

# Enhancing Spatial Consistency Enforcement By Using DPM-based Object Localizer

Duy-Dinh Le<sup>(1)</sup>, Tiep V. Nguyen<sup>(3)</sup>, Caizhi Zhu<sup>(2)</sup>, Thanh D. Ngo<sup>(3)</sup>,  
Duc M. Nguyen<sup>(4)</sup>, Shin'ichi Satoh<sup>(1)</sup>, Duc A. Duong<sup>(3)</sup>

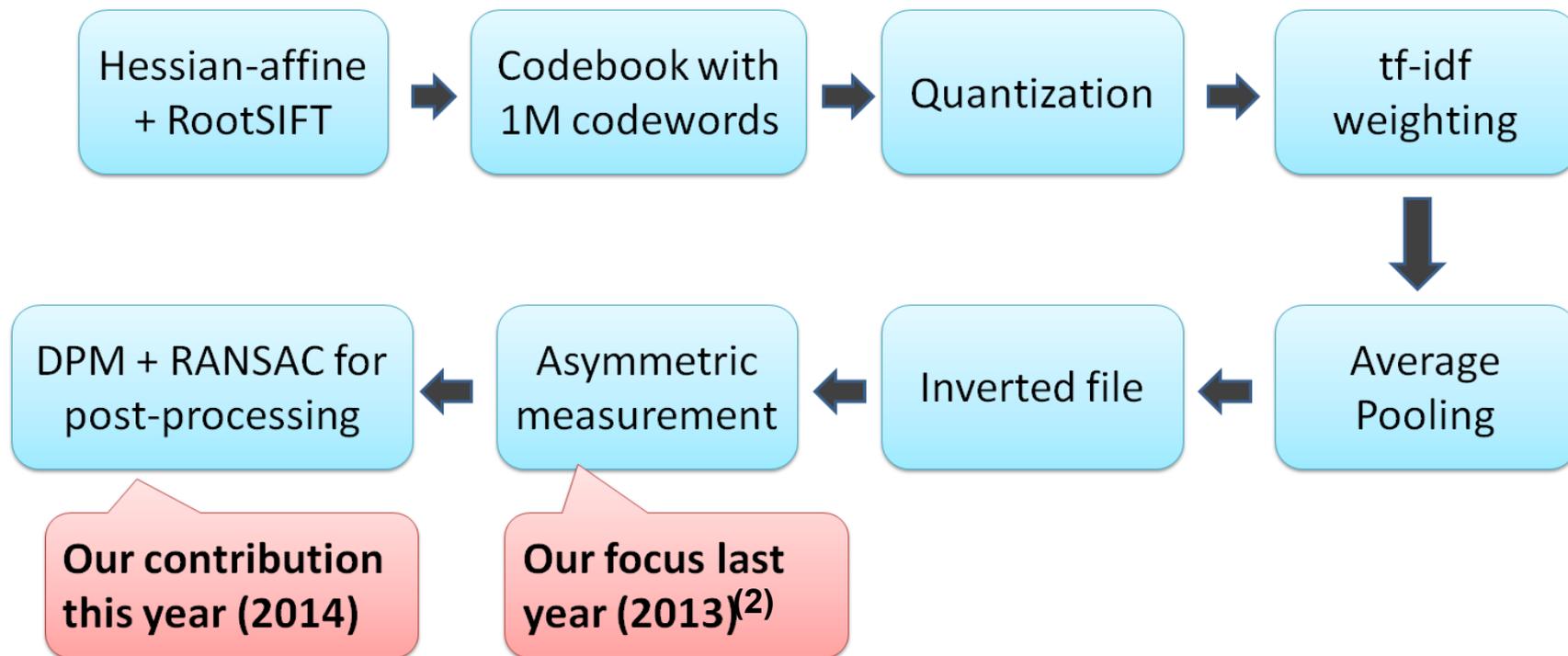
<sup>(1)</sup> National Institute of Informatics, Japan (NII)

<sup>(2)</sup> Nagoya University , Japan (NU)

<sup>(3)</sup> VNU-HCMC - University of Information Technology, Vietnam (UIT-HCM)

<sup>(4)</sup> VNU University of Engineering and Technology, Vietnam (VNU-UET)

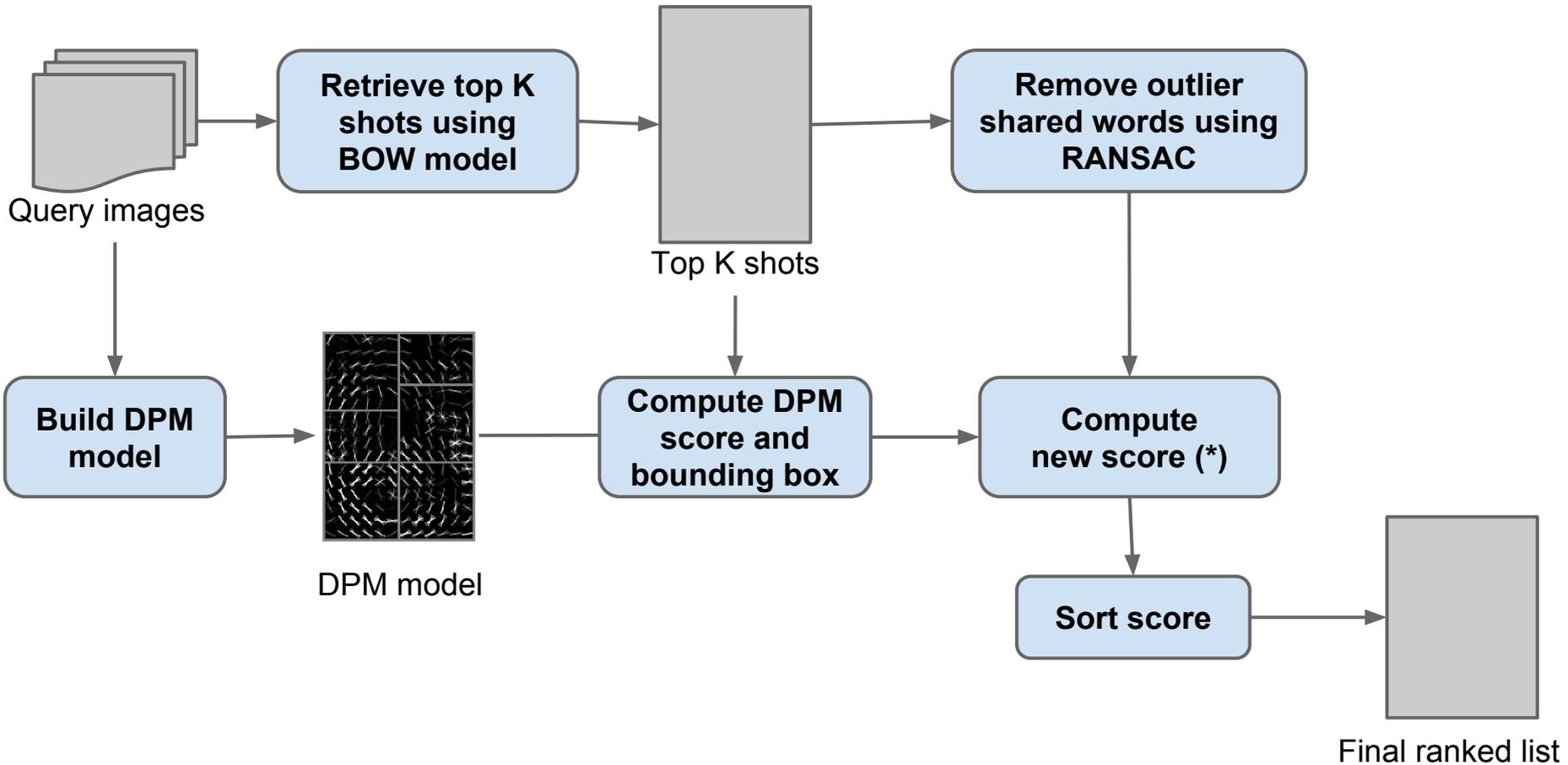
# General Instance Search Framework (1)



(1) ***Three things everyone should know to improve object retrieval***, R. Arandjelović, A. Zisserman, CVPR 2012

(2) ***Query-adaptive asymmetrical dissimilarities for visual object retrieval***, Cai-Zhi Zhu, Hervé Jégou, Shin'Ichi Satoh, ICCV 2013.

# Method Overview



# BOW is Good

- Background is helpful.



# But ...

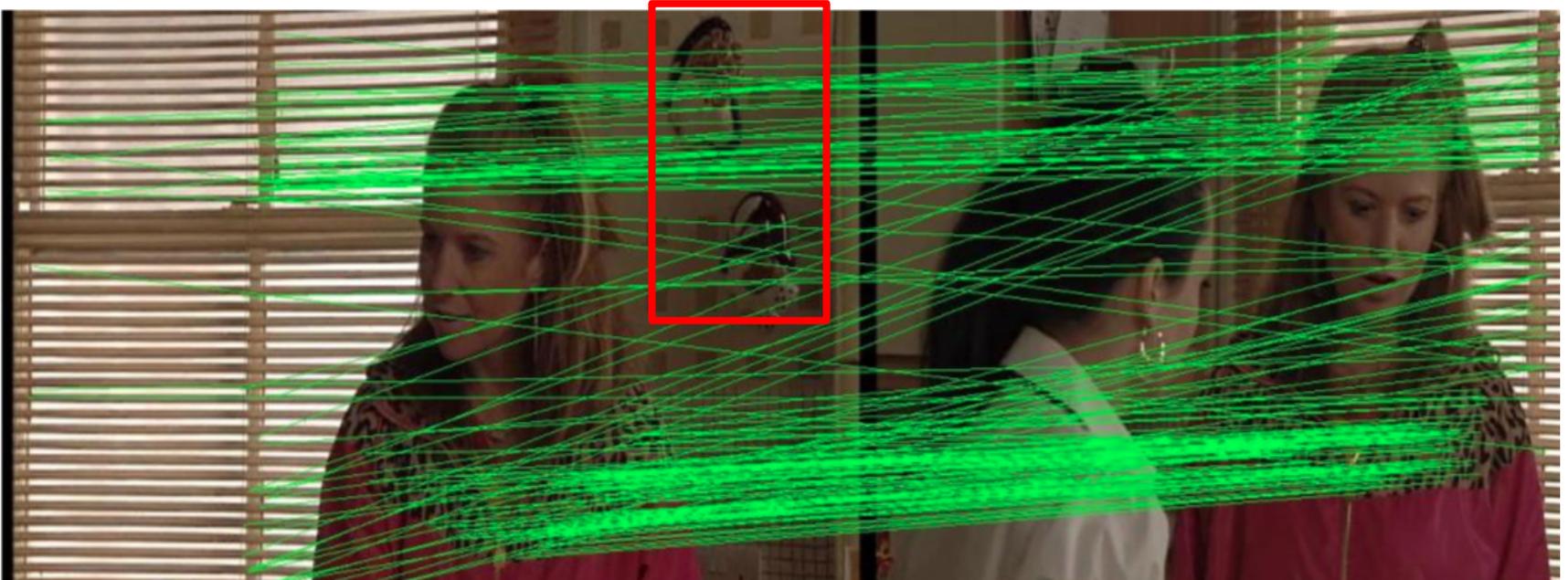
- Small objects



Query

# But ...

- Burstiness



# Why Geometric Verification?

- Avoid false matches.
- Take into account spatial arrangement of matched points.



# Geometric Verification by RANSAC



Before



After

# Geometric Verification by RANSAC

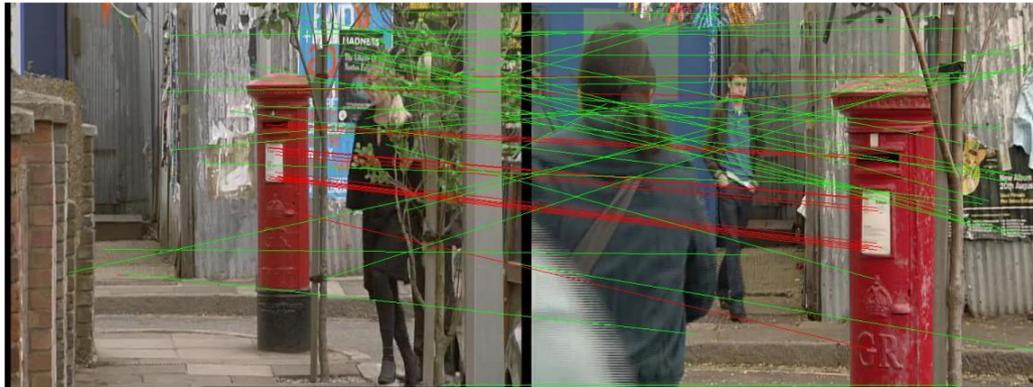


Before



After

# Geometric Verification by RANSAC



Before



After

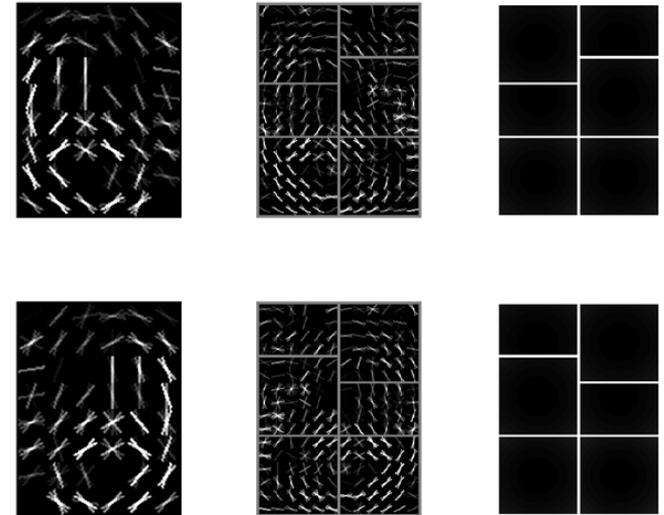
# Our Proposal

- Existing methods
  - Same treatment for correct and incorrect matches.
  - Not effective with small objects (number of matches is below 4).
- Our method
  - ***Different treatments of correct and incorrect matches***  
→ HOW: to use ***estimated location returned by an object localizer (e.g. DPM-based object localizer)***
- Benefit:
  - Since RANSAC is ***point-based*** and DPM is ***region-based*** spatial consistency verification, they are expected to be complementary each other.

# DPM-based Object Localizer



Query 9109

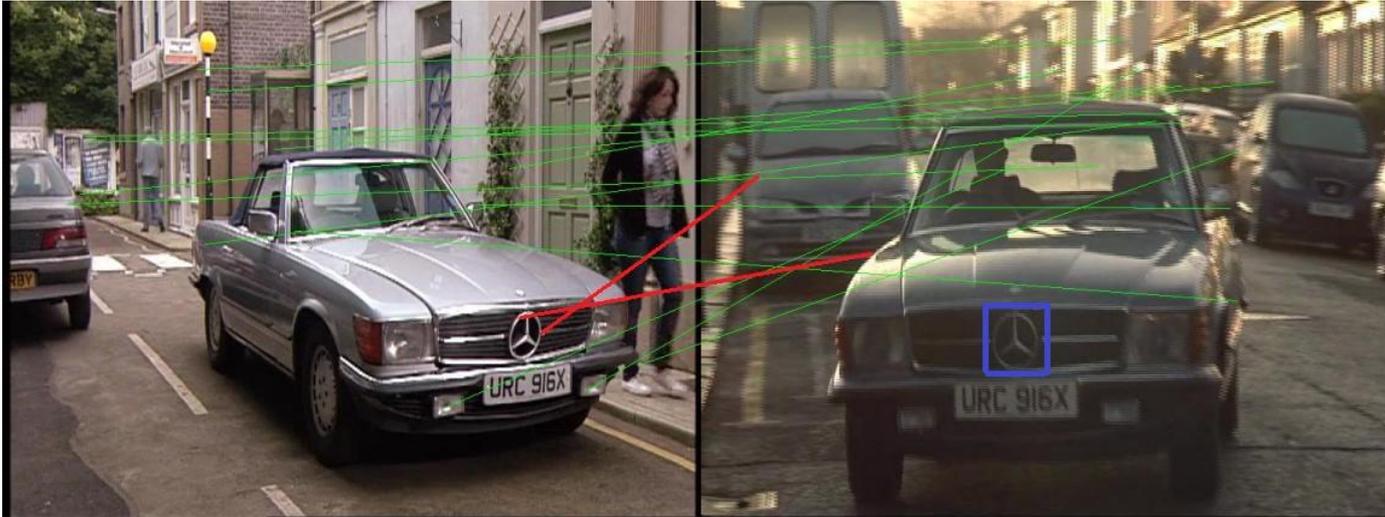


Visualization of DPM model for query 9109

- **Benefit:**

- Model query object as a shape structure.
- Work well with small and texture-less object.
- Augment bounding box information.

# How useful is DPM



Wrong shared words case



No shared word case

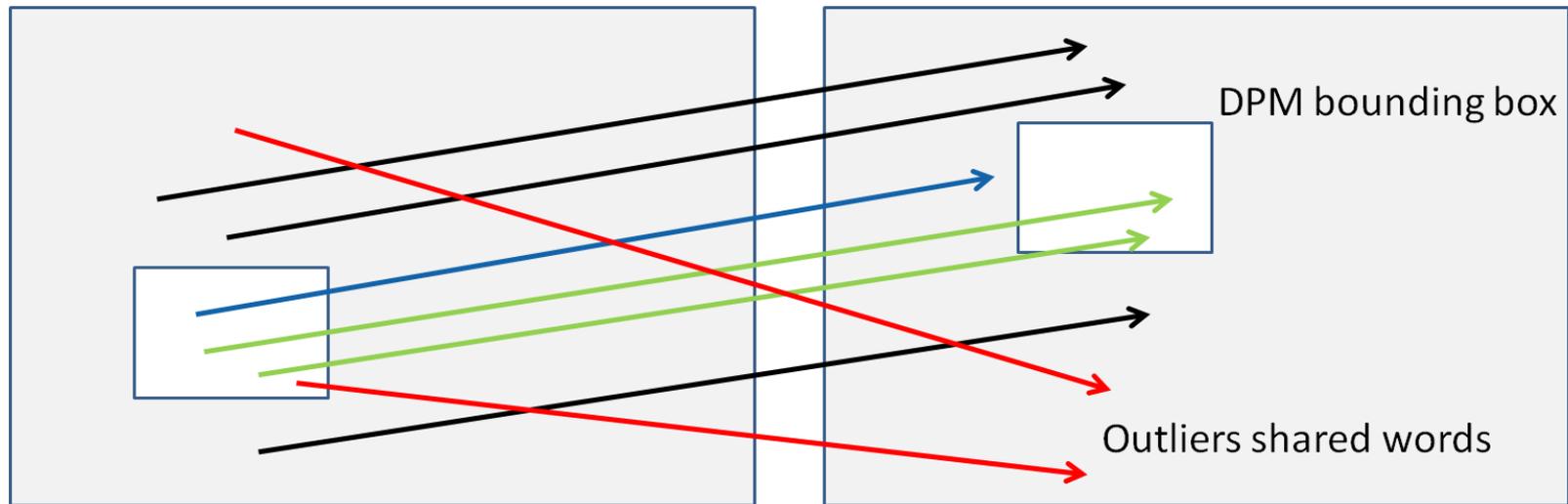
# DPM: The Good and The Bad



# Geometric Verification by Our Method

- Assume matches are verified by RANSAC.
- Divide these matches into 3 categories
  - **(green ones)**: high confident matches.
  - **(blue ones)**: low confident matches.
  - **(black ones)**: background matches.
  - **(red ones)**: false matches removed by RANSAC.
- Re-scoring
  - Base score: (naive) fusion of BoW and DPM.
  - Boost the base score for high confident matches.

# Re-scoring



$$S_{new} = (1 + N_d)^2 (1 + N_{fg} - N_d) \log_2 (2 + N_{bg}) (w_1 S_{BOW} + w_2 S_{DPM})$$

where:

$N_d$  : number of shared words of foreground inside bounding box (green lines)

$N_{fg}$  : number of shared word of foreground (both blue and green lines)

$N_{bg}$  : number of shared word of background (black lines)

$w_1$  : weight of BOW score

$w_2$  : weight of DPM score

# Experiments

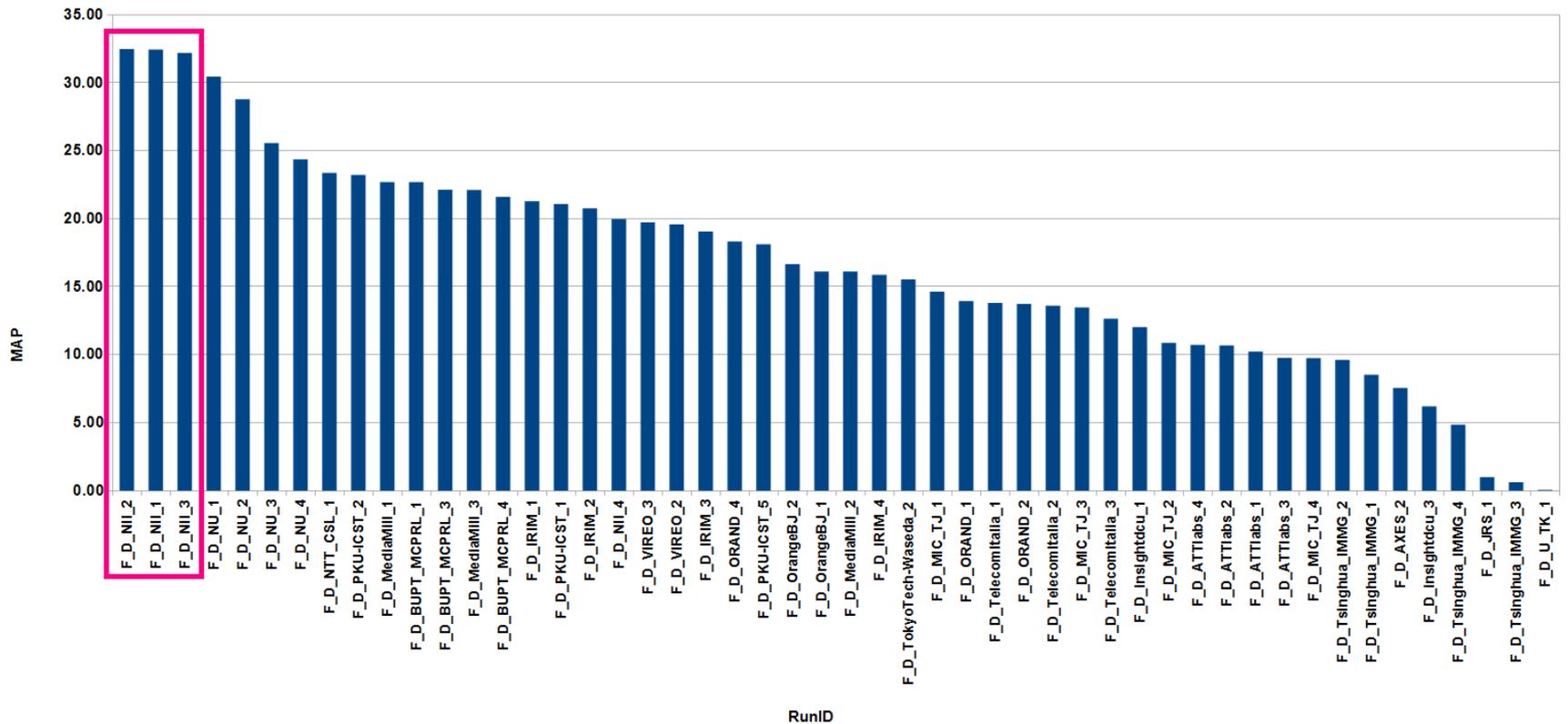
Run Name	MAP*	Notice
BOW	22.51	Standard BOW with asymmetric dissimilarity.
DPM only	19.11	Run DPM on Top K shots returned by BOW.
BOW + RANSAC+ tf-idf weighting	25.67	Run RANSAC + tf-idf weighting as a new score.
BaseScore[BOW + DPM]	25.41	$w_1 S_{BOW} + w_2 S_{DPM}$ : based score only.
Fusion[BOW+DPM w/o RANSAC]	26.25	Compute $N_d$ , $N_{fg}$ , $N_{bg}$ including outliers.
Fusion[BOW+DPM with RANSAC]	<b>29.24</b>	$S_{new} = (1 + N_d)^2 (1 + N_{fg} - N_d) \log_2 (2 + N_{bg}) (w_1 S_{BOW} + w_2 S_{DPM})$

(\*) this score is computed using ourselves function

***We obtain consistent results on both INS 2013 and INS 2014.***

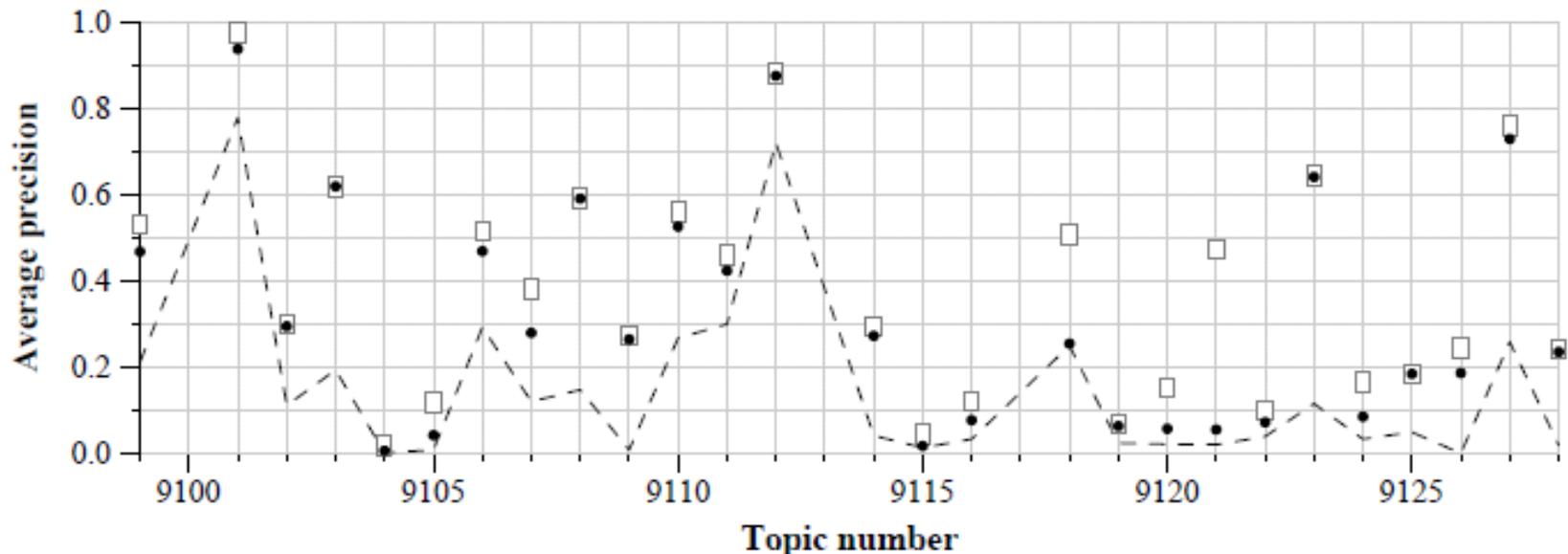
# INS - Result

Performance of TRECVID Instance Search Task



# Best Run Result

- Our 3 runs achieve the best performance for total 10 queries.



Run score (dot) versus median (---) versus best (box) by topic

# Unsolved problems → PERSON query



Lucky  
Background helps



Unlucky

# Conclusions

- New flexible fusion scheme to improve the accuracy
  - key idea: combine verified matches (RANSAC) and estimated object location (DPM).
  - Since RANSAC is point-based and DPM is region-based spatial consistency verification, they are complementary each other.
  - good in the cases:
    - small size object.
- Experiments
  - **Pros: 30% MAP improved (both INS 2013 & INS 2014).**
  - **Cons: slow in DPM and RANSAC verification step.**