Presentation

Context-Aware Approaches In Deep Learning Models

Prepared by: Nhu-Tai Do

September 16th, 2024

AGENDA

- Research Process Steps
- Research Topics about Context-Aware Approach
  - Emotion Recognition
  - Medical Tumor Detection
  - Hand Gesture Recognition
  - Image Colorization

RESEACH PROCESS STEPS

Doing “research”:

to propose a validated solution
to an interesting unsolved
technical problem

RESEARCH INGREDIENTS

- Writing
- Oral

- Experimentation
- Proof of concept
- Math proof
- Case studies
- Comparative analysis
- Qualitative/quantitative

- Process
- Output

to propose a validated solution

to an interesting unsolved technical problem

- important
- fundamental
- widely used in various domains

applicability/practicality

no existing work has addressed it

originality

- Input
- Process
- Output

≠ non-technical (business, app.)

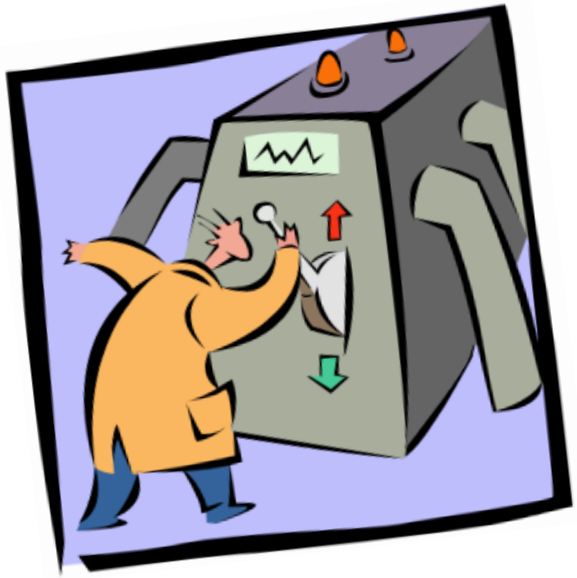
- Topic
- Thesis (focus)

- specific
- small, narrow
- 3+ sub-problems

... *k* sub-sub-problems

WRITING: PURPOSE

*to convey your **idea***



NOT to describe a WizWoz System

Source: http://research.microsoft.com/en-us/um/people/simonpj/papers/giving-a-talk/writing-a-paper-slides.pdf

WRITING

Favorite Quotes

- "*Writing is hard*"
- "*Writing is rewriting*"
- *"Writing aims to express, not to impress."*

Writing Strategy

- Top-down/Forest-tree
- 1st sentence, 1st para: important
- Start with any comfortable part
- Neutral language (*adjectives: use with care*)
- Practice! Practice! Practice! => Read-Imitate!

Research Strategy

- Bottom-up approach/Generalization/Abstraction
- Quality survey papers
- Quality papers in VLDB, SIGMOD

THESIS/PAPER OUTLINE

STYLE 1

1. Introduction
2. Related Work
3. [Preliminaries]
4. Proposed Approach: Overview
5. Contribution 1
6. Contribution 2
7. Contribution 3
8. Evaluation
9. Conclusion

STYLE 2

1. Introduction
2. [Preliminaries]
3. Proposed Approach: Overview
4. Contribution 1
5. Contribution 2
6. Contribution 3
7. Evaluation
8. Related Work
9. Conclusion

"INTRODUCTION"

Introduction part should answer the following questions:

1. What is the research topic (area)?
2. Why is this topic important?
3. What is current state of the art - related work (in brief)?
4. What are specific unsolved technical sub-problems?
5. Why is solving these specific sub-problems important?

6. What is your proposed method (in summary)?
7. What are your specific contributions? Number them!
8. What are assumptions & scope of your work?
9. How are the final results evaluated, compared?
10. Are your contributions significant enough?

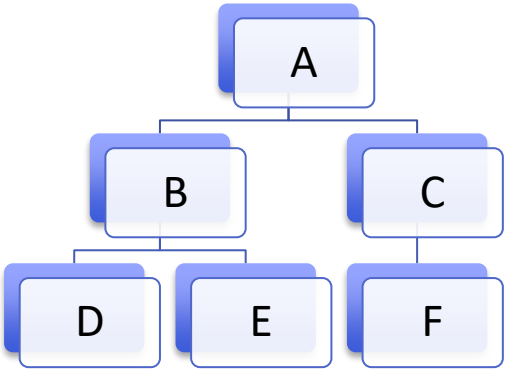
11. What are the structure of the paper/thesis?

"RELATED WORK"

Classification/ Taxonomy

By-Feature

By-Product



F1	F2	Fn
X	✓	X
Y	X	✓
Z	X	✓

X:
✓
X

Y:
✓
X

Z:
✓
X

- Solution Space
- Used to formulate problems (STYLE1) or highlight contributions (STYLE2)

Doing "research": to propose a validated solution to an interesting unsolved technical problem

Terms: "Related Work" = "Lit. Review" = "Lit. Survey"

“Related Work”: Classification

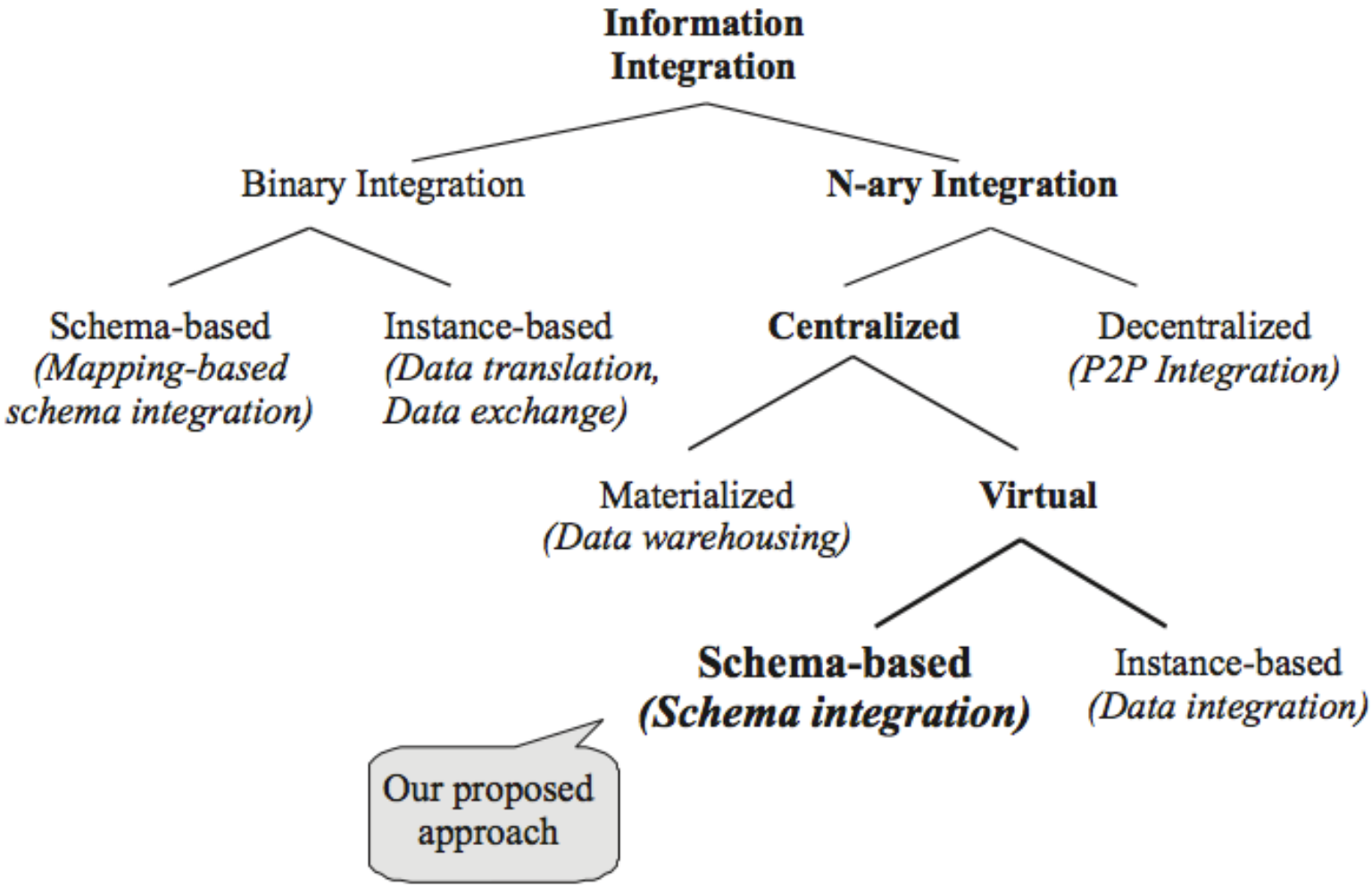


Figure 2.1: Taxonomy of information integration approaches

“Related Work”: By-Feature

Table 2.1: Characteristics of representative schema integration prototypes

Prototype	Strategy	Sources	Metadata Representation	Auxiliary info	Output solution
PORSCHE (Saleem et al., 2008)	binary	XML schemas, XML instances	schema trees	thresholds, dictionaries	schema trees
RONDO (Similarity Flooding) (Melnik et al., 2002, 2003)	binary	two models (database schemas, XML schemas, UML models, ontologies)	directed labeled graphs	thresholds, (edge) weights	merged graphs, mappings
Model Merge* (Pottinger and Bernstein, 2002)	binary	two models (as in RONDO)	set of elements and relation-ships	correspon-dences	mappings
XML-SI* (Madria et al., 2008)	binary	XML schemas	XML schema data model	dictionaries	XML schema data model
COMA/ COMA++ (Do, 2006), (Do and Rahm, 2002, 2007)	binary	relational, XML schemas	concept graphs	thresholds (top-k, %), weights, constraints, thesauri	merged schema, mappings

“Related Work”: By-Product

2.4.1 COMA and COMA++

COMA (COmbining MAtchers) (Do and Rahm, 2002) and its successor COMA++ (Do, 2006; Do and Rahm, 2007) present a powerful composite matching approach that produces schema correspondences used for mapping-based data integration. COMA++ supports an aggregation of multiple schema matching techniques, or matchers. Each matcher uses a particular technique (e.g., string-based or synonym-based) to exploit a specific aspect of the input information, such as element names or [illegible] provides an extensible matcher library, a flexible architecture [illegible]sults, and a platform for evaluating various

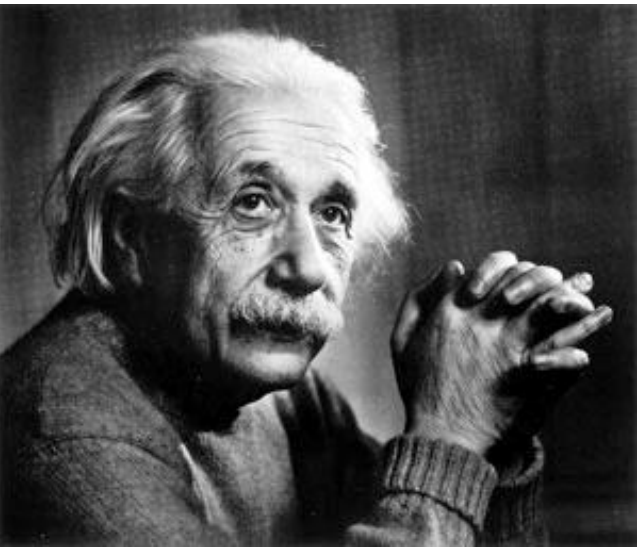
2.4.2 RONDO (Similarity Flooding)

The Similarity Flooding (SF) approach (Melnik et al., 2002) is motivated by the principle of similarity propagation in which the similarity is spread from similar nodes to the adjacent nodes through propagation coefficients. The idea of SF is implemented in RONDO prototype (Melnik et al., 2003).

Input schemas are encoded as directed labeled graphs which are iteratively ma

"Proposed Approach": Problem Definition

Doing "research": to propose a validated solution to an interesting unsolved technical problem

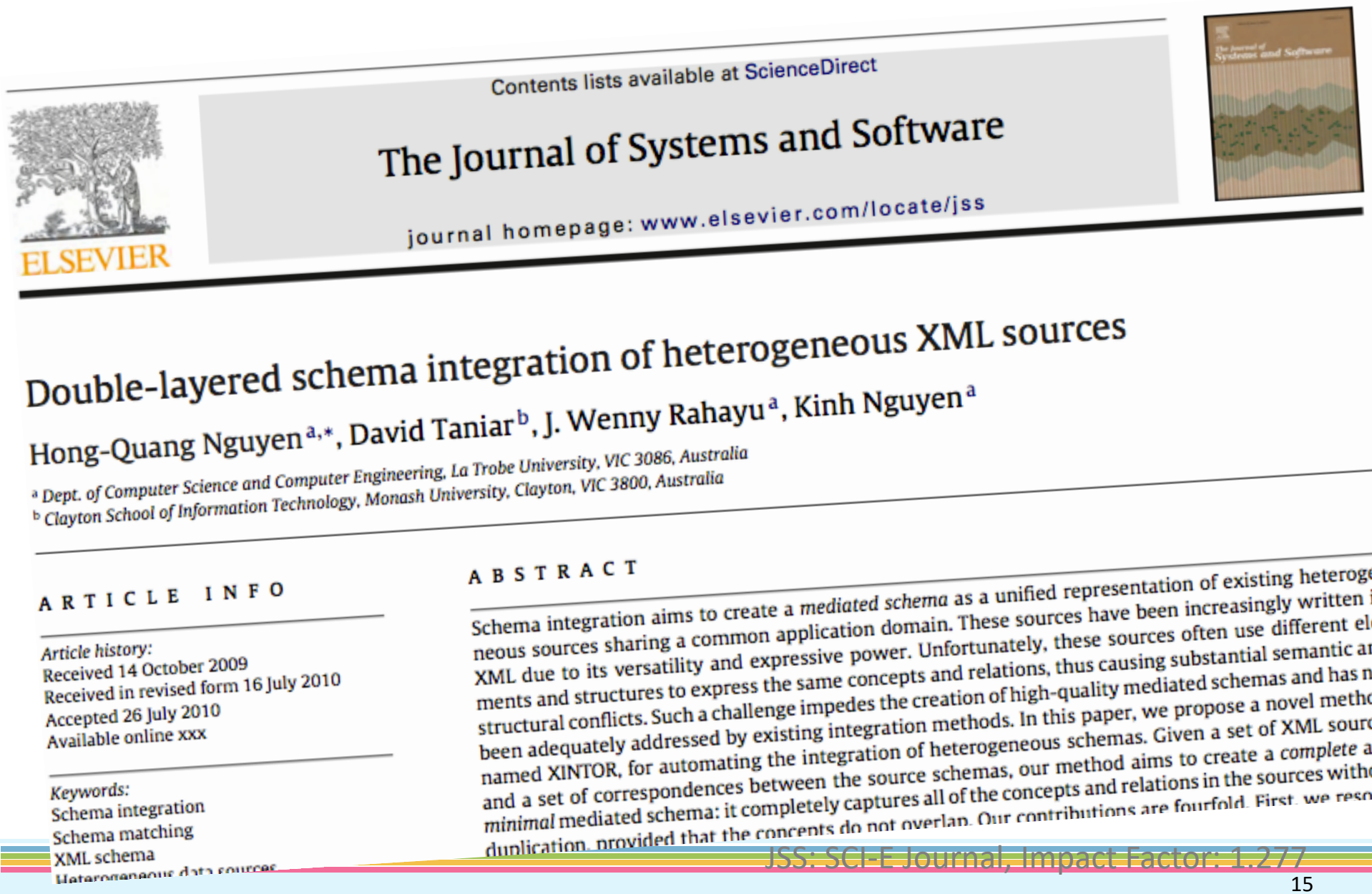


*"If I had an hour to solve a problem, I'd spend **55** minutes thinking about the **problem** and **5** minutes thinking about **solutions**."*

-- *Albert Einstein*

Source: http://litemind.com/problem-definition/

“Proposed Approach”: Example



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ELSEVIER

Double-layered schema integration of heterogeneous XML sources

Hong-Quang Nguyen[a,*], David Taniar[b], J. Wenny Rahayu[a], Kinh Nguyen[a]

[a] Dept. of Computer Science and Computer Engineering, La Trobe University, VIC 3086, Australia
[b] Clayton School of Information Technology, Monash University, Clayton, VIC 3800, Australia

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Heterogeneous data sources

ABSTRACT

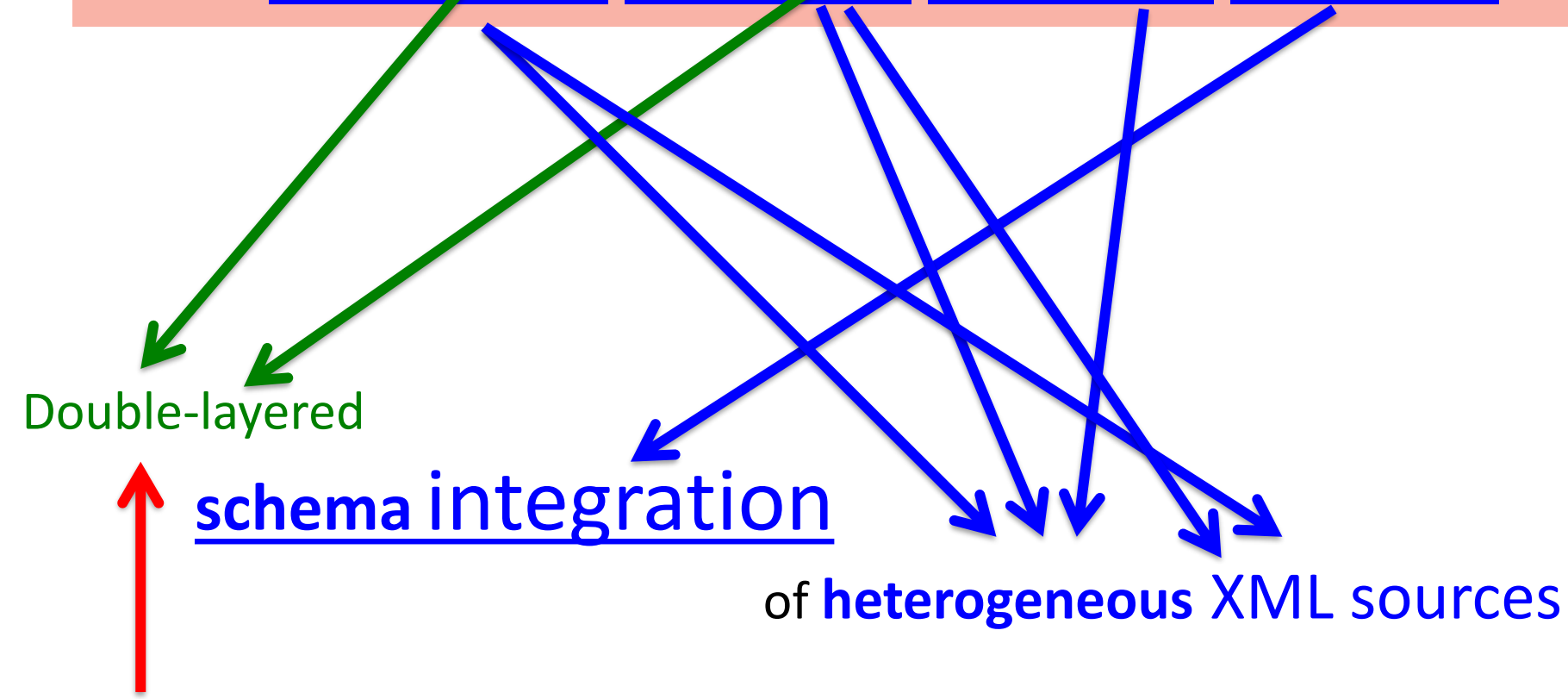
Schema integration aims to create a *mediated schema* as a unified representation of existing heteroge
neous sources sharing a common application domain. These sources have been increasingly written i
XML due to its versatility and expressive power. Unfortunately, these sources often use different el
ments and structures to express the same concepts and relations, thus causing substantial semantic ar
structural conflicts. Such a challenge impedes the creation of high-quality mediated schemas and has n
been adequately addressed by existing integration methods. In this paper, we propose a novel metho
named XINTOR, for automating the integration of heterogeneous schemas. Given a set of XML sourc
and a set of correspondences between the source schemas, our method aims to create a *complete* a
minimal mediated schema: it completely captures all of the concepts and relations in the sources witho
duplication, provided that the concepts do not overlap. Our contributions are fourfold. First, we reso

JSS: SCI-E Journal, Impact Factor: 1.277

Title vs. Ingredients

to propose a validated solution

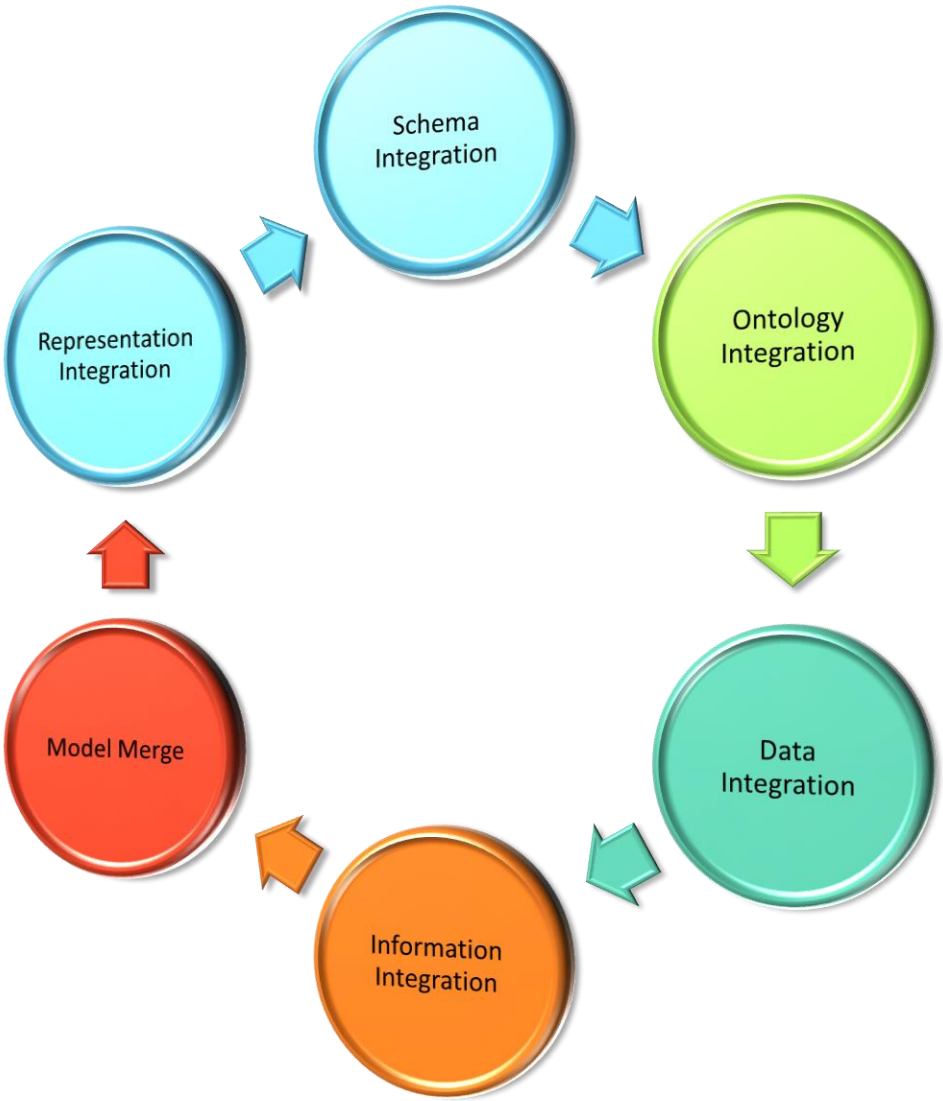
to an interesting unsolved technical problem

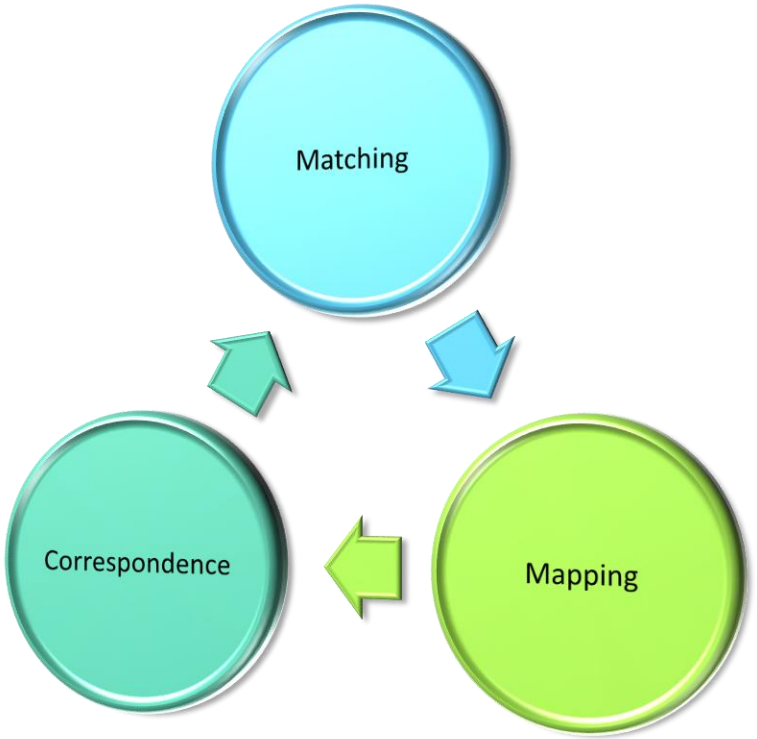


Specific/differentiated contribution! – OUTPUT vs. PROCESS?

how about "*Effective schema integration of XML sources*" ?

Title vs. Ingredients





Doing “research”: to propose a validated solution to an interesting unsolved technical problem

2+ years...
to understand the keywords

Abstract vs. Ingredients

Schema integration aims to create a mediated schema as a unified representation of existing heterogeneous sources sharing a common application domain. These sources have been increasingly written in XML due to its versatility and expressive power. Unfortunately, these sources often use different elements and structures to express the same concepts and relations, thus causing substantial semantic and structural conflicts. Such a challenge impedes the creation of high-quality mediated schemas and has not been adequately addressed by existing integration methods.

In this paper, we propose a novel method, named XINTOR, for automating the integration of heterogeneous schemas. Given a set of XML sources and a set of correspondences between the source schemas, our method aims to create a complete and minimal mediated schema: it completely captures all of the concepts and relations in the sources without duplication, provided that the concepts do not overlap.

Our contributions are fourfold. First, we resolve structural conflicts inherent in the source schemas. Second, we introduce a new statistics-based measure, called path cohesion, for selecting concepts and relations to be a part of the mediated schema. The path cohesion is statistically computed based on multiple path quality dimensions such as average path length and path frequency. Third, we resolve semantic conflicts by augmenting the semantics of similar concepts with context-dependent information. Finally, we propose a novel double-layered mediated schema to retain a wider range of concepts and relations than existing mediated schemas, which are at best either complete or minimal, but not both.

Performed on both real and synthetic datasets, our experimental results show that XINTOR outperforms existing methods with respect to (*i*) the mediated-schema quality using precision, recall, F-measure, and schema minimality; and (*ii*) the execution performance based on execution time and scale-up performance.

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Abstract vs. Ingredients

Schema integration aims to create a mediated schema as a unified representation of existing **heterogeneous** sources sharing a common application domain. These sources have been **increasingly** written in **XML** due to its versatility and expressive power. **Unfortunately**, these sources often use different elements and structures to express the same concepts and relations, thus causing **substantial semantic and structural conflicts**. Such a challenge **impedes** the creation of high-quality mediated schemas and has **not been adequately addressed** by **existing integration methods**.

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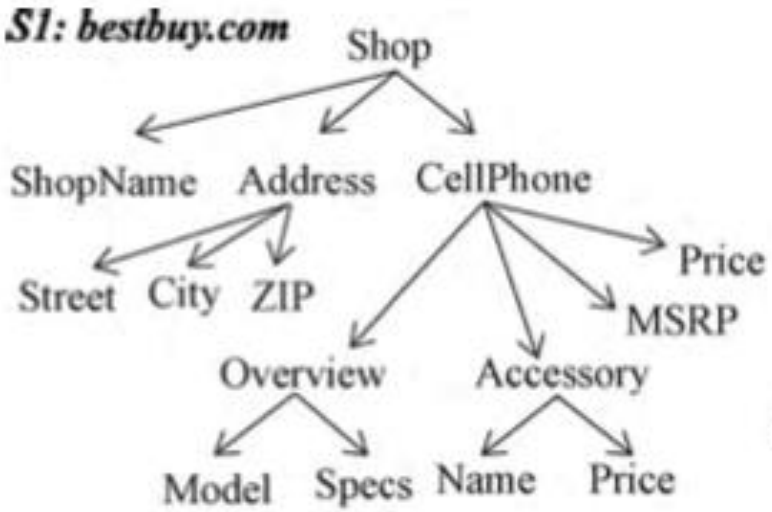
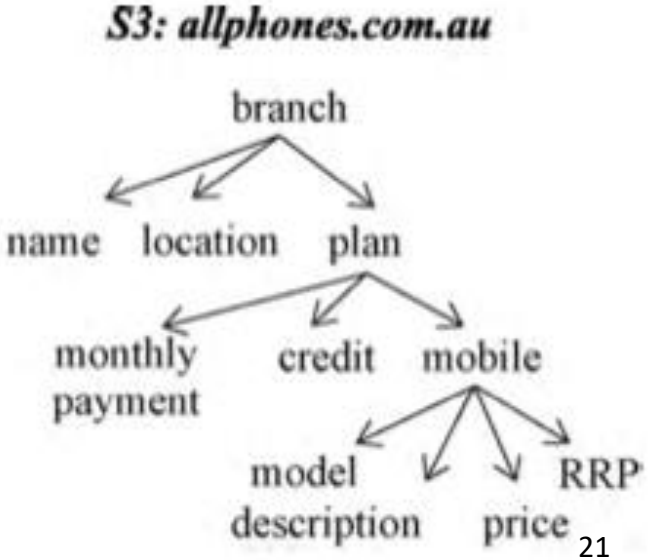
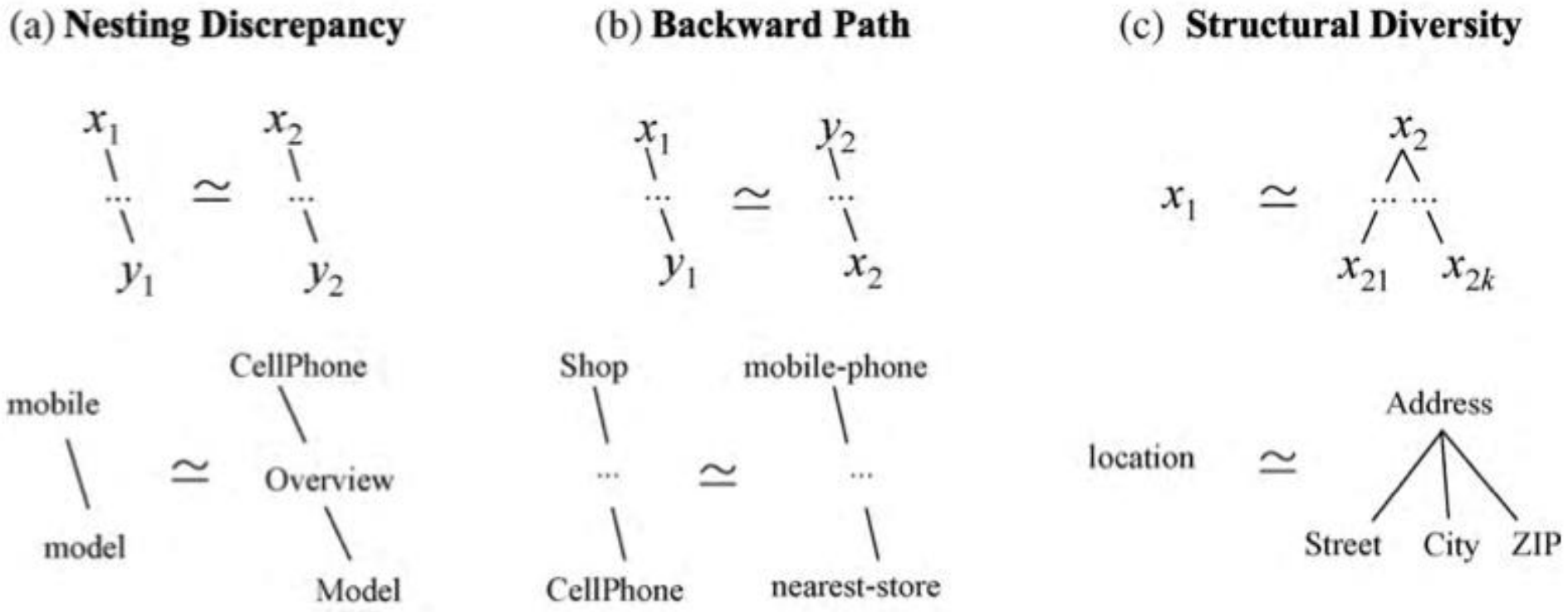
Technical Problem from Input: heterogeneous XML sources





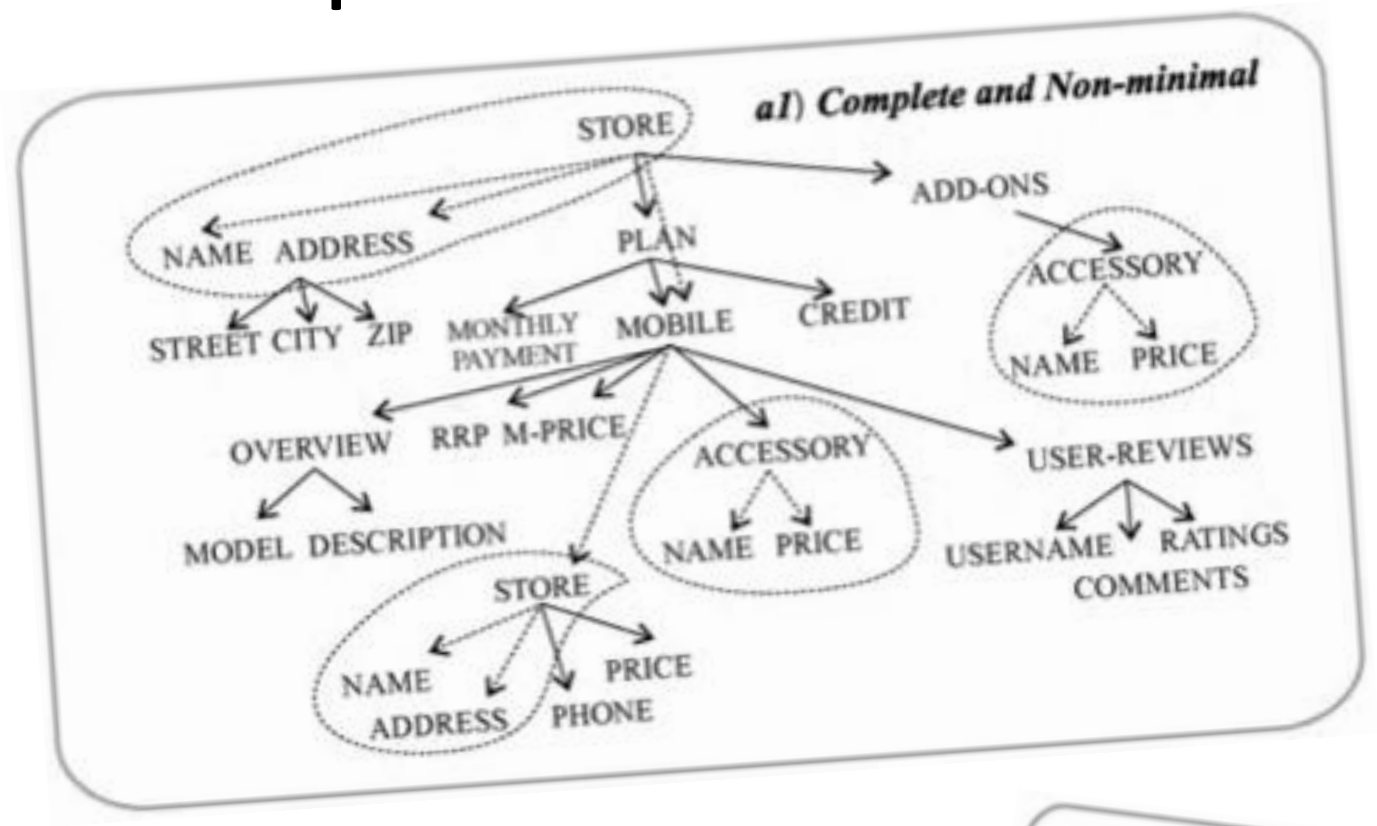
Doing "research": to propose a validated solution to an interesting unsolved technical problem

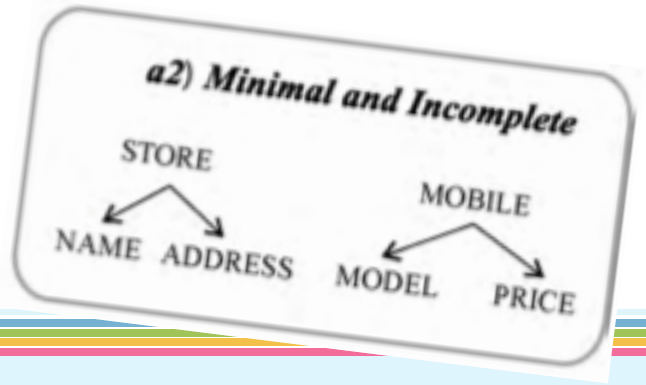
Technical Problem from Input: Specific Sub-problems



Doing "research": to propose a validated solution to an interesting unsolved technical problem

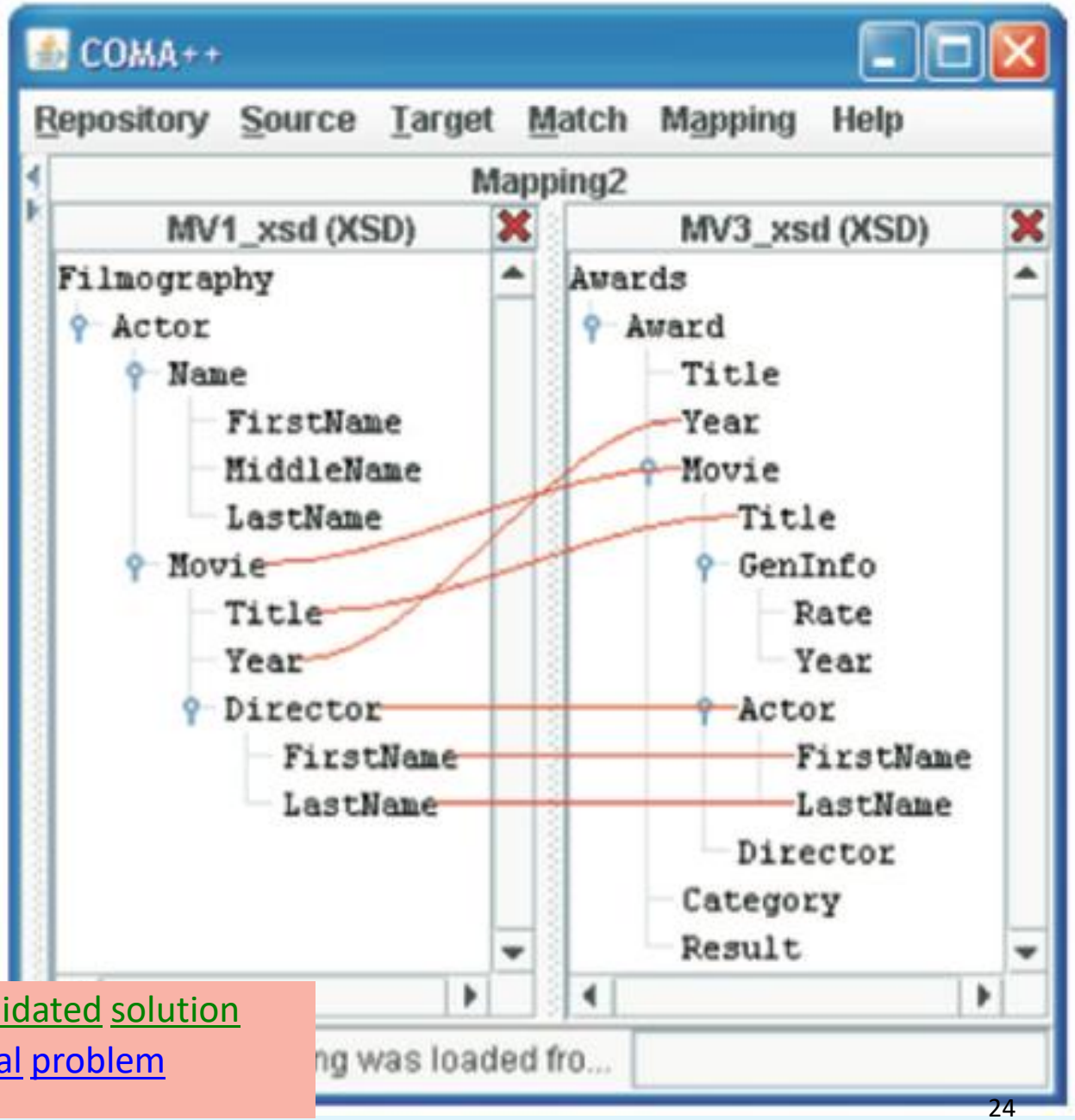
Technical Problem from Output: Specific Sub-Problems





Doing "research": to propose a validated solution to an interesting unsolved technical problem

Unsolved Problem: Existing Work



Doing "research": to propose a validated solution to an interesting unsolved technical problem

Proposed Solution

INPUT: unsolved technical problem

① PROCESS

a) algorithms, process, framework, methodology, architecture, model, equations, formulas, metrics (eval)

b) internal data structures, representation, model

② OUTPUT

data structures, representation, model

Doing "research": to propose a validated solution to an interesting unsolved technical problem

Proposed Solution

① PROCESS

a) algorithms, process, framework, methodology, architecture, model, equations, formulas, metrics (eval)

Listing 1 Mediated schema creation algorithms.

enumCandidates(CS: set of context-independent concepts)

1 *Cands* ← {} /* Initialize set of candidate clusters to return */
2 **for each** concept *X* in *CS* **loop**
3 *P* ← {} /* Initialize a cluster of resolved paths */
4 **for each** concept *Y* in *CS* such that *X* ≠ *Y* **loop**
5 *SSet* = set of common sources {S_i} shared by *X* and *Y*

Definition 2 (Path cohesion). The cohesion of a relation *x*//*y*, denoted by *coh*(*x*//*y*), is defined as a weighted sum of statistics-based path quality functions $F_i(x//y)$:

$$coh(x//y) = \sum_{i=1}^{|\mathcal{F}|} w_i \times F_i(x//y)$$

here $0 \le w_i \le 1$ and
The weight w_i reflec
to the path *x*//*y* in *D*. In

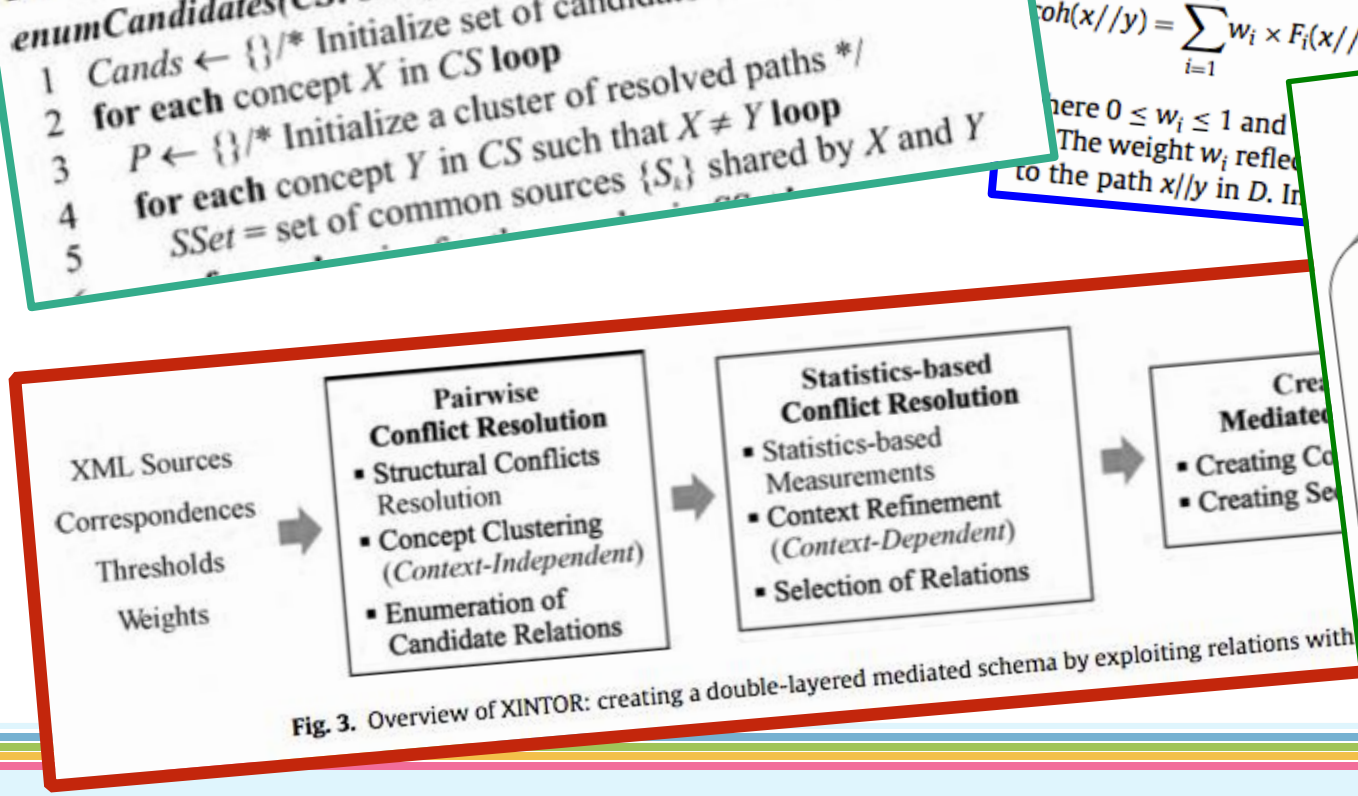
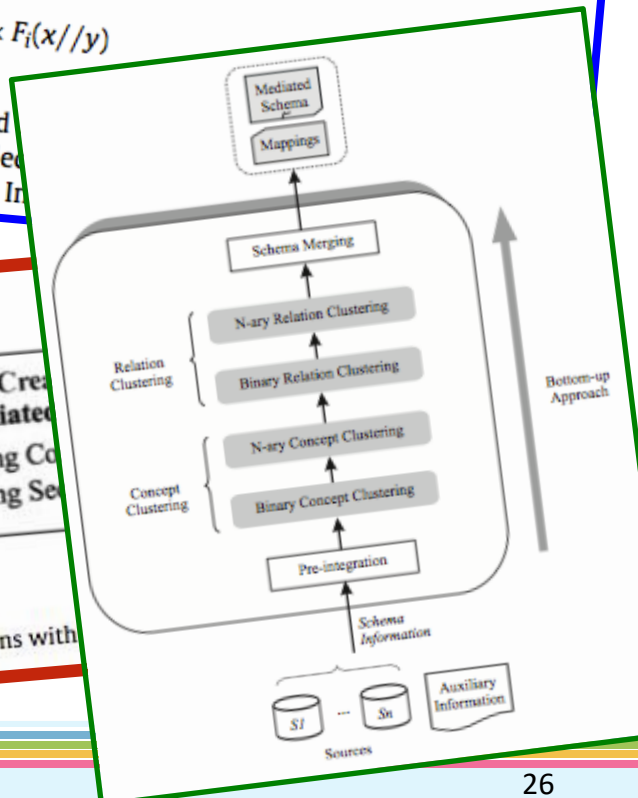


Fig. 3. Overview of XINTOR: creating a double-layered mediated schema by exploiting relations with

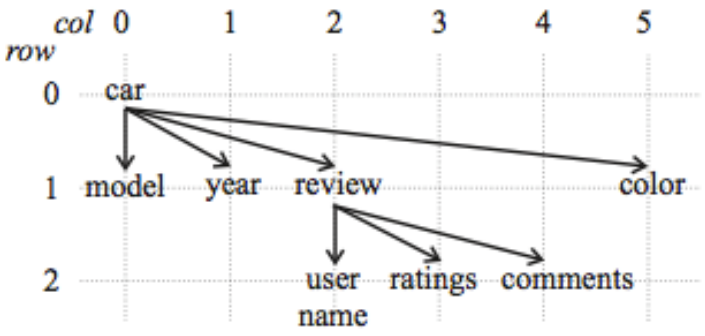


Proposed Solution

① PROCESS

b) internal data structures, representation, model

Graphical Tree-Grid



Node:
node*(label)* =<*lid, row, col, width*>

Tree-Grid:
$T = \{$
node(*car*) = <0, 0, 0, 6>
node(*model*) = <1, 1, 0, 0>
node(*year*) = <2, 1, 1, 0>
node(*review*) = <3, 1, 2, 3>
node(*username*) = <4, 2, 2, 0>
node(*ratings*) = <5, 2, 3, 0>
node(*comments*) = <6, 2, 4, 0>
node(*color*) = <7, 1, 5, 0>
};

Label Table

lid	Label	cid	Concept
3	*review*	5	REVIEW
7	*color*	10	COLOR
4	*username*	8	NAME
8	*auto*	6	CAR
6	*comments*	4	COMMENTS
9	*seller*	3	SELLER
5	*ratings*	2	RATINGS
0	*car*	6	CAR
2	*year*	7	YEAR
1	*model*	9	MODEL
10	*dealer*	3	SELLER
...	...	...	...

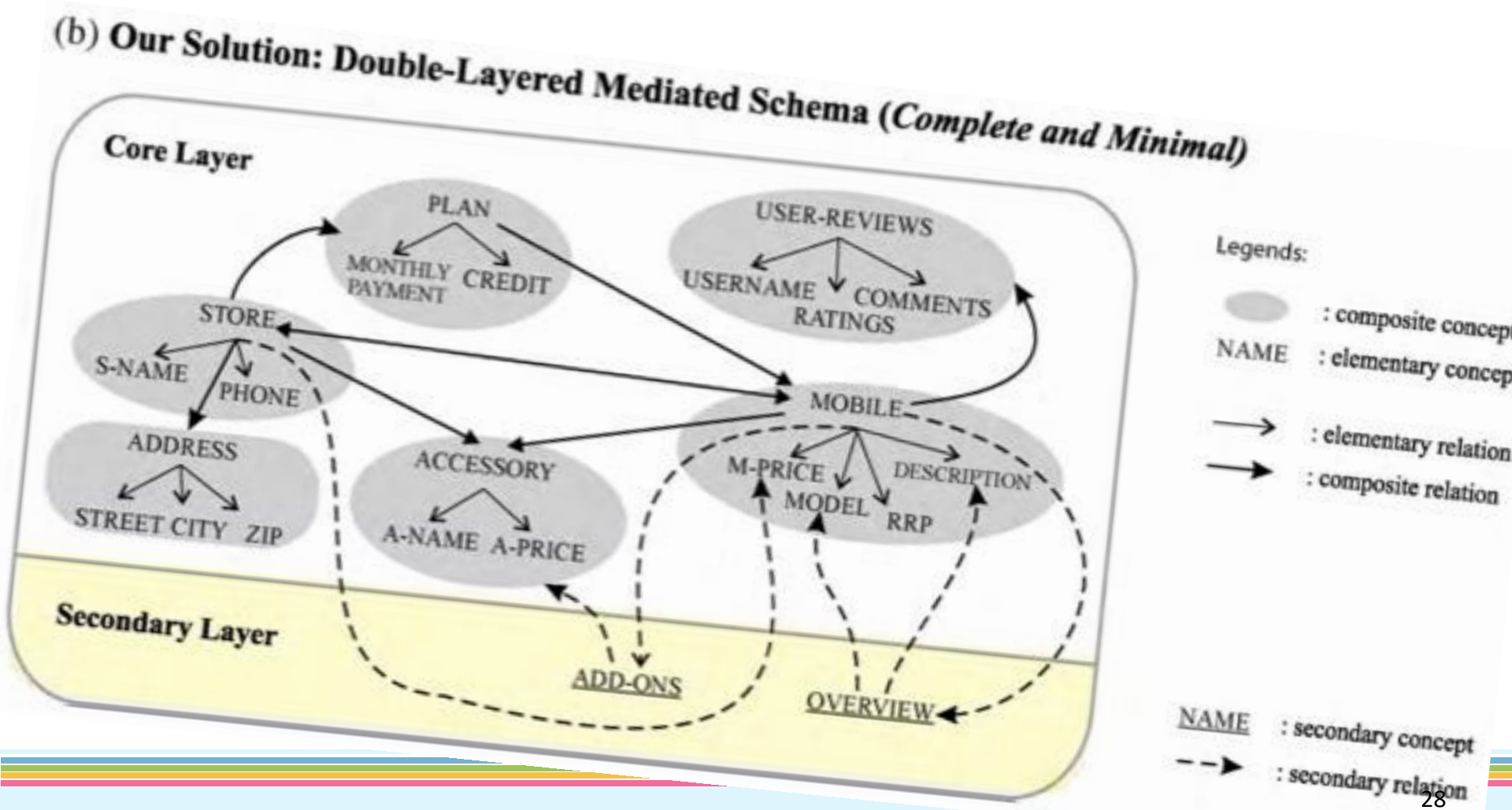
Concepts generated from concept clustering

Figure 4.5: A Tree-Grid example

Proposed Solution

② OUTPUT

data structures, representation, model



"Evaluation": Validated Solution

- **Datasets:** real v. synthetic v. benchmarking
- **Datasets Characteristics:** domain, size

Table 1
Experimental datasets.

Characteristics	OAGIS	MOVIES	BOOKS
No. of schema trees	108	1312	176
No. of distinct labels	925	87	19
Total no. of elements	218,762	64,706	1320
Schema size			
Smallest	99	14	5
Largest	11,972	91	14
Average	2025.57	49.32	7.59

Doing "research": to propose a validated solution to an interesting unsolved technical problem

"Evaluation": Validated Solution

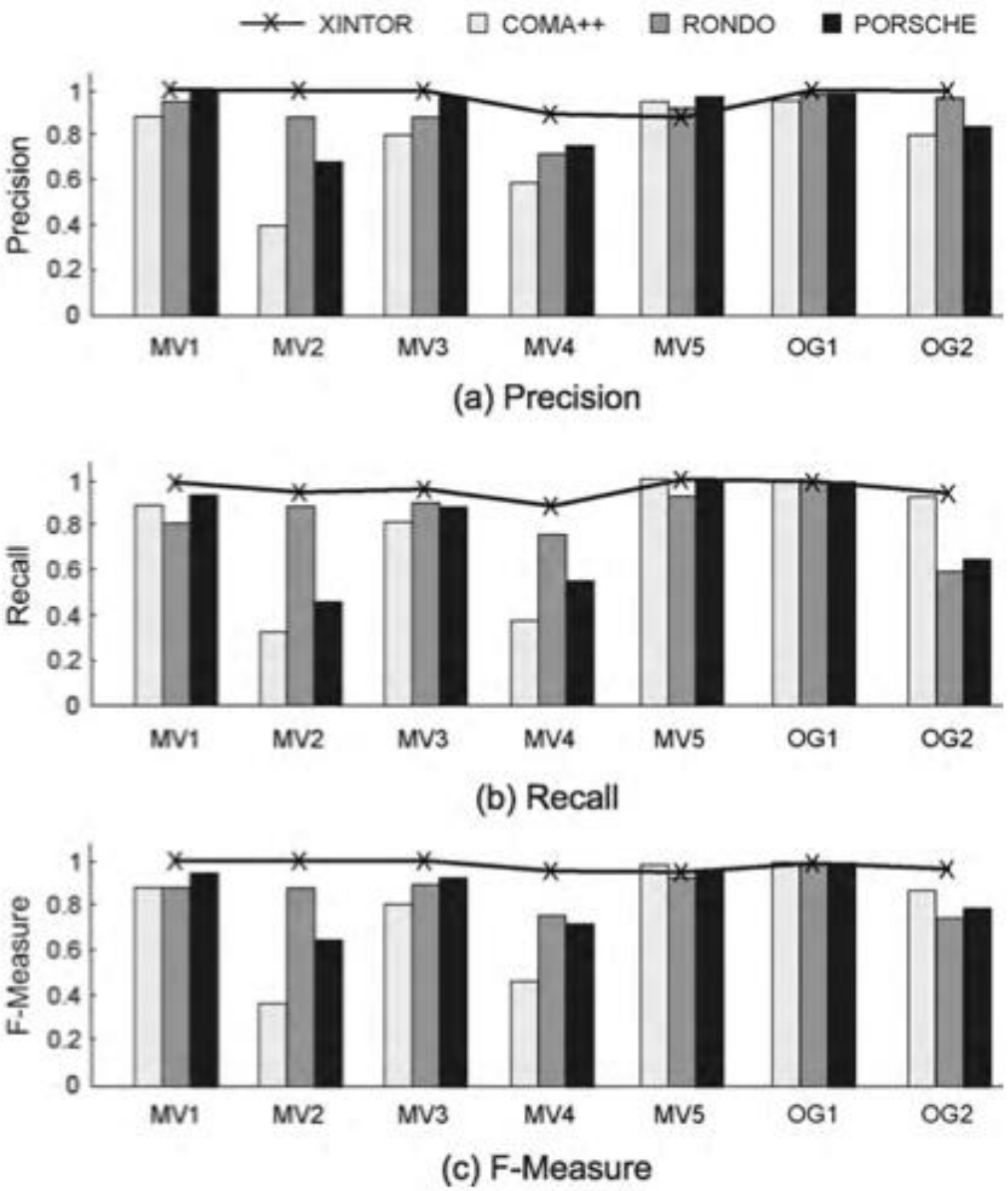
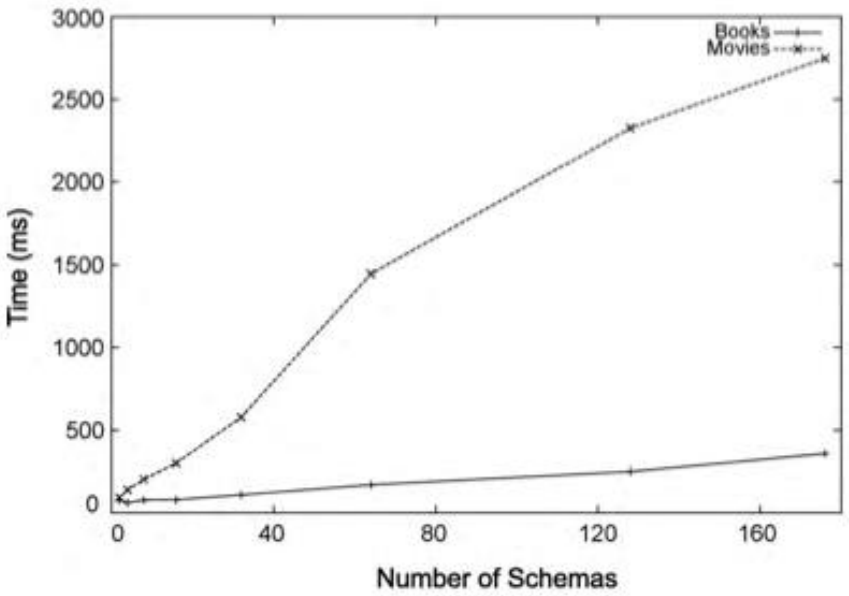


Fig. 7. Precision, recall and F-measure of XINTOR, COMA++, RONDO, and PORSCHE

Effectiveness

vs.

Efficiency



(a) **Scale-up Performance on MOVIES/BOOKS**

“Conclusion”

- Conclusion = Summary + Future work
- Summary
  - Highlight key points
  - Re-emphasize your contributions
- Future work
  - Limitations (scope: what NOT addressed)
  - Further research opportunities

Research Ingredients: Summary

- Writing
- Oral

- Experiments
- Proof-of-concept
- Math proof
- Case studies
- Comparative analysis
- Qualitative/quantitative

- Process
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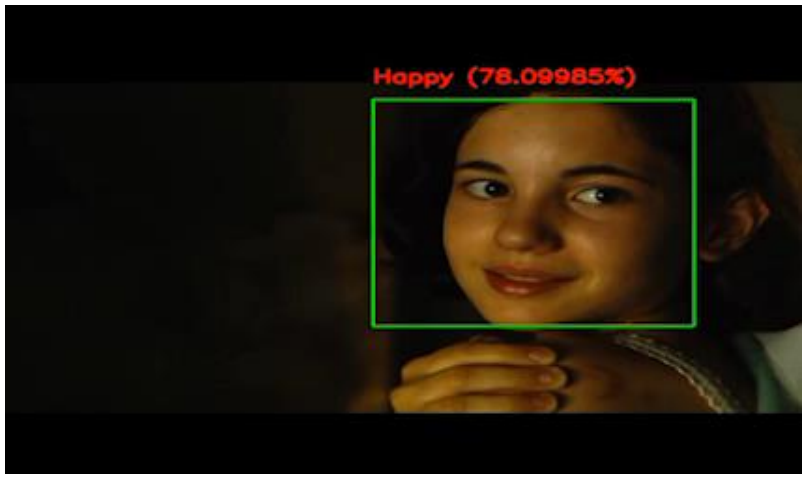
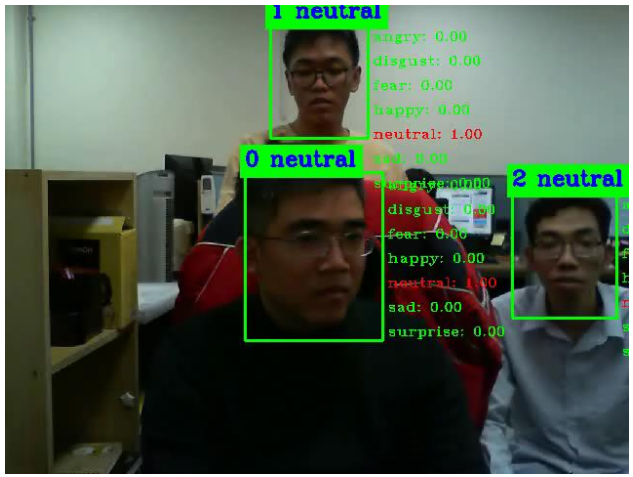
MY RESEARCH APPROACHES

EMOTION RECOGNITION PROBLEM

- **Our problem:**
  - Given ***a short video clip***
  - Detect ***emotion recognition in-the-wild*** condition ***using facial expression***
  - Product ***seven basic emotions*** (Angry, Disgust, Fear, Happy, Sad, Surprise)





7 emotions:
- ❑ Angry
- ❑ Disgust
- ❑ Fear
- ❑ Happy
- ❑ Neutral
- ❑ Sad
- ❑ Surprise

(a) Movie (b) Application (c) Output

Emotion Recognition in (a) Movie and (b) Application to product (c) seven basic emotions

CHALLENGES IN EMOTION RECOGNITION

- **Challenges**:
  - ***Complex property*** of human emotional expressions (change over time in terms of such factors as physiology and language)
  - Emotions ***cannot be interpreted without context***.

(a) Emotion without context

(b) Emotion with context

Emotion affected by context (a) most people agree that the ***left image expresses sadness***, while the ***right image is a clear display of anger*** (b) adding context to the facial expressions, most observers agree that the people shown are ***experiencing a joyful event***.

[1] A. M. Martinez, "***Context may reveal how you feel***," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 116, no. 15, pp. 7169–7171, 2019, doi: 10.1073/pnas.1902661116. (Link)

CONTEXT-AWARE IN EMOTION RECOGNITION

Emotion Context[1]

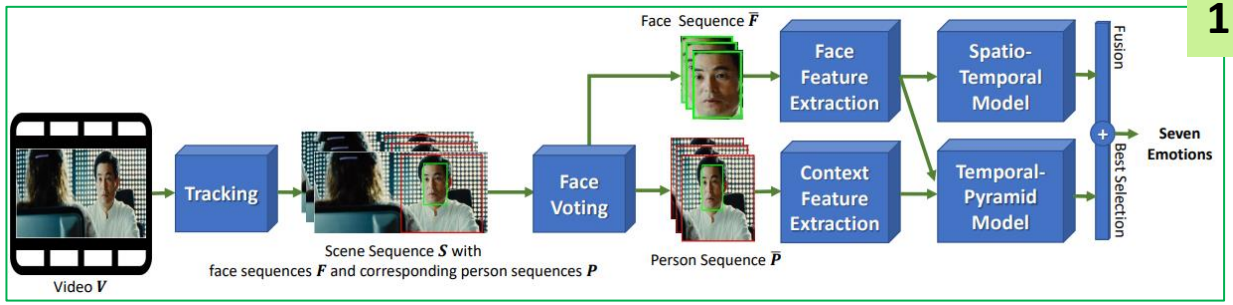
3D Emotion[2]

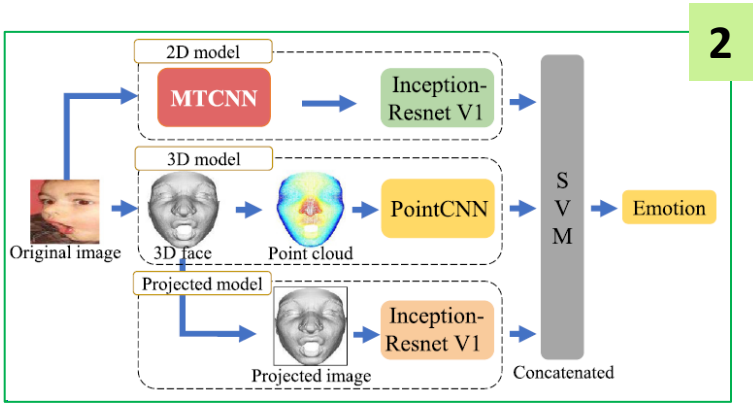
Emotion

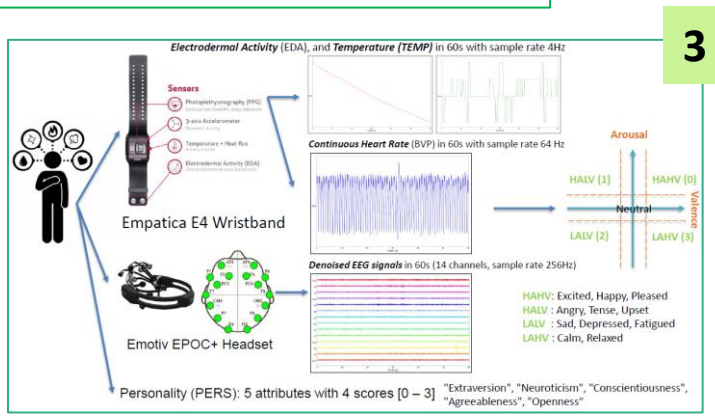
Emotion Signal[3]

Current

Emotion Healthcare







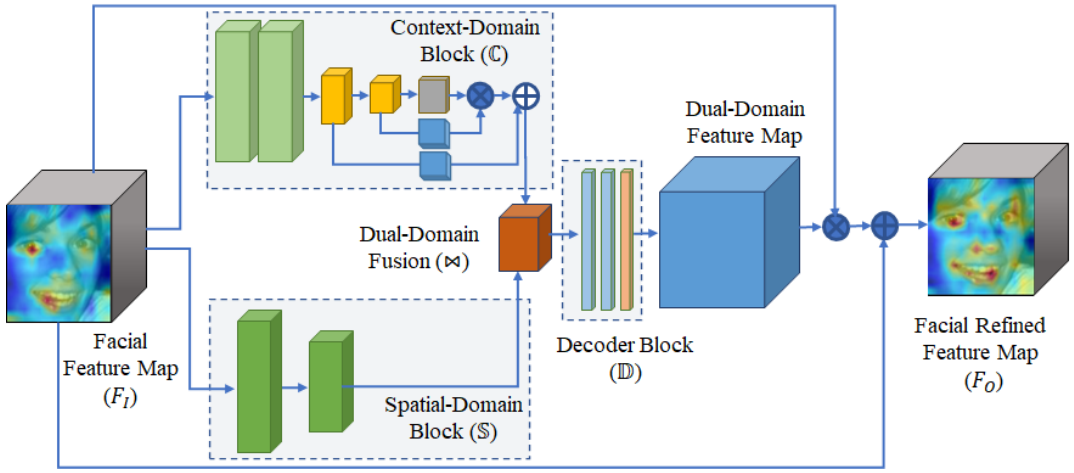
[1] N.-T. Do, S.-H. Kim, H.-J. Yang, G.-S. Lee, and S. Yeom, ***"Context-Aware Emotion Recognition in the Wild Using Spatio-Temporal and Temporal-Pyramid Models***," *Sensors*, vol. 21, no. 7, p. 2344, Mar. 2021, doi: 10.3390/s21072344.

[2] T. Son Ly, D. Nhu Tai, *et al.*, "***A novel 2D and 3D multimodal approach for in-the-wild facial expression recognition***," *Image Vis. Comput.*, vol. 92, p. 103817, 2019, doi: 10.1016/j.imavis.2019.10.003.

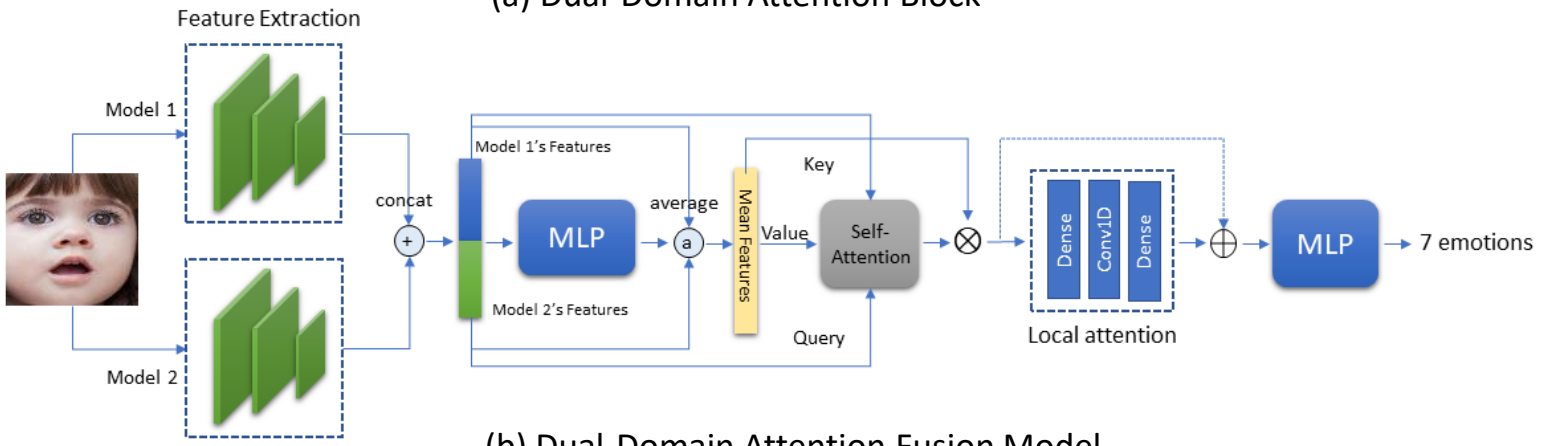
[3] KERC21 Winner

DUAL-DOMAIN IN CONTEXT-AWARE

$$F_O = \left(1 + \mathbb{D}\left(\mathbb{S}(F_I) \bowtie \mathbb{C}(F_I)\right)\right) \otimes F_I$$



(a) Dual-Domain Attention Block



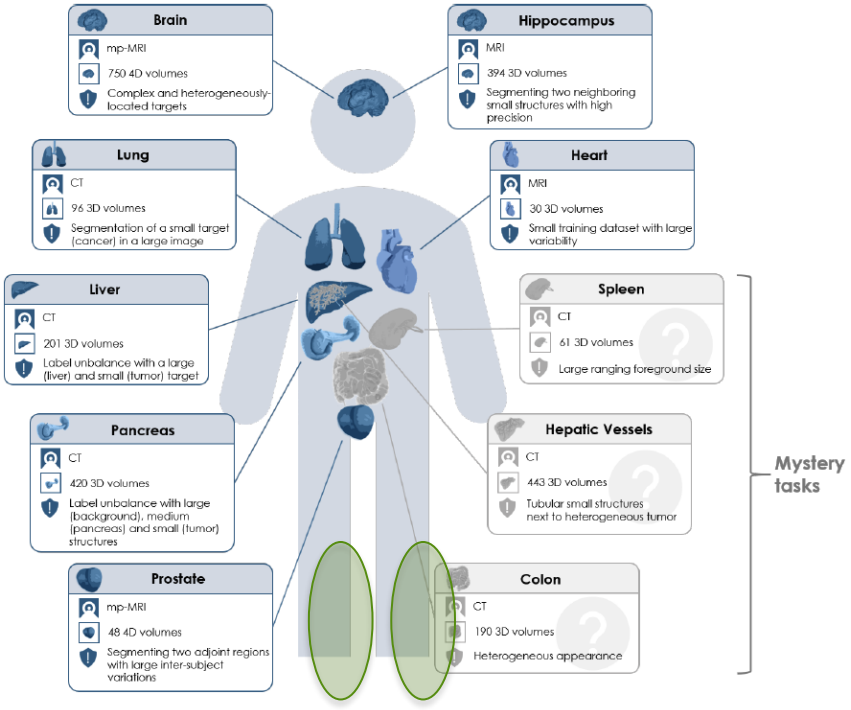
(b) Dual-Domain Attention Fusion Model

[1] [Submitting] Nhu-Tai Do, Minh-Hai Tran, Tram-Tran Nguyen Quynh, Soo-Hyung Kim "DDA: Dual Domain Attention For Facial Emotion Recognition," ICIP2023 - International Conference on Image Processing 2023.

[2] Minh-Hai Tran, Tran-Tram Nguyen Quynh, Nhu-Tai Do, Soo-Hyung Kim. "Local and Global Attention Fusion network for Facial Expression Recognition," ASK 2023: Annual Spring Conference of KIPS, pp. 493-495, 2023.

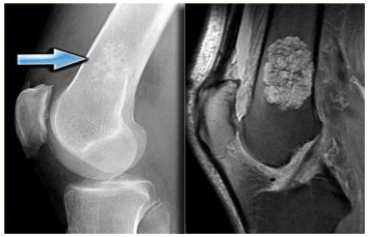
MEDICAL TUMOR DETECTION PROBLEM

- Knee Bone Tumor Detection

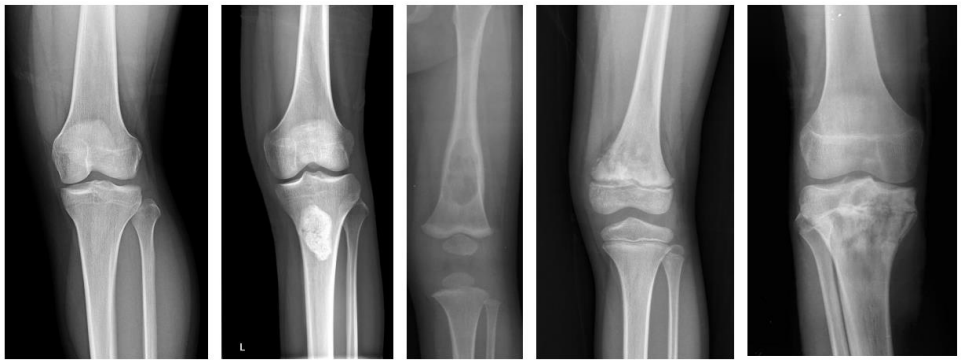


Our Interested Region

XRay MRI

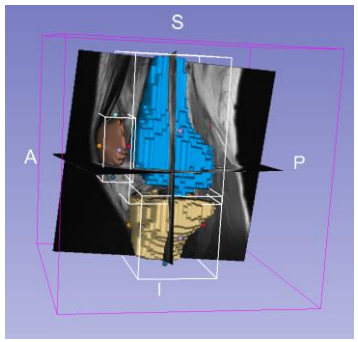


Data from CNUH (Chonnam National University Hospital)

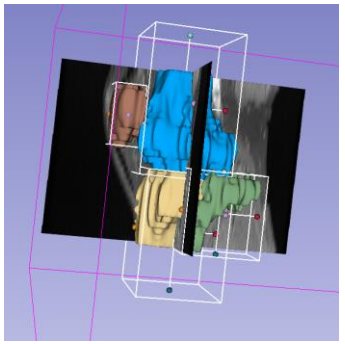


Normal knee bone | Benign tumor Proximal Tibia | Benign tumor Distal Femur | Malignant tumor Distal Femur | Malignant tumor Proximal Tibia

Knee Bone Tumor Detection in X-Ray



Normal Study



Tumor Study
(Benign + Malignant)

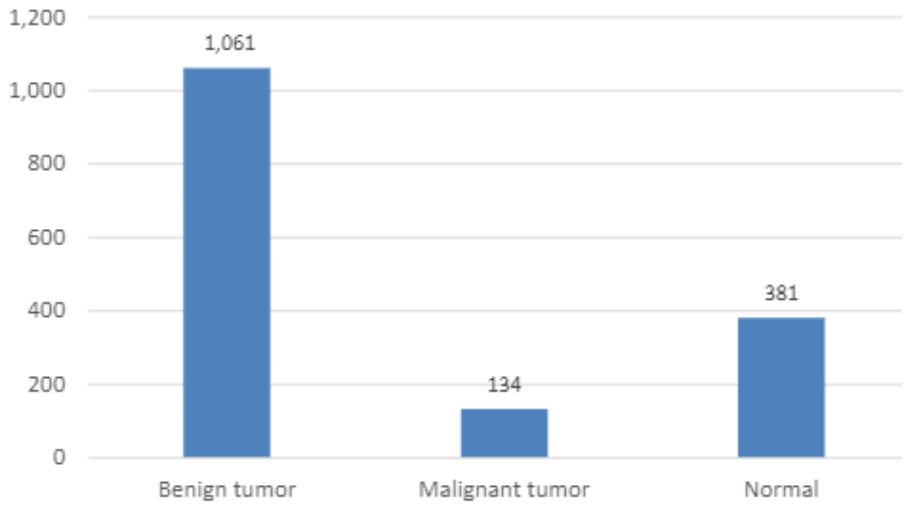
[1] Do, Nhu-Tai, Sung-Taek Jung, and Soo-Hyung Kim. "Abstract PO-024: Boosting up knee bone tumor detection from radiology and magnetic resonance imaging by using deep learning techniques." *Clinical Cancer Research* 27, no. 5_Supplement (2021): PO-024.

DATA AND CHALLENGES IN X-RAY KNEE TUMOR DETECTION

(a) Many tumor regions

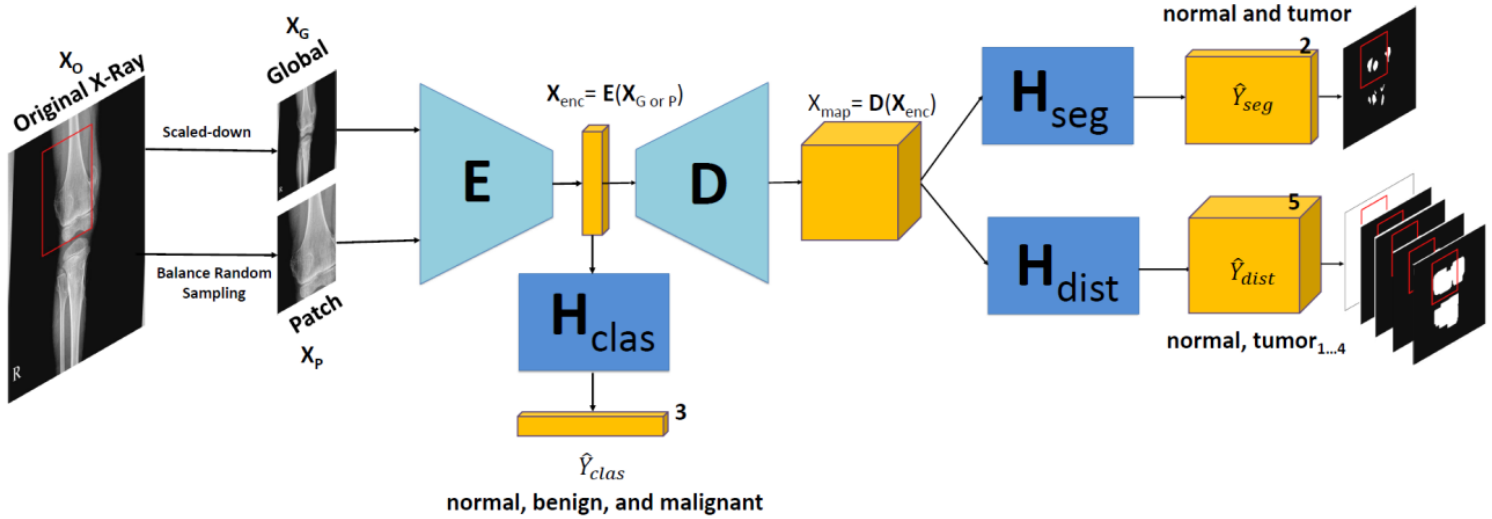
(b) Small tumor region

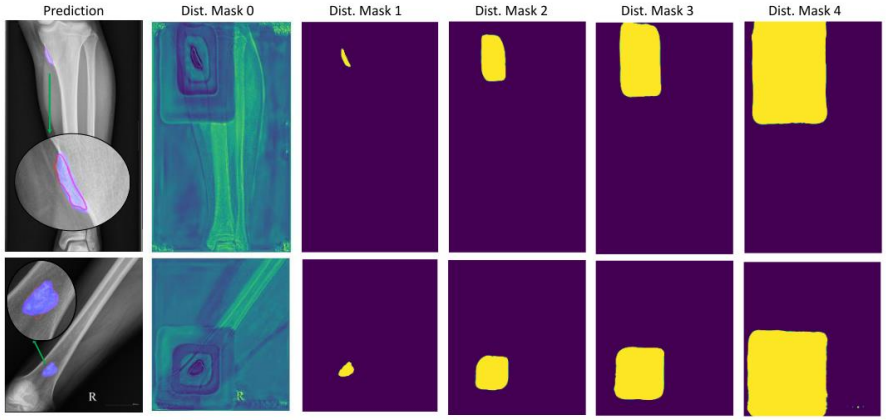
(c) Large tumor region



CONTEXT-AWARE IN X-RAY KNEE TUMOR DETECTION

- Proposed method



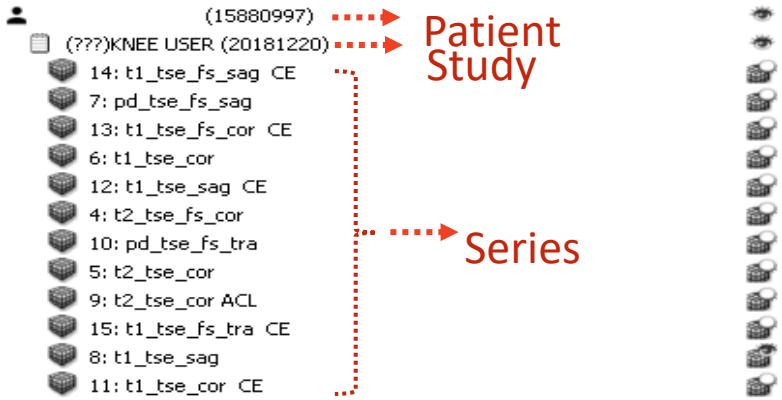


No	Model	*Accuracy*	*MeanIoU*
1	MobileNet V2 [26]	93.60%	
2	VGG16 [27]	90.50%	
3	RSS-BW with VGG16-B [20]	86.93%	
4	U-Net [13]		38.30%
5	Seg-Net [22]		57.10%
6	Seg-Unet [28]		69.50%
7	Seg-Unet with Clas. and Seg.[21]	95.30%	77.28%
8	Seg-Unet with Clas., Seg., and distance features [29]	97.16%	78.83%
9	Our proposed method (Patch)	77.28%	66.53%
	Our proposed method (Global)	94.32%	78.78%
	Our proposed method (Gloal+Patch)	**97.48%**	**82.23%**

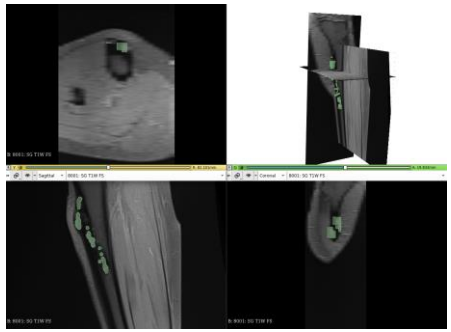
[1] N.-T. T. Do, S.-T. T. Jung, H.-J. J. Yang, and S.-H. H. Kim, "Multi-level seg-unet model with global and patch-based x-ray images for knee bone tumor detection," *Diagnostics*, vol. 11, no. 4, pp. 1–15, 2021, doi: 10.3390/diagnostics11040691.

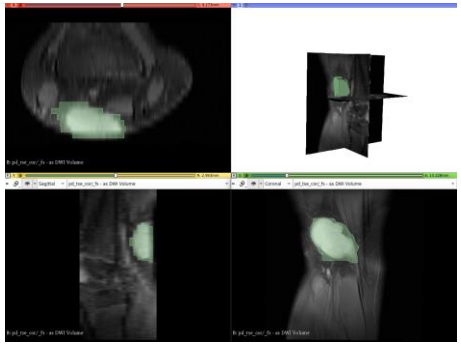
CHALLENGES IN MRI KNEE TUMOR DETECTION

Multi-View in a diagnosis

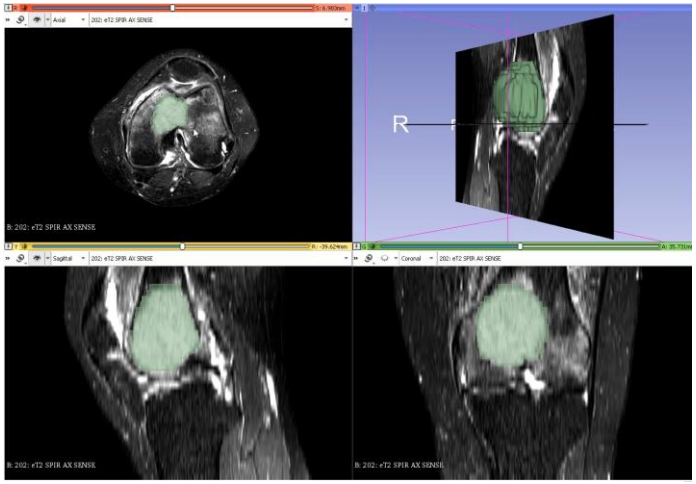


MRI Sequences: T1, T2, PD, GD
Other attributes: ACL, FS, TSE
Axials: Cor, Axial, Sagittal

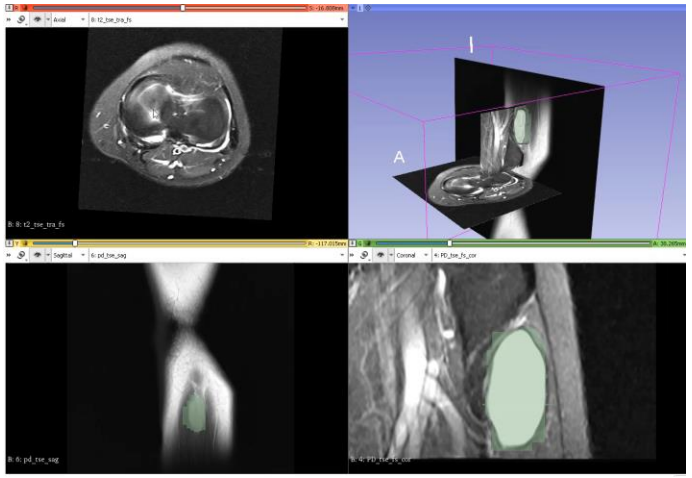




Diversity in every views

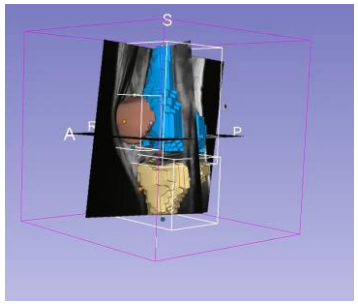


Small tumors

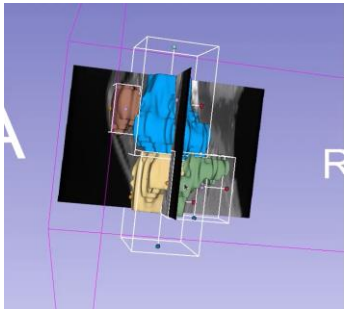


DATASET IN MRI KNEE TUMOR DETECTION

	Category Name	Validation	Test
1	Normal	31	5
2	Beginin	27	26
3	Malignant	8	7
	Total	66	38



Normal Study

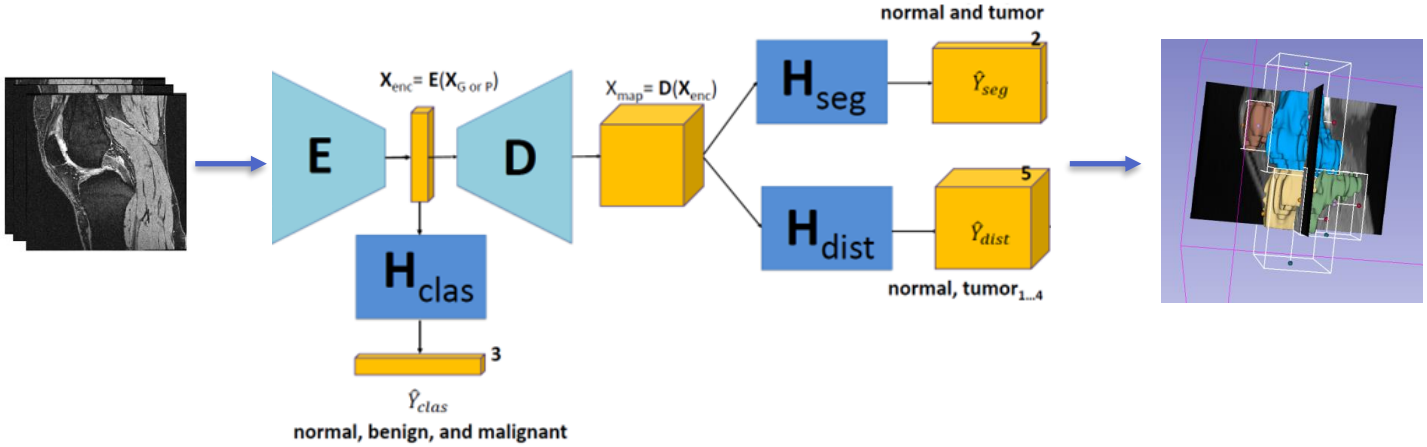


Tumor Study

- Including **bounding-box** and **segmentation mask** regions for **tumor**, **femur**, **tibia**, **patella**
- Validation MRI Attributes:

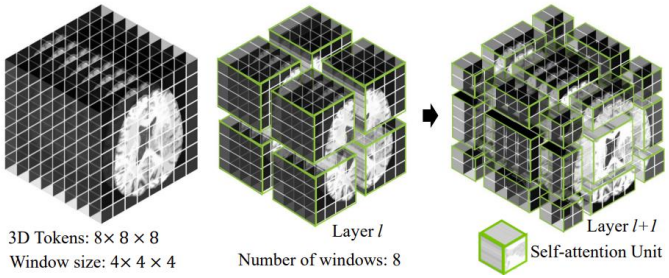
Label	Study	Series	ax				cor				sag			
			t1	t2	pd	gd	t1	t2	pd	gd	t1	t2	pd	gd
Normal	31	185	30	31			1	1	61			1	60	
Begnin	27	229	32	15	9	10	27	17	27	10	26	19	27	10
Malignant	8	71	7	9		7	8	7	4	6	6	5	5	7
Total	66	485	**69**	55	9	17	36	25	**92**	16	32	24	**92**	17

CONTEXT-AWARE IN MRI KNEE TUMOR DETECTION



Backbone: Swin-Unet[1]

– Contributions:
  - MRI CNUH Dataset for Knee Tumor
  - Distance3D Transform on Global – Local Context

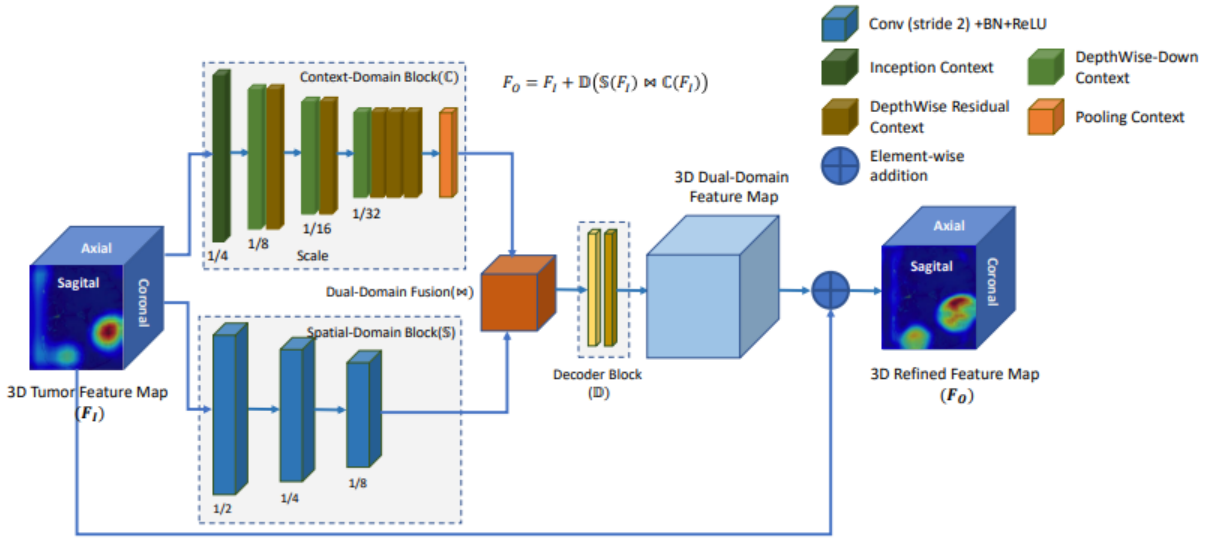


Global-Local Context

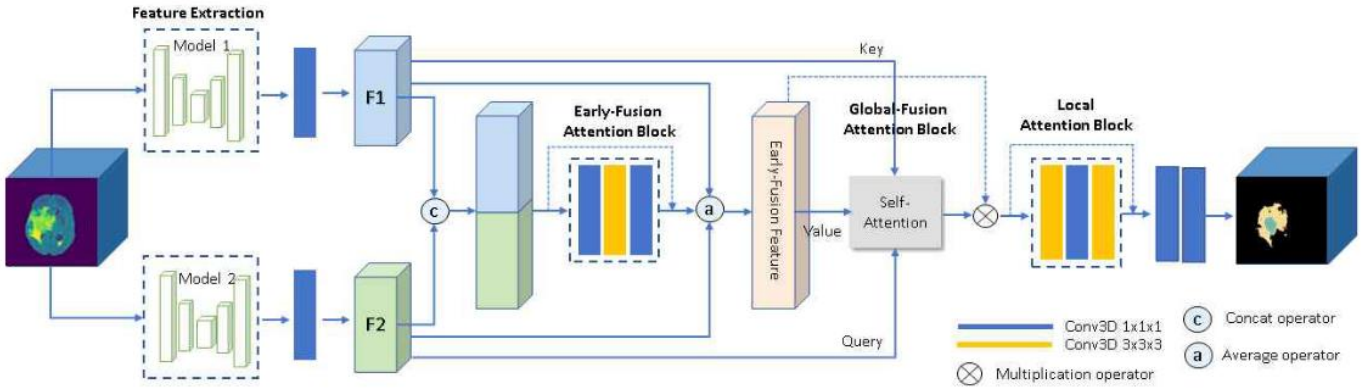
Method	Dice Score
3D Unet [1]	63%
UNetTrans	64%
Our method	**64.5%**

[1] Cao, Hu, Yueyue Wang, Joy Chen, Dongsheng Jiang, Xiaopeng Zhang, Qi Tian, and Manning Wang. "Swin-unet: Unet-like pure transformer for medical image segmentation." *arXiv preprint arXiv:2105.05537* (2021).

3D DUAL-DOMAIN IN CONTEXT-AWARE



(a) 3D Dual-Domain Attention Block

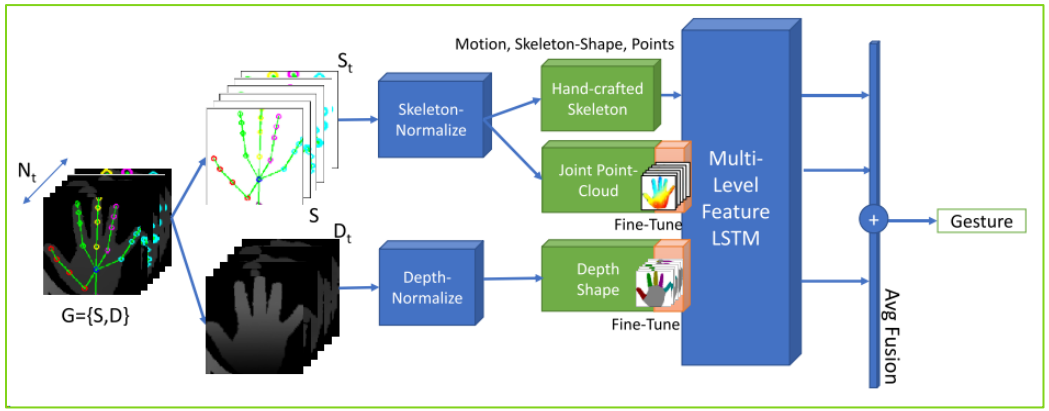


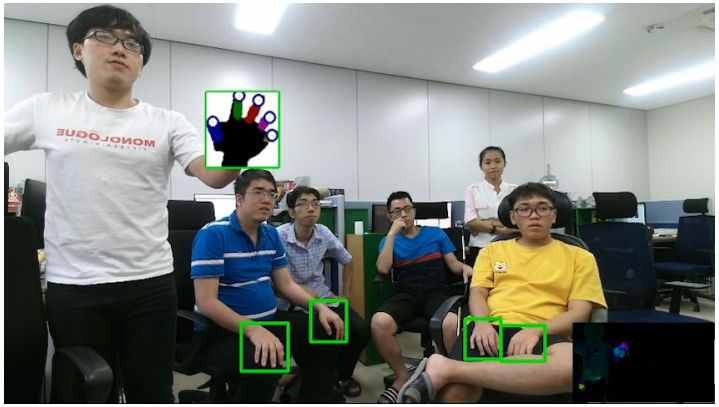
(b) 3D Dual-Domain Attention Fusion Model

[1] Hoang-Son Vo-Thanh, Tram-Tran Nguyen-Quynh, Nhu-Tai Do, and Soo-Hyung Kim, "3D Dual-Fusion Attention Network: A fusion attention network for Brain Tumor Segmentation," in ASK 2023 : Annual Spring Conference of KIPS, pp. 496–498, 2023

CONTEXT-AWARE IN HAND GESTURE RECOGNITION

- Hand-shape Features in Gesture





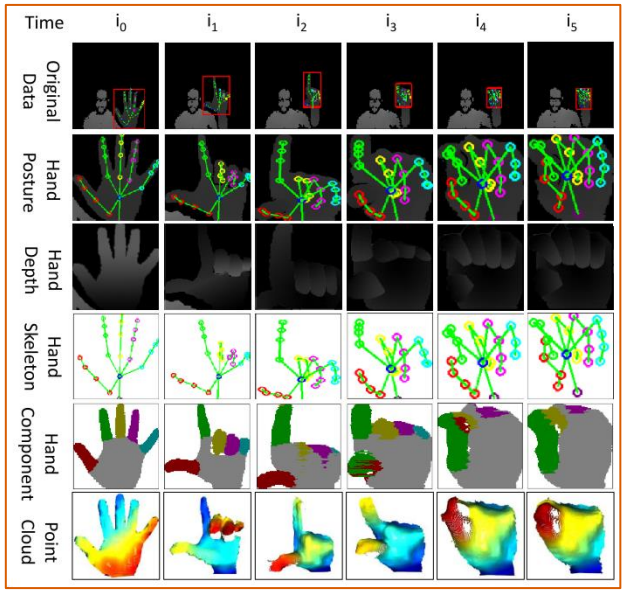


Table 9. Comparison with the related works. SoCJ, Shape of Connected Joints.

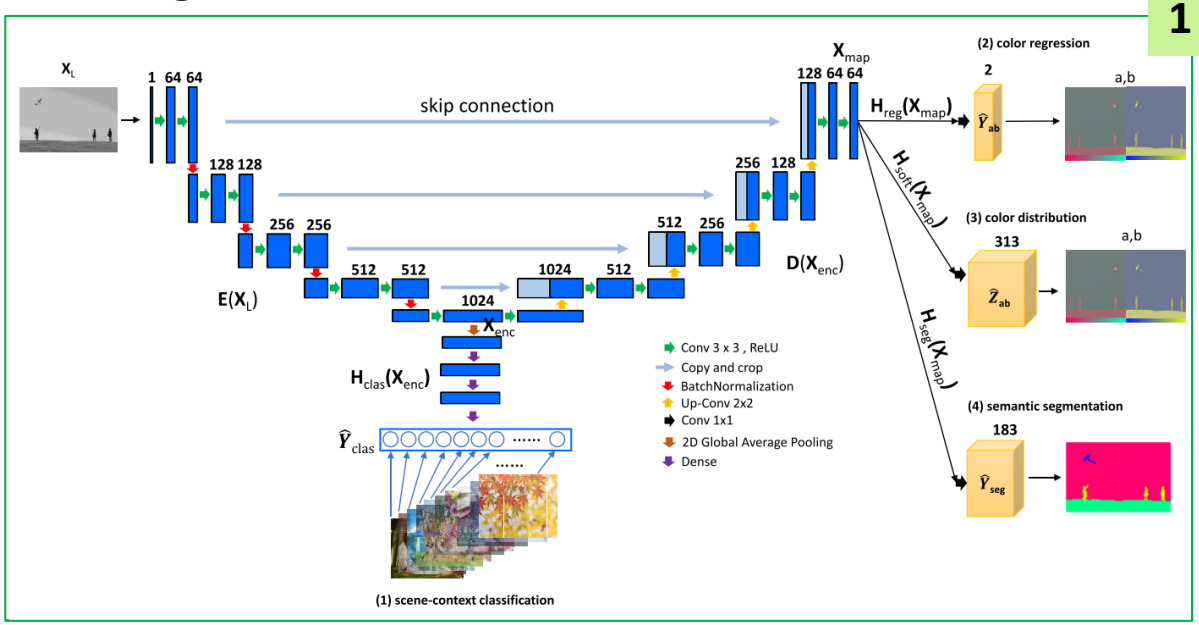
Method	Input	Year	DHG 14	DHG 28
HOG2 [14]	Depth	2013	81.85	76.53
HON4D [22]	Depth	2013	75.53	74.03
MotionManifold [49]	Skeleton	2015	76.61	62
SkeletalQuads [50]	Skeleton	2014	84.5	79.43
Fea-SVM [51]	Skeleton	2014	50.32	30.85
3D Key Frame [52]	Depth	2017	82.9	71.9
MotionFeature+RNN [32]	Skeleton	2017	84.68	80.32
CNN+LSTM [53]	Skeleton	2017	85.6	81.1
STA-Res-TCN [54]	Skeleton	2018	89.2	85
Parallel CNN [55]	Skeleton	2018	91.28	84.35
NIUKF-LSTM [56]	Skeleton	2018	84.92	80.44
ST-GCN [57]	Skeleton	2018	91.2	81.7
SoCJ+HoHD+HoWR [34]	Skeleton	2019	86.86	84.22
DG-STA [58]	Skeleton	2019	91.9	88
GREN [59]	Skeleton	2020	82.29	82.03
Our proposed method	Skeleton		93.69	90.11
Our proposed method	Depth		92.26	88.33
Our proposed method	Overall		96.07	94.4

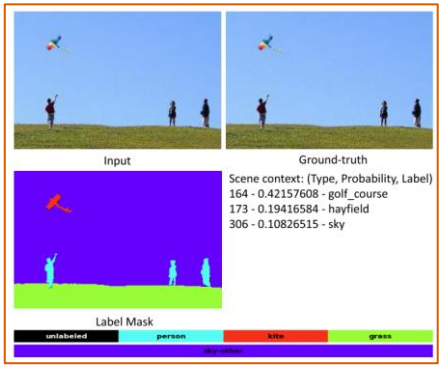
[1] N.-T. N.-T. Do, S.-H. S.-H. Kim, H.-J. H.-J. H.-J. Yang, and G.-S. G.-S. G.-S. Lee, "***Robust Hand Shape Features for Dynamic Hand Gesture Recognition Using Multi-Level Feature LSTM***," *Appl. Sci.*, vol. 10, no. 18, p. 6293, Sep. 2020, doi: 10.3390/app10186293.

CONTEX-AWARE IMAGE COLORIZATION

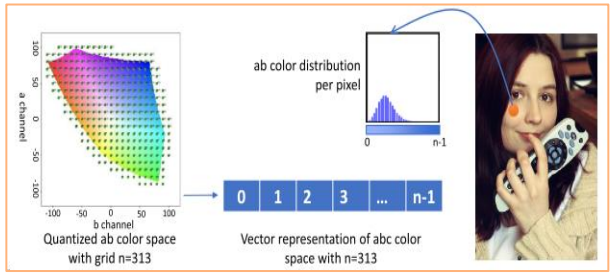
- **Scene-Conext in Image Colorization**

1





Scene-context



Soft-Encoding

[1] T.-T. Nguyen-Quynh *et al.*, "Image colorization using the global scene-context style and pixel-wise semantic segmentation," 2020. doi: 10.3390/appxx010005.

THANK YOU FOR LISTENING