, 2018.

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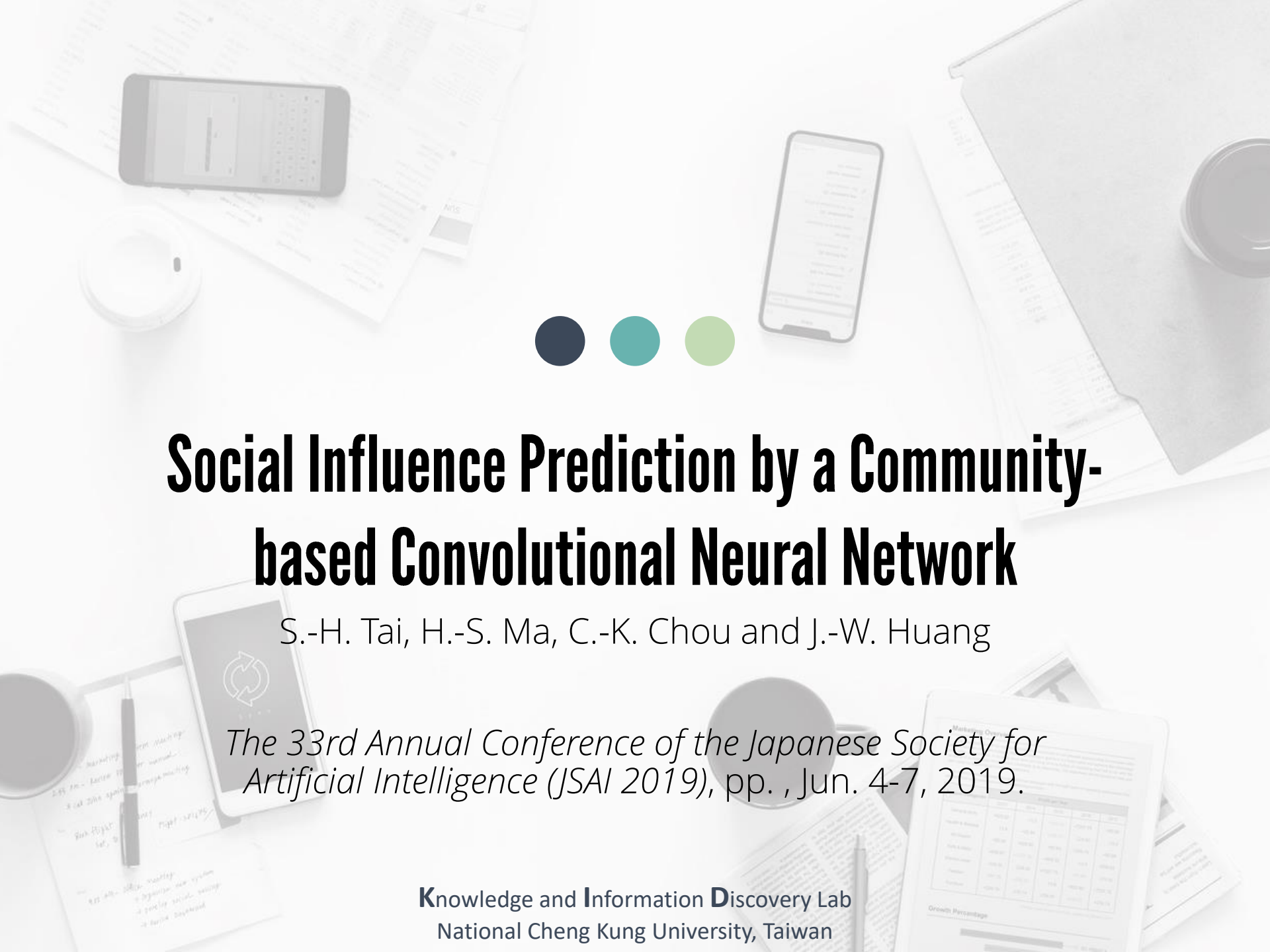


Three colored dots (dark blue, teal, light green) are positioned above the title.

IDR: Positive Influence Maximization and Negative Influence Minimization under Competitive Linear Threshold Model

 C.-L. Lee, C.-E. Sung, H.-S. Ma, and J.-W. Huang

International Workshop on Mobile Data Management, Mining, and Computing on Social Networks (MobiSocial 2019), Jun. 10-13, 2019



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Social Influence Prediction by a Community-based Convolutional Neural Network

S.-H. Tai, H.-S. Ma, C.-K. Chou and J.-W. Huang

The 33rd Annual Conference of the Japanese Society for Artificial Intelligence (JSAI 2019), pp. , Jun. 4-7, 2019.



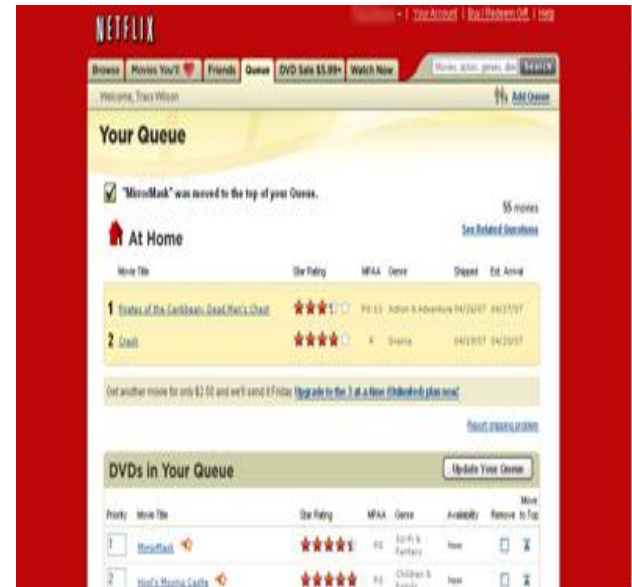
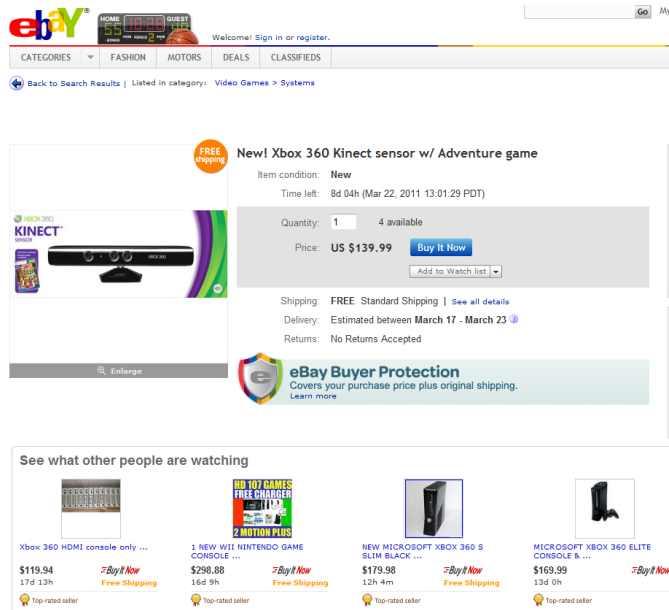
Three colored dots (dark blue, teal, light green) are positioned above the title.

Social Recommendation

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Social Recommendation

- Recommendation system is an information filtering system that seeks to predict the 'rating' or 'preference'.



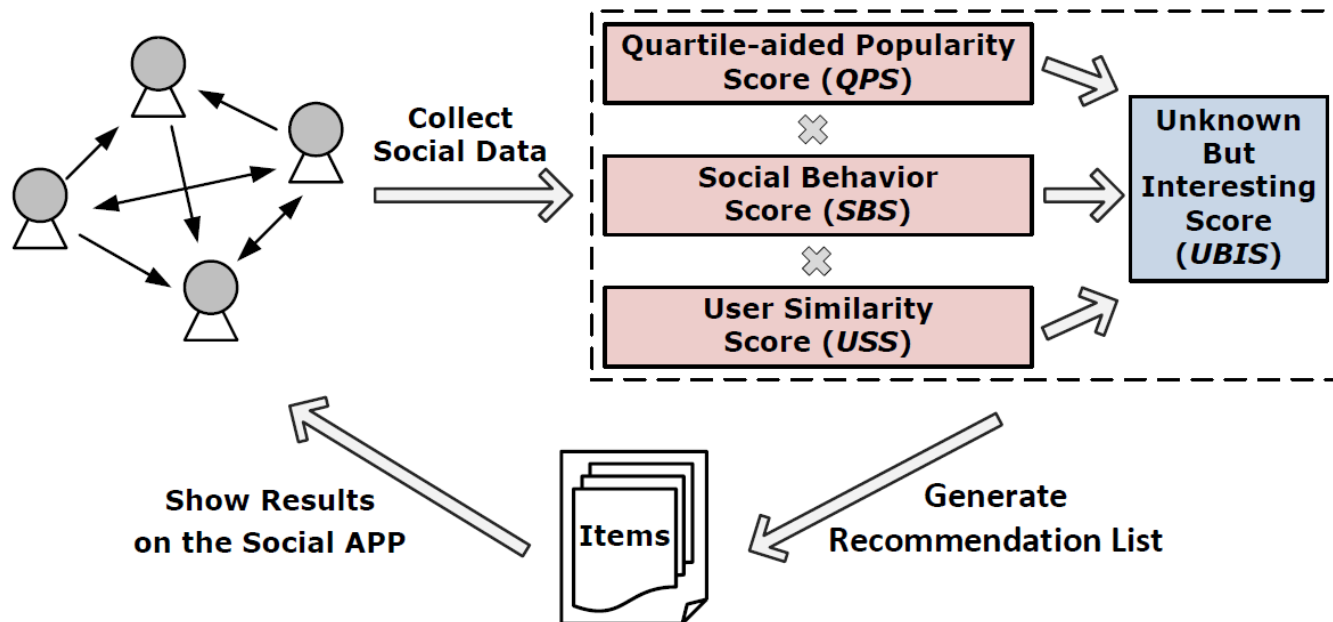


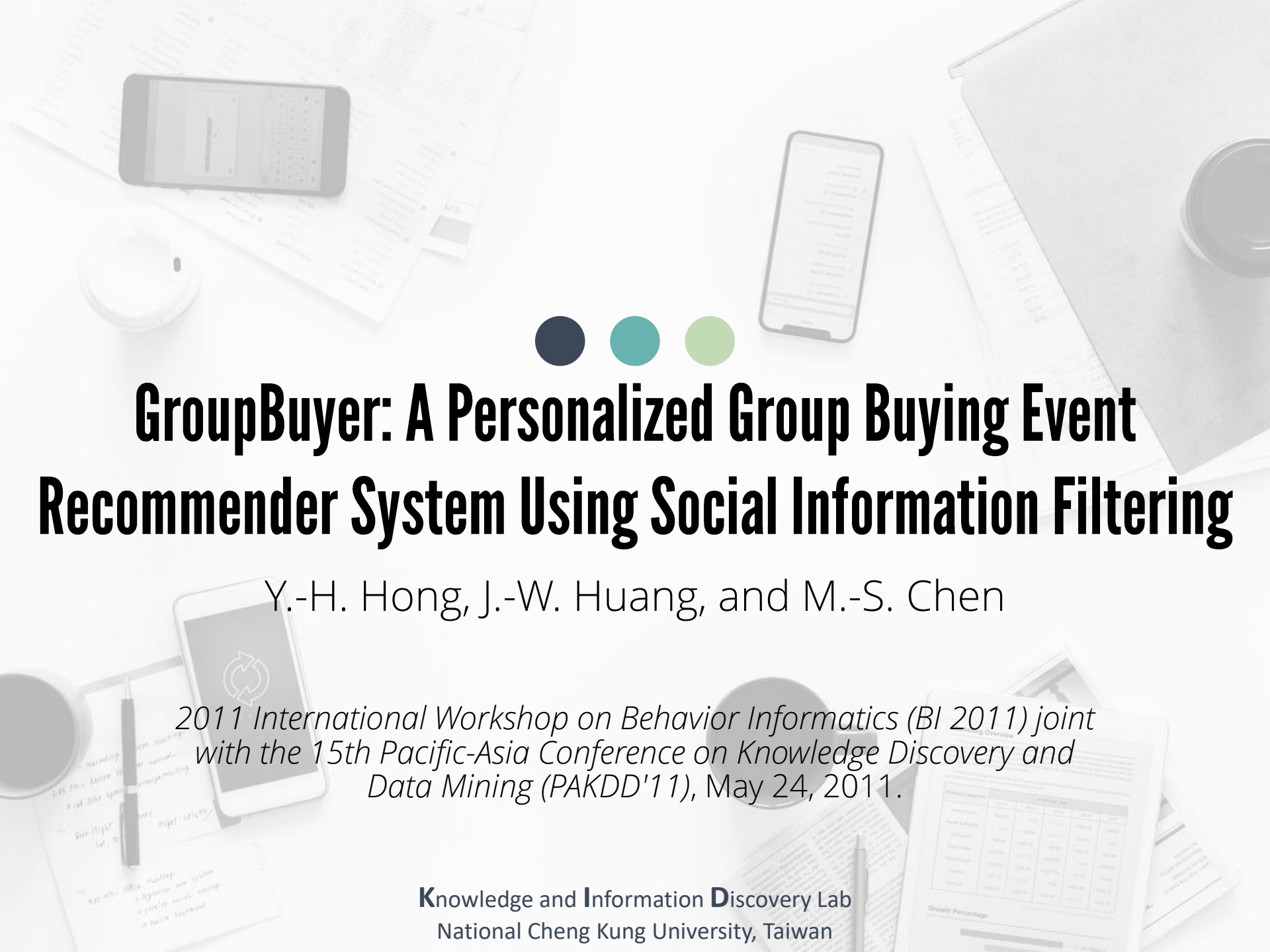
Social Recommendation Methods

- Collaborative filtering
 - Building a model from a user's past behavior and interaction with others/friends.
 - Using that model to predict items that the user may have an interest in.
- Content-based filtering
 - Utilizing a series of discrete characteristics of an item in order to recommend additional items with similar properties.

Social Recommendation

- Considering the user's social information in the social network such as relationships between users or social behavior of users to recommend items



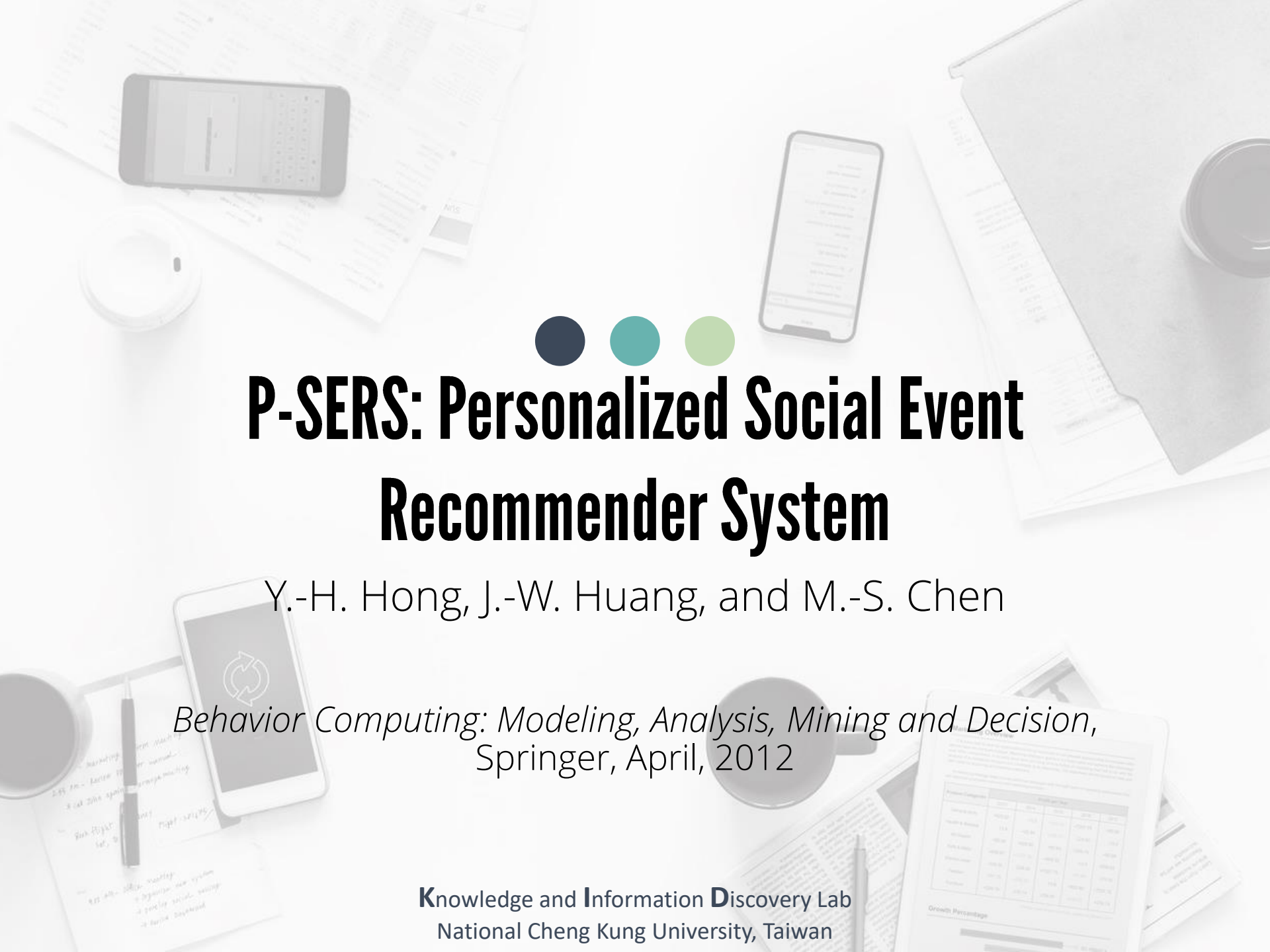


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GroupBuyer: A Personalized Group Buying Event Recommender System Using Social Information Filtering

Y.-H. Hong, J.-W. Huang, and M.-S. Chen

*2011 International Workshop on Behavior Informatics (BI 2011) joint
with the 15th Pacific-Asia Conference on Knowledge Discovery and
Data Mining (PAKDD'11), May 24, 2011.*

The background is a light gray collage of various items related to technology and work. It includes two smartphones, one showing a calendar and the other a list; a laptop; a white coffee cup; a tablet displaying a document; a pen; and some papers with handwritten notes. In the center, above the title, are three colored circles: dark blue, teal, and light green.

P-SERS: Personalized Social Event Recommender System

Y.-H. Hong, J.-W. Huang, and M.-S. Chen

Behavior Computing: Modeling, Analysis, Mining and Decision,
Springer, April, 2012

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National Cheng Kung University, Taiwan



Discovering Unknown But Interesting Items on Personal Social Network

Juang-Lin Duan, Shashi Prasad, Jen-Wei Huang

*Proc. of the 16th Pacific-Asia Conference on Knowledge Discovery and
Data Mining (PAKDD'12)*

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National Cheng Kung University, Taiwan



Unknown But Interesting Recommendation Using Social Penetration

Jen-Wei Huang, Hao-Shang Ma,
Chih-Chin Chung, and Zhi-Jia Jian

Soft Computing, accepted, 2018

Knowledge and Information Discovery Lab
National Cheng Kung University, Taiwan



Introduction to Social Recommendation

- Generally a social recommendation system generates recommendation list based on three factors—popularity, familiarity, and similarity.
- By quantifying popularity, familiarity, and similarity into scores, traditional recommendation systems recommend items with the highest scores to users.



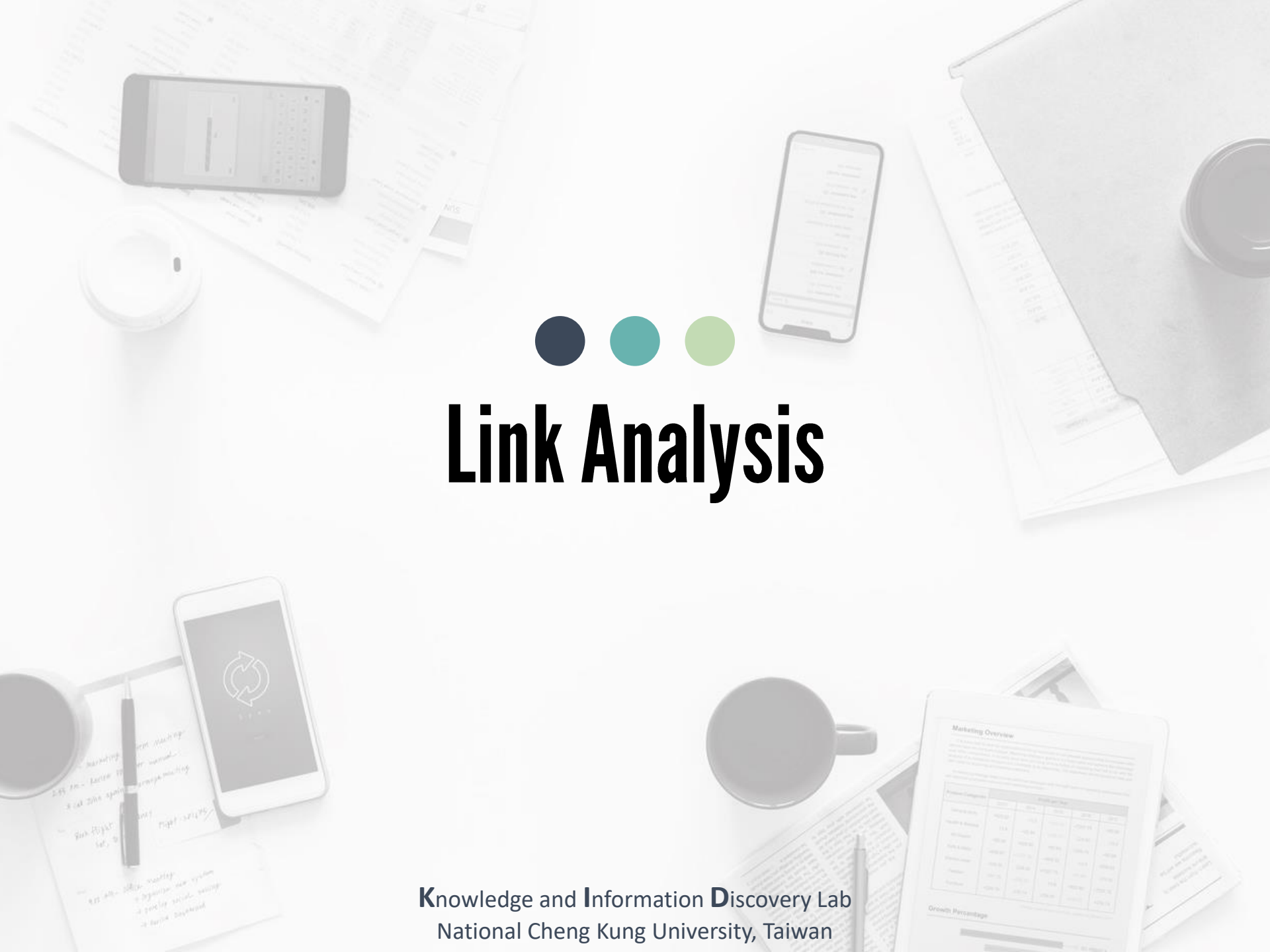
Problems of Traditional Recommendation System

- The target user may have already know the most popular items.
- The target user may not be interested in the items recommended by his/her familiar users.



Unknown But Interesting Recommendation

- We proposed algorithms to discover unknown but interesting items.
- UBI: Unknown But Interesting recommendation
- WUBI: Weighted UBI algorithm
- SPUBI: Social Penetration UBI algorithm



Link Analysis

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Link Analysis

- Link analysis is to evaluate relationships (connections) between nodes.
- Relationships may be identified among various types of nodes, including organizations, people and transactions
- Applications of the link analysis
 - Web search
 - HITS and Page Rank
 - Link prediction

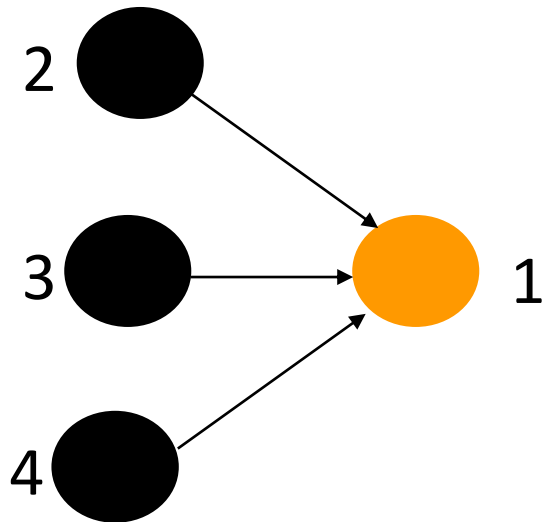


HITS

Hypertext Induced Topic Selection

- Hubs and Authorities:

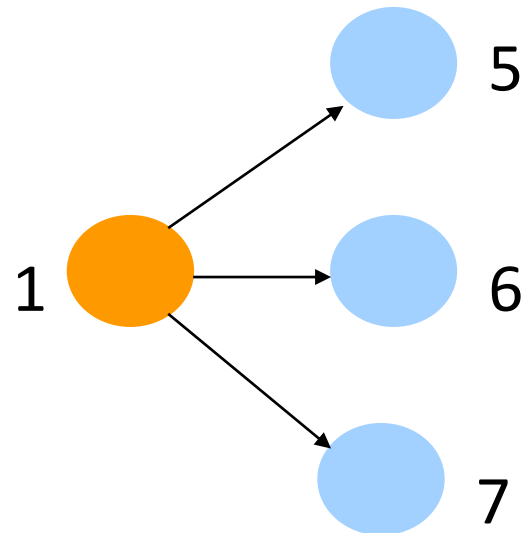
$$a(v) \leftarrow \sum h(w)$$



$$a(1) = h(2) + h(3) + h(4)$$

- Recursive dependency:

$$h(v) \leftarrow \sum a(w)$$



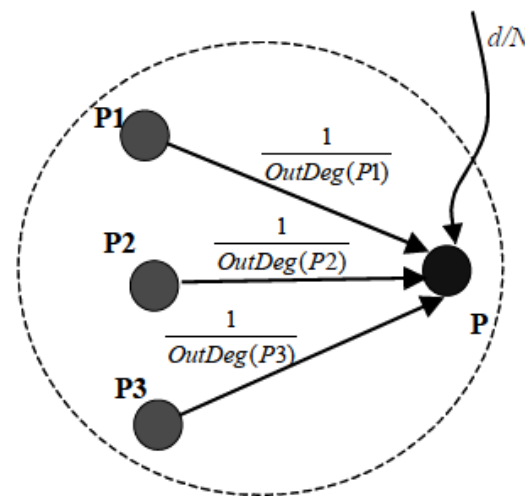
$$h(1) = a(5) + a(6) + a(7)$$

PageRank

- PageRank is a metric for ranking hypertext documents that determines their quality

$$PR(P) = \frac{d}{N} + (1 - d) \left(\frac{PR(P1)}{OutDeg(P1)} + \frac{PR(P2)}{OutDeg(P2)} + \frac{PR(P3)}{OutDeg(P3)} \right)$$

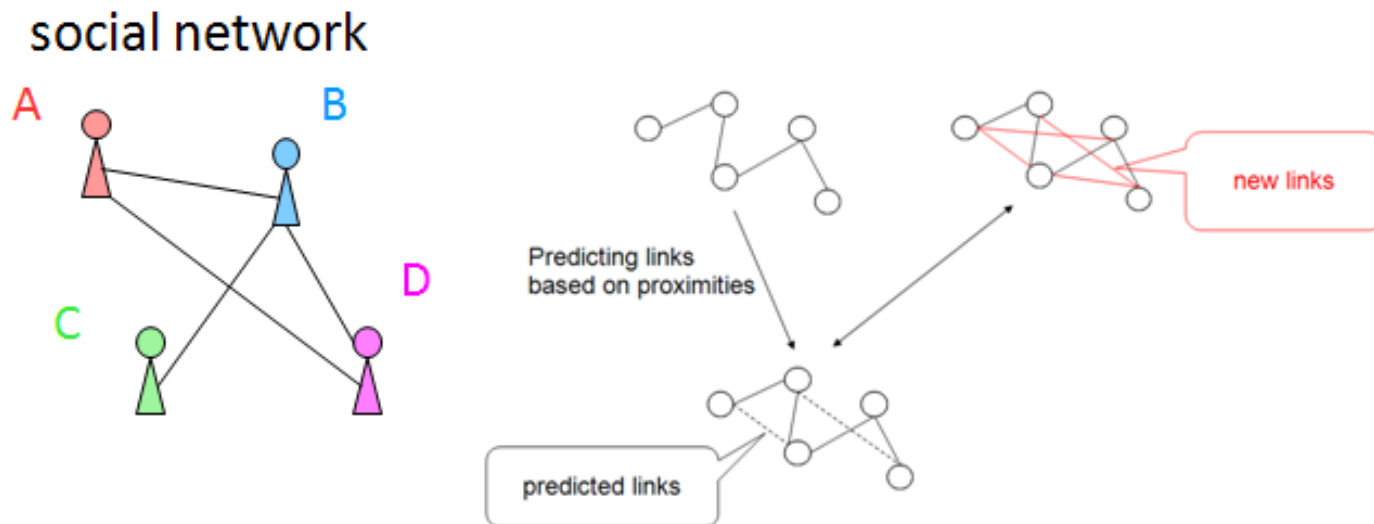
- N is the number of nodes in the graph
- OutDeg (q) is the number of hyperlinks on page q
- d is the probability that a random surfer chooses a URL directly

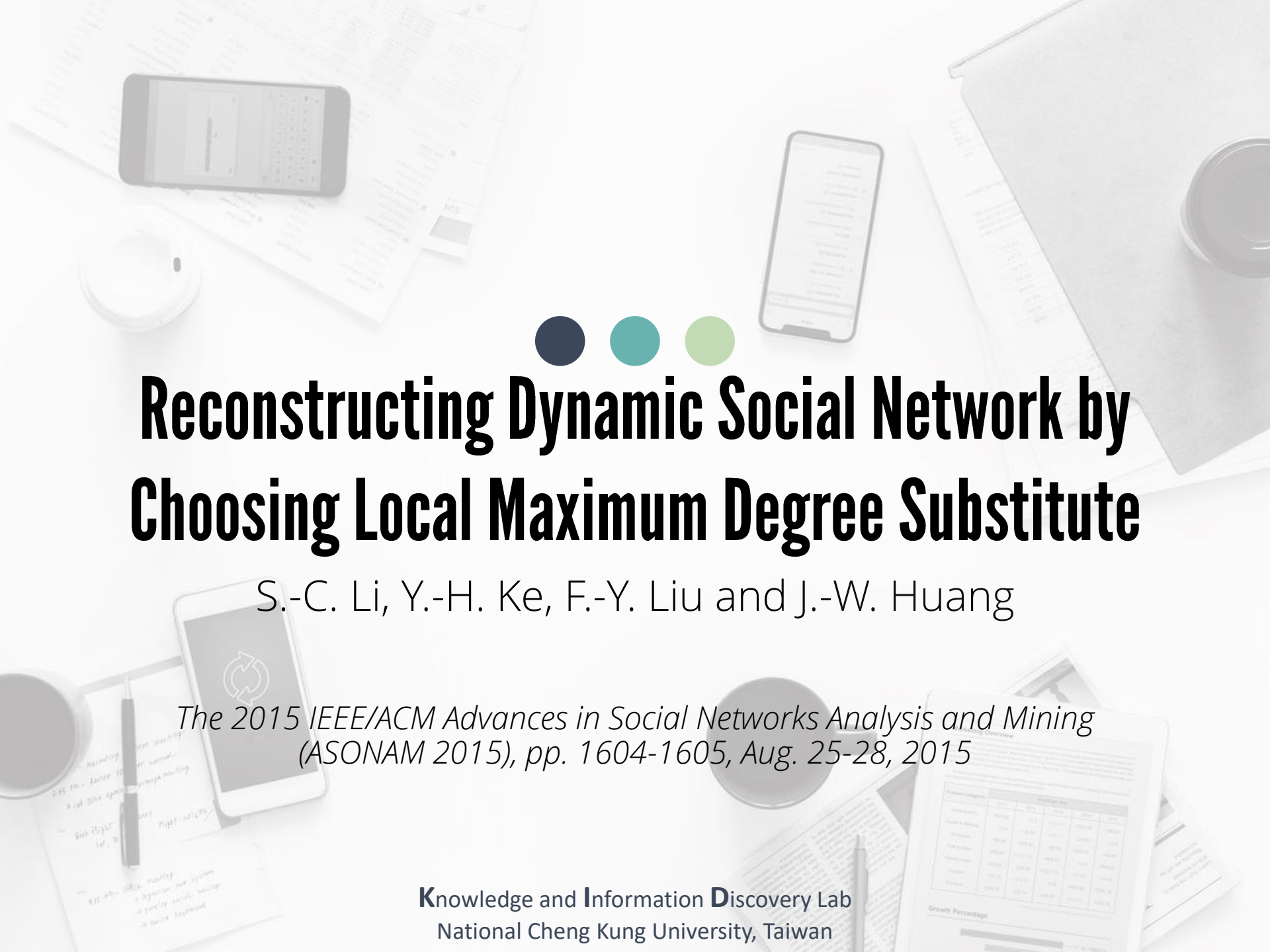




Link Prediction

- Given a snapshot of a social network at time t , we seek to accurately predict the edges that will be added to the network during the interval from time t to a given future time t' .

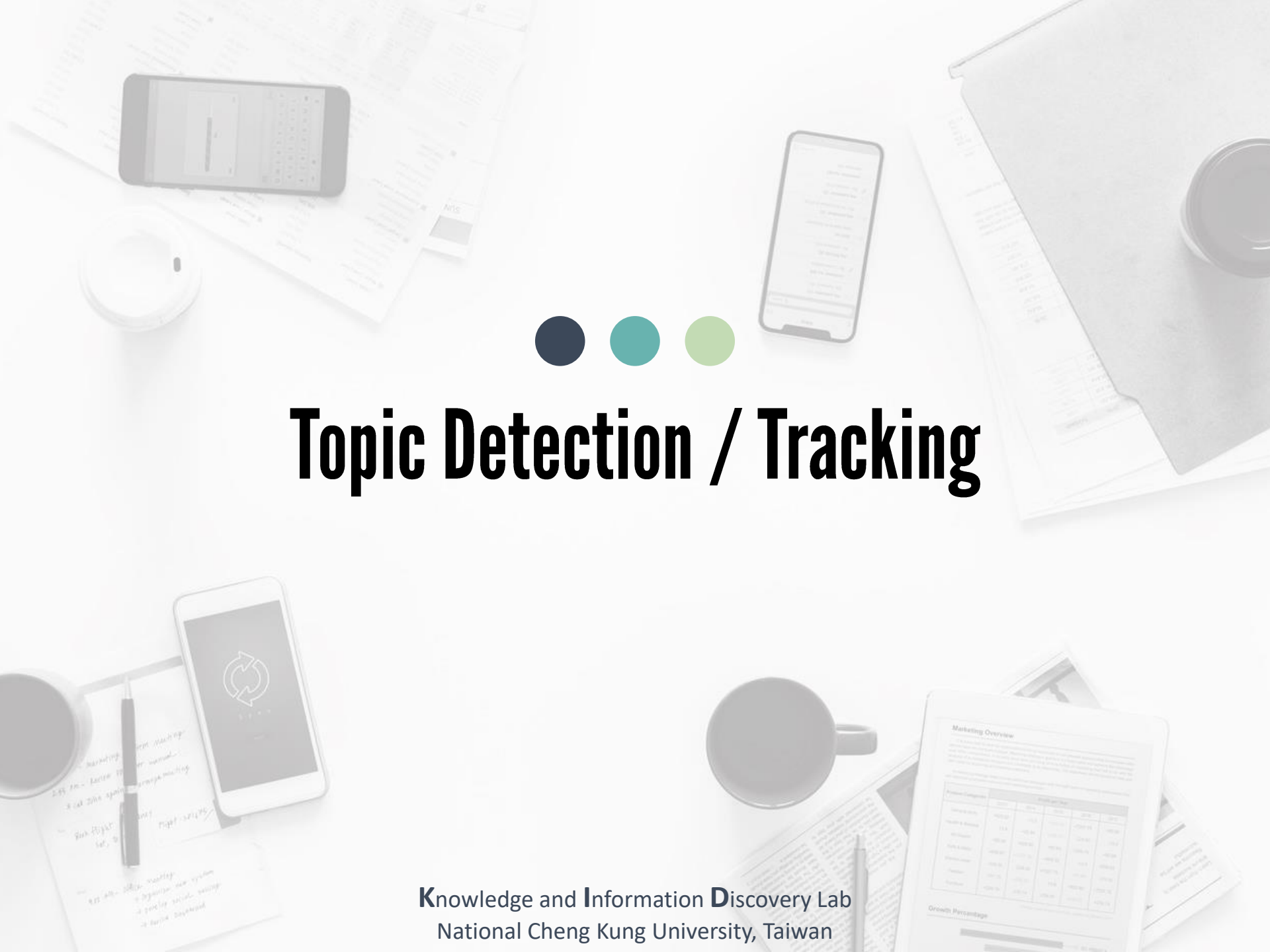




Reconstructing Dynamic Social Network by Choosing Local Maximum Degree Substitute

S.-C. Li, Y.-H. Ke, F.-Y. Liu and J.-W. Huang

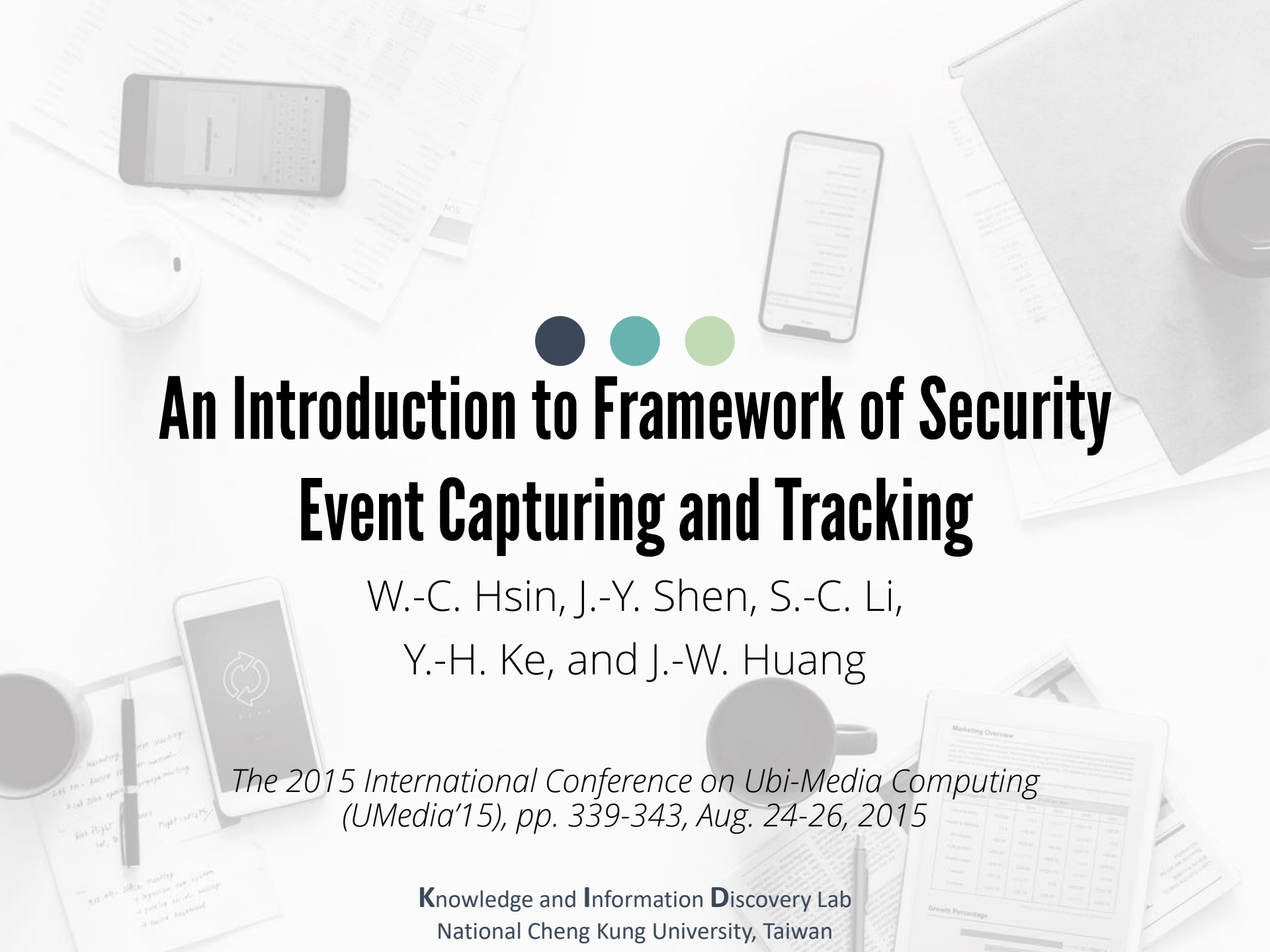
*The 2015 IEEE/ACM Advances in Social Networks Analysis and Mining
(ASONAM 2015), pp. 1604-1605, Aug. 25-28, 2015*



Three colored circles (dark blue, teal, light green) are positioned above the title.

Topic Detection / Tracking

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An Introduction to Framework of Security Event Capturing and Tracking

W.-C. Hsin, J.-Y. Shen, S.-C. Li,
Y.-H. Ke, and J.-W. Huang

*The 2015 International Conference on Ubi-Media Computing
(UMedia'15), pp. 339-343, Aug. 24-26, 2015*

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Multi-dependent Latent Dirichlet Allocation

Wei-Cheng Hsin and Jen-Wei Huang

Proc. of Conference on Technologies and Applications of Artificial Intelligence (TAAI'17), Dec. 1-3, 2017

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National Cheng Kung University, Taiwan



Multi-factor Topic Detection

- Latent Dirichlet Allocation (LDA) is an attractive topic model. Recent researchers have focused on novel dependency to fit datasets.
- However, real world data is too diverse and abundant to be fitted with one single dependency.
- In addition, the model selection for different situations is always difficult.
- We propose Multi-dependent Latent Dirichlet Allocation, MD-LDA, to apply various dependencies into the model.
- MD-LDA can pick up the most optimal fitting dependency from the dependency set and therefore obtain the best dependencies for the dataset.



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- Y.-C. Chen, H.-S. Ma and J.-W. Huang, "Multi-state Open Opinion Model based on Positive and Negative Social Influences," The 2015 IEEE/ACM Advances in Social Networks Analysis and Mining (ASONAM 2015), pp. 170-177, Aug. 25-28, 2015.
- J.-L. Duan, Shashi Prasad, J.-W. Huang, "Discovering Unknown But Interesting Items on Personal Social Network," Proc. of the 16th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD'12), pp. 145-156, May 29-Jun. 1, 2012.
- J.-W. Huang, H.-S. Ma, C.-C. Chung, and Z.-J. Jian, "Unknown but Interesting Recommendation Using Social Penetration," Soft Computing, accepted, 2018.



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- C.-L. Lee, C.-E. Sung, H.-S. Ma, and J.-W. Huang, "IDR: Positive Influence Maximization and Negative Influence Minimization under Competitive Linear Threshold Model," International Workshop on Mobile Data Management, Mining, and Computing on Social Networks (MobiSocial 2019) in conjunction with the 20th IEEE Conference on Mobile Data Management (MDM 2019), pp. , Jun. 10-13, 2019.
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THANK YOU FOR YOUR ATTENTION

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