

# Integrating storage manager (TASM) and query optimizer (FiGO) in Video-DBMS

Data Systems Project  
(Instructor: Prof. Kamal Karlapalem)

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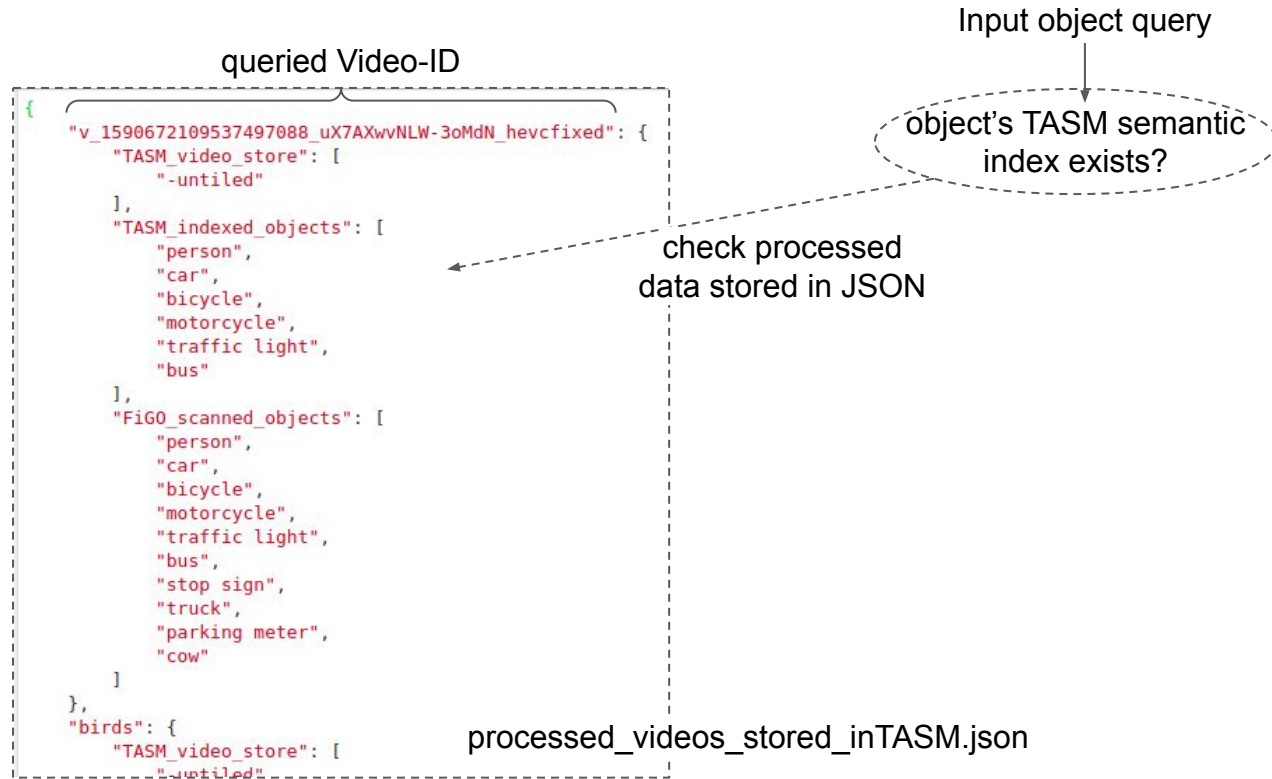
Roll no: 2022900005

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GitHub: [https://github.com/chirag26495/FiGO\\_TASMst](https://github.com/chirag26495/FiGO_TASMst)

# Integration Method

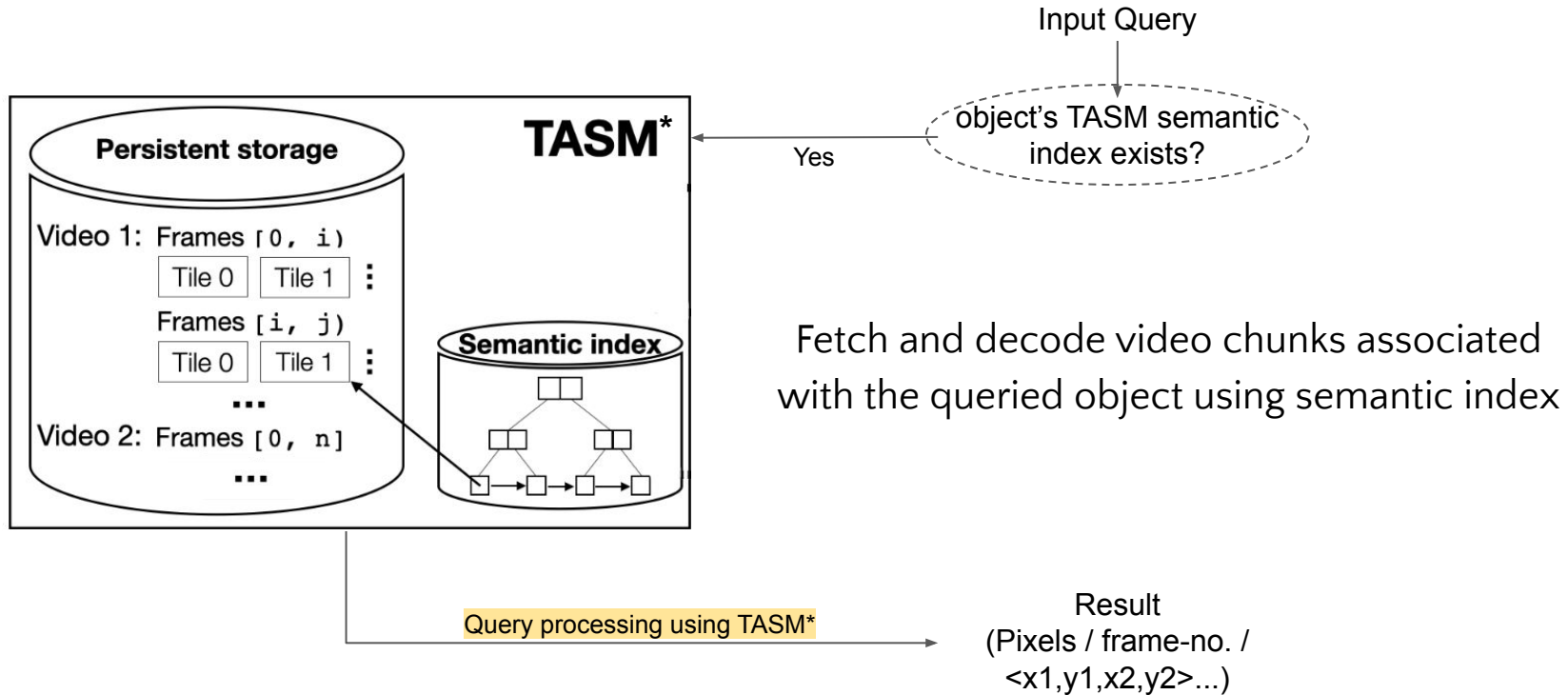
# FiGO [2] and TASM [1] integration in VDBMS



[1] Daum, Maureen, et al. "Tasm: A tile-based storage manager for video analytics." 2021 IEEE 37th International Conference on Data Engineering (ICDE). IEEE, 2021.

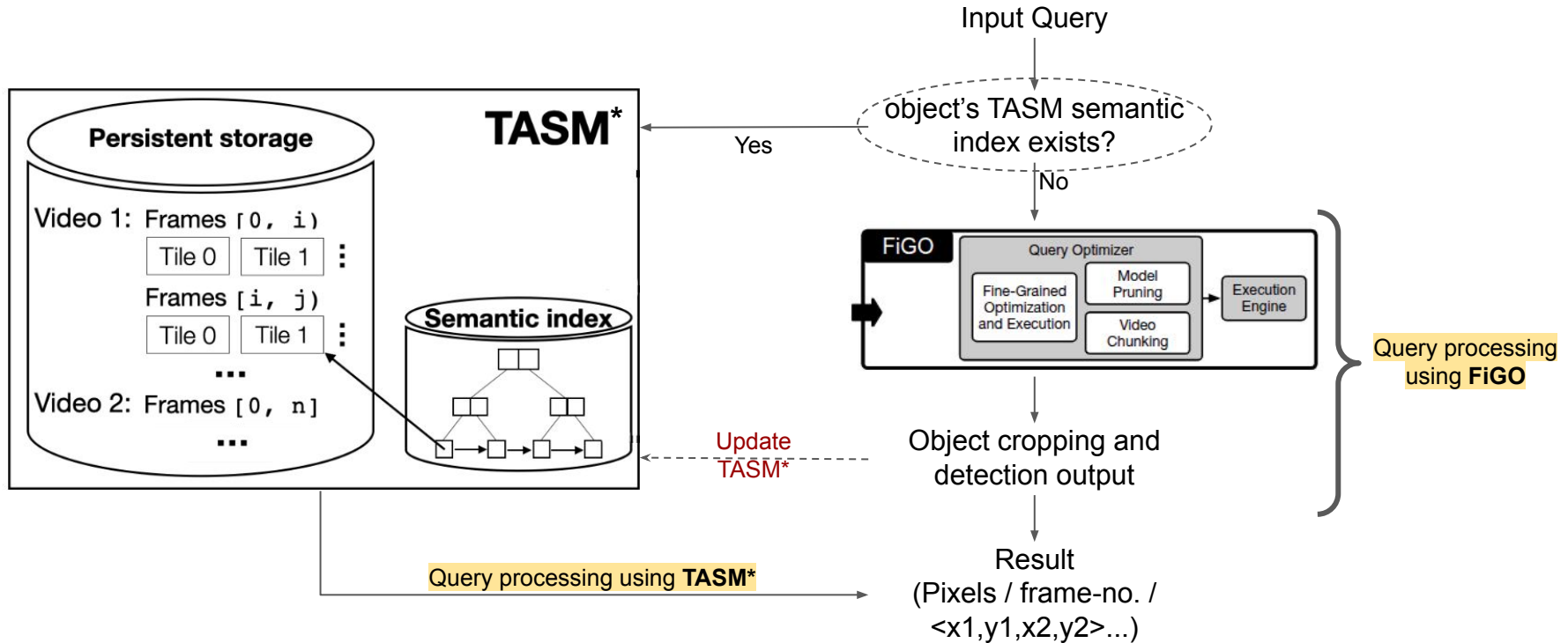
[2] Cao, Jiashen, et al. "Figo: Fine-grained query optimization in video analytics." Proceedings of the 2022 International conference on management of data. 2022.

# FiGO and TASM\* integration in VDBMS



**Note:** As opposed to TASM, **TASM\*** stores videos in 8-frame chunks instead of full video in untitled form. This enables **faster retrieval of relevant frames** as per input object query.

# FiGO and TASM\* integration in VDBMS



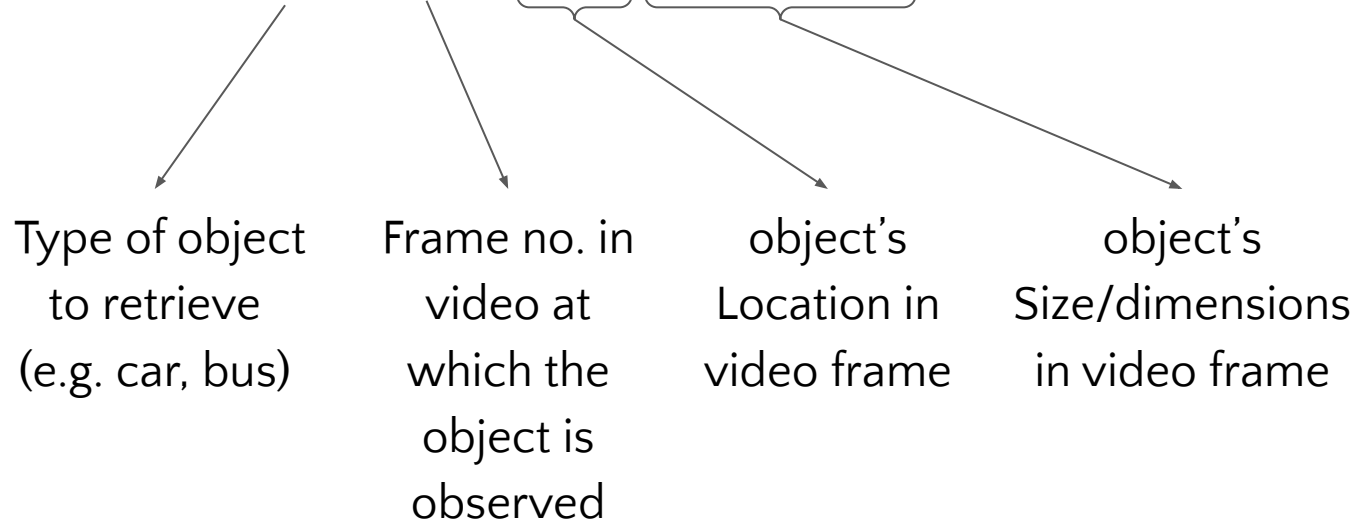
Update TASM\* semantic index using detection output and store video in untiled 8-frame chunk form (unlike TASM) for faster retrieval of future queries

Input Query template

# FiGO and TASM\* integration in VDBMS

## Input Query template:

SELECT (object, frame, x1, y1, width, height) FROM video



Sample Query Output



# FiGO and TASM\* integration in VDBMS



SELECT (motorcycle, frame, x1, y1, width, height)  
FROM video1\_hevcfixed.mp4



... 1392 objects retrieved  
→ from 504 frames  
→ stored as cropped jpgs

■ / ... / query\_out / v\_1590672109537497088\_uX7

Name  
frame560\_motorcycle\_x500\_y580\_w16\_h20.jpg  
frame561\_motorcycle\_x552\_y596\_w48\_h50.jpg  
frame562\_motorcycle\_x198\_y606\_w30\_h48.jpg  
frame562\_motorcycle\_x342\_y574\_w20\_h34.jpg  
frame562\_motorcycle\_x370\_y600\_w42\_h68.jpg  
frame562\_motorcycle\_x502\_y580\_w20\_h30.jpg  
frame562\_motorcycle\_x548\_y596\_w48\_h52.jpg  
frame563\_motorcycle\_x198\_y608\_w28\_h50.jpg  
frame563\_motorcycle\_x372\_y602\_w42\_h68.jpg  
frame563\_motorcycle\_x500\_y582\_w32\_h30.jpg  
frame563\_motorcycle\_x544\_y596\_w48\_h52.jpg  
frame562\_motorcycle\_x502\_y580\_w20\_h30.jpg  
frame562\_motorcycle\_x548\_y596\_w48\_h52.jpg  
frame563\_motorcycle\_x198\_y608\_w28\_h50.jpg  
frame563\_motorcycle\_x372\_y602\_w42\_h68.jpg  
frame563\_motorcycle\_x500\_y582\_w32\_h30.jpg  
frame563\_motorcycle\_x544\_y596\_w48\_h52.jpg

frame	label	x1	y1	width	height
152	motorcycle	4	544	30	72
153	motorcycle	398	522	78	82
153	motorcycle	132	546	200	332
154	motorcycle	372	524	74	78
154	motorcycle	124	548	208	356
155	motorcycle	346	524	72	76
155	motorcycle	116	550	218	384
156	motorcycle	120	544	230	452
156	motorcycle	292	526	70	74
156	motorcycle	78	730	106	164

+

155	motorcycle	346	524	72	76
155	motorcycle	116	550	218	384
156	motorcycle	120	544	230	452
156	motorcycle	292	526	70	74
164	motorcycle	78	730	106	164

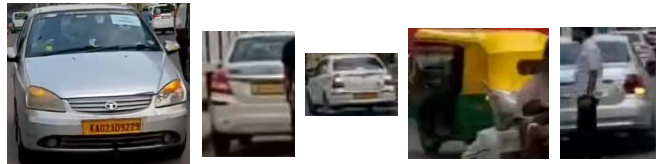
query-output in csv

# FiGO and TASM\* integration in VDBMS



query Video

SELECT (**car**, frame, x1, y1, width, height)  
FROM video1\_hevcfixed.mp4



... **1649** objects retrieved  
→ from **530** frames  
→ stored as **cropped jpgs**

query Output

... / query\_out / v\_1590672109537497088\_t

Name

frame105\_car\_x392\_y442\_w328\_h326.jpg  
frame105\_car\_x496\_y416\_w78\_h42.jpg  
frame106\_car\_x214\_y476\_w68\_h90.jpg  
frame106\_car\_x382\_y474\_w26\_h22.jpg  
frame106\_car\_x394\_y442\_w326\_h330.jpg  
frame106\_car\_x400\_y472\_w22\_h24.jpg  
frame106\_car\_x496\_y418\_w78\_h42.jpg  
frame106\_car\_x640\_y436\_w80\_h86.jpg  
frame107\_car\_x216\_y476\_w66\_h90.jpg  
frame107\_car\_x382\_y474\_w26\_h24.jpg  
frame107\_car\_x396\_y442\_w78\_h42.jpg

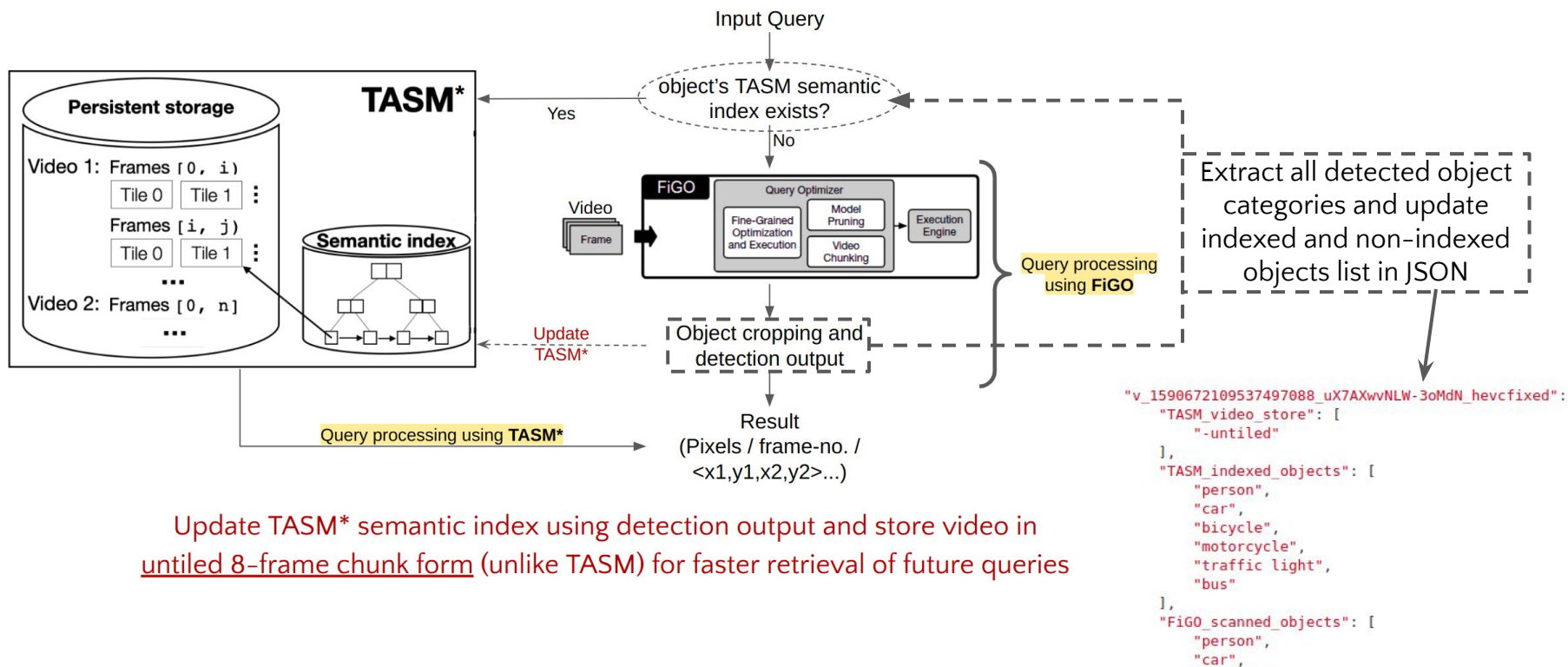
+

frame	label	x1	y1	width	height
370	car	464	544	104	72
370	car	402	548	26	26
370	car	422	548	22	26
371	car	630	534	92	156
371	car	464	546	94	74
371	car	420	544	64	56
371	car	402	546	28	28
372	car	458	546	94	72
377	car	416	548	60	54

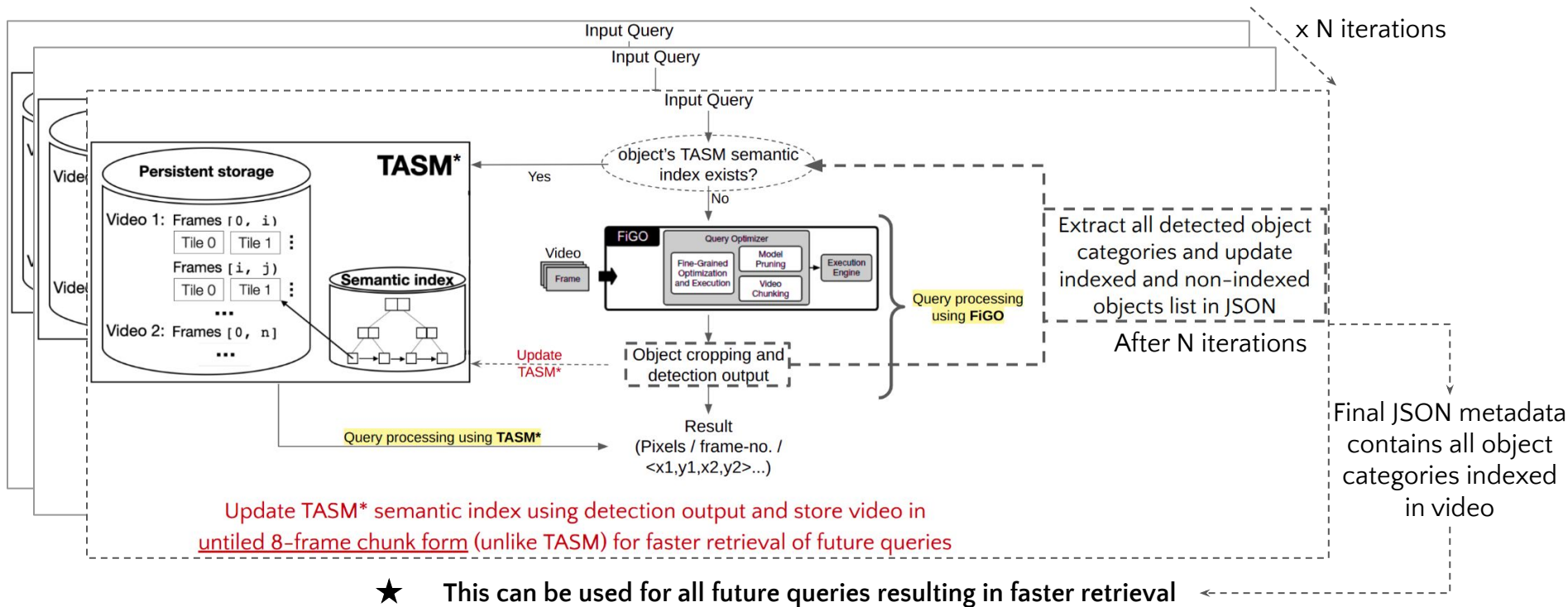
query-output in csv

Automated retrieval and profiling  
of all object categories present in query video

# Automated retrieval and profiling of all object categories present in query video



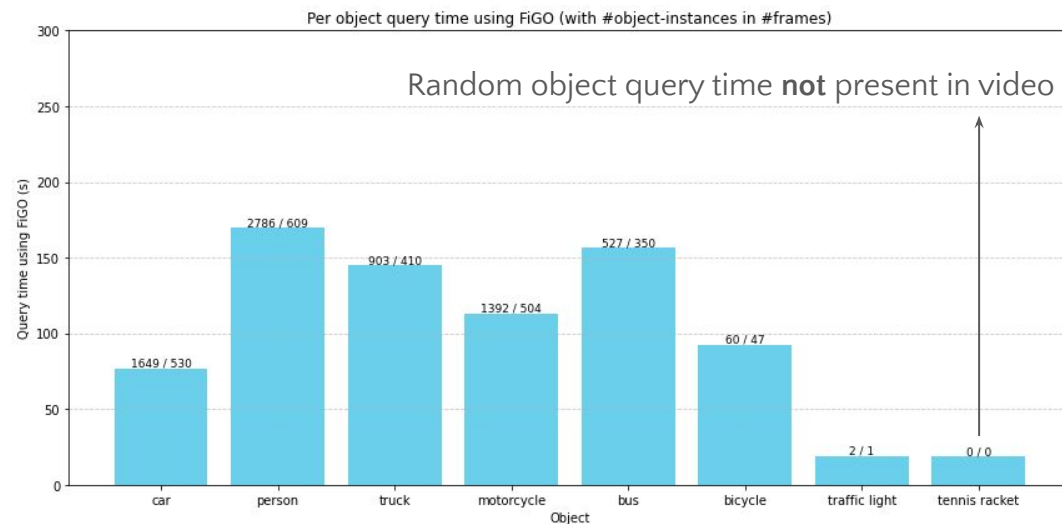
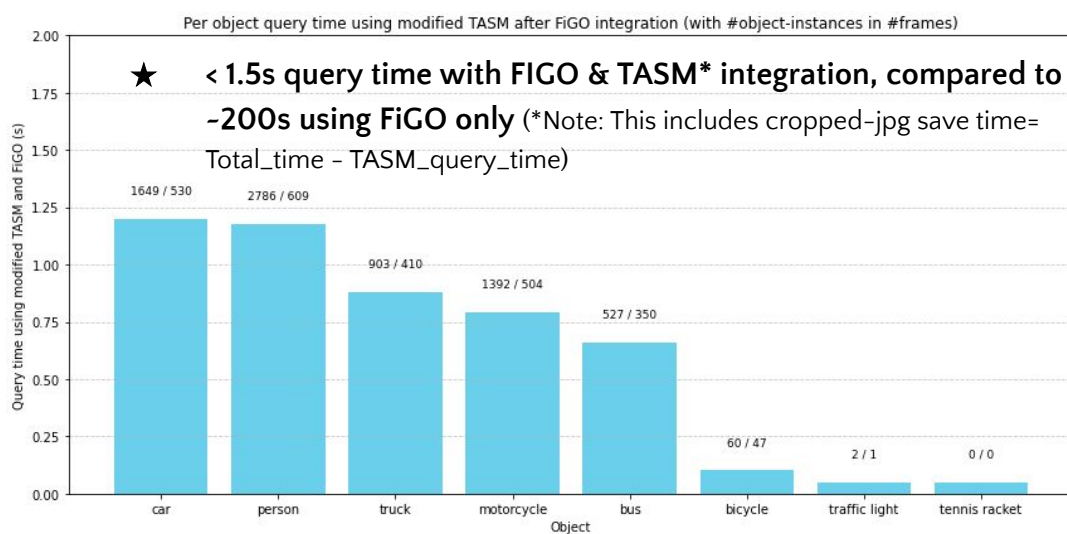
# Automated retrieval and profiling of all object categories present in query video



**Note:** Value of N is iteratively determined based on the number of object categories present in video

# **Results of** Automated retrieval and profiling

# Object Query Times from Query Video (#objects / #frames)



## Query Video



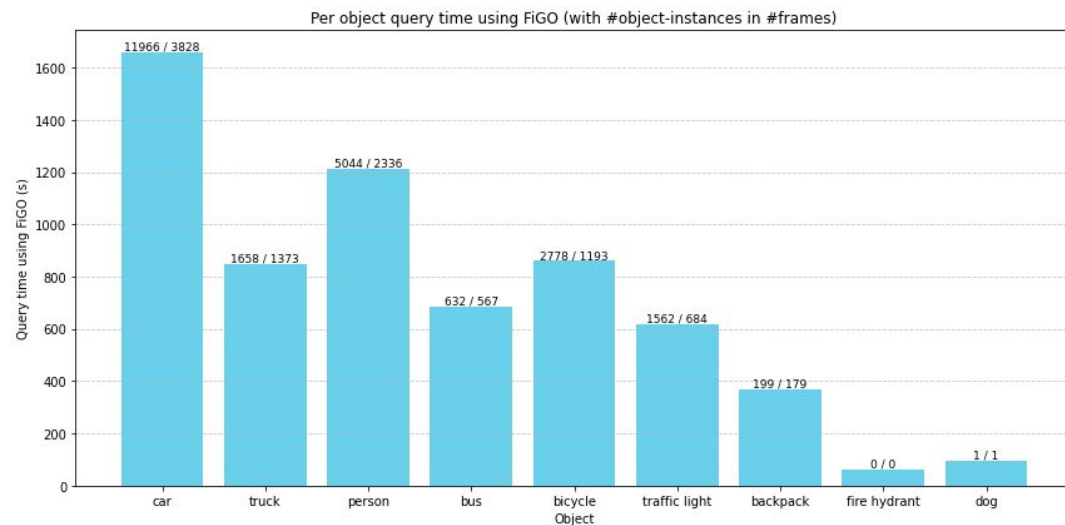
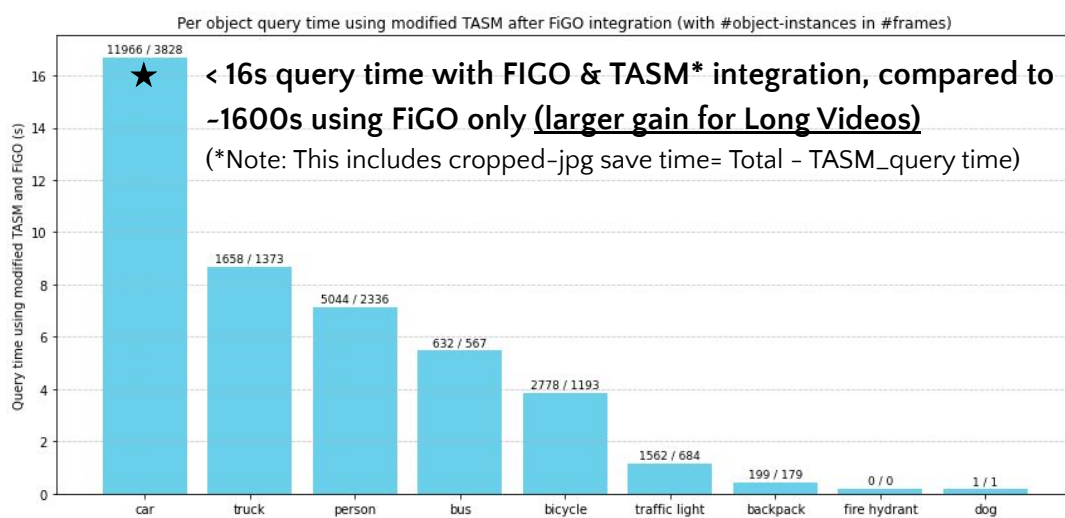
Total **623** frames  
(High Object Density)

**NOTE:** FiGO query times are **more** for smaller objects (e.g. person) in video as it requires **best model** having **high latency**

More Examples



# Object Query Times from Query Video (#objects / #frames)

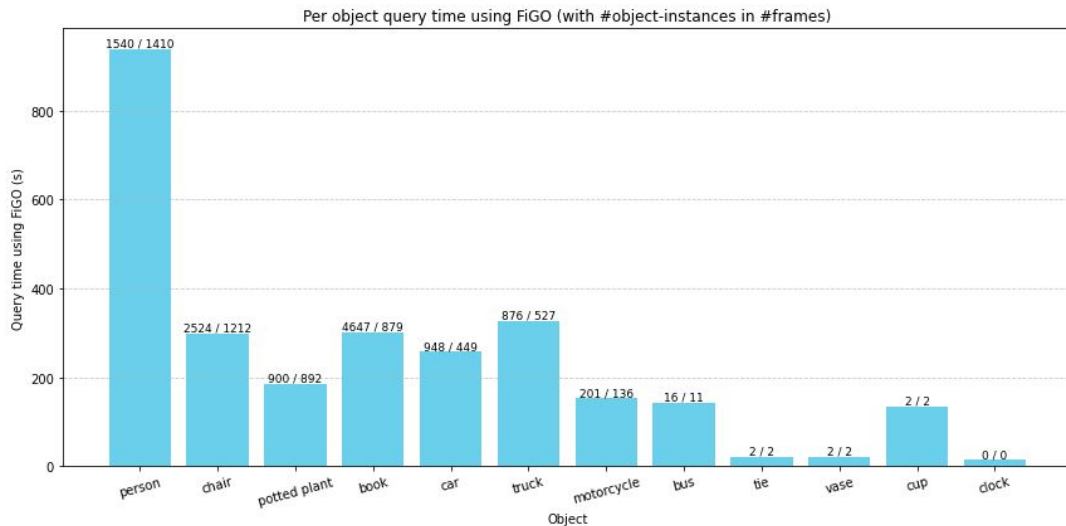
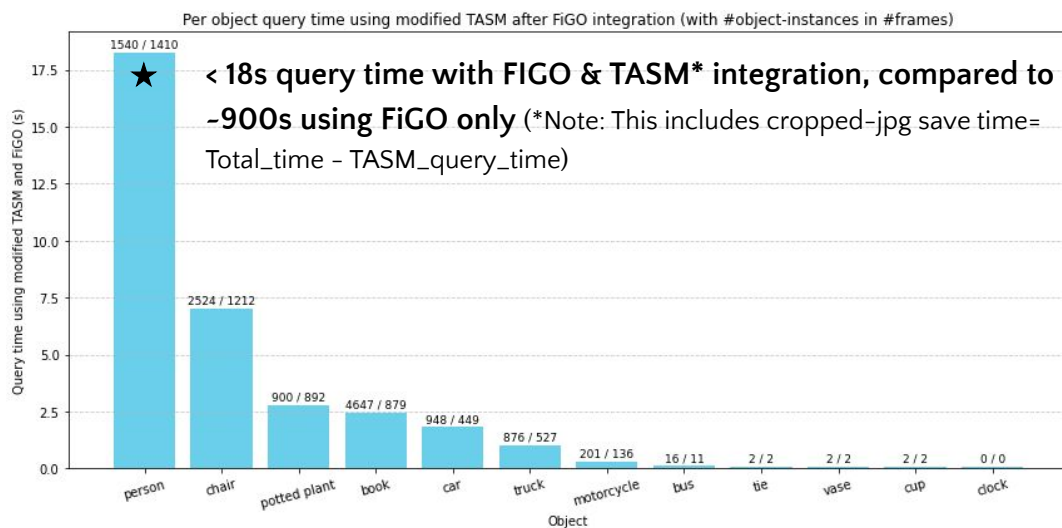


## Query Video



Total **4645** frames  
(Long duration Video)

## Object Query Times from Query Video (#objects / #frames)



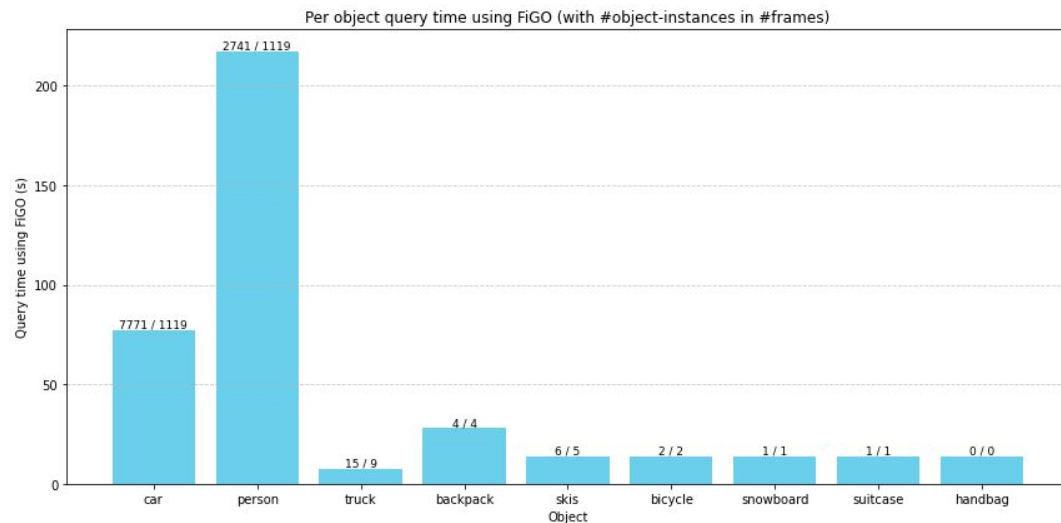
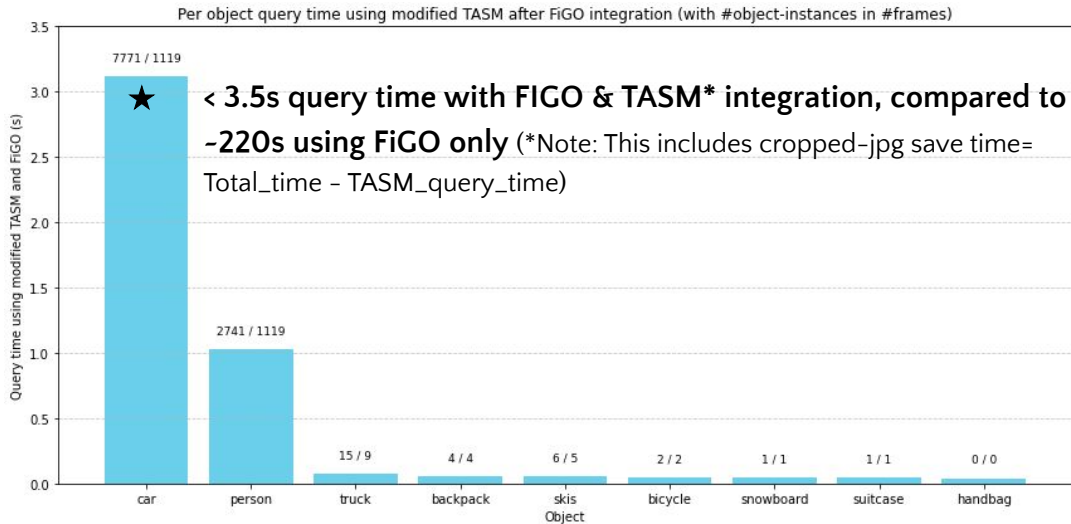
## Query Video



Total 1720 frames

**NOTE:** FiGO query times are **more** for smaller objects (e.g. person) in video as it requires **best model** having **high latency**

# Object Query Times from Query Video (#objects / #frames)



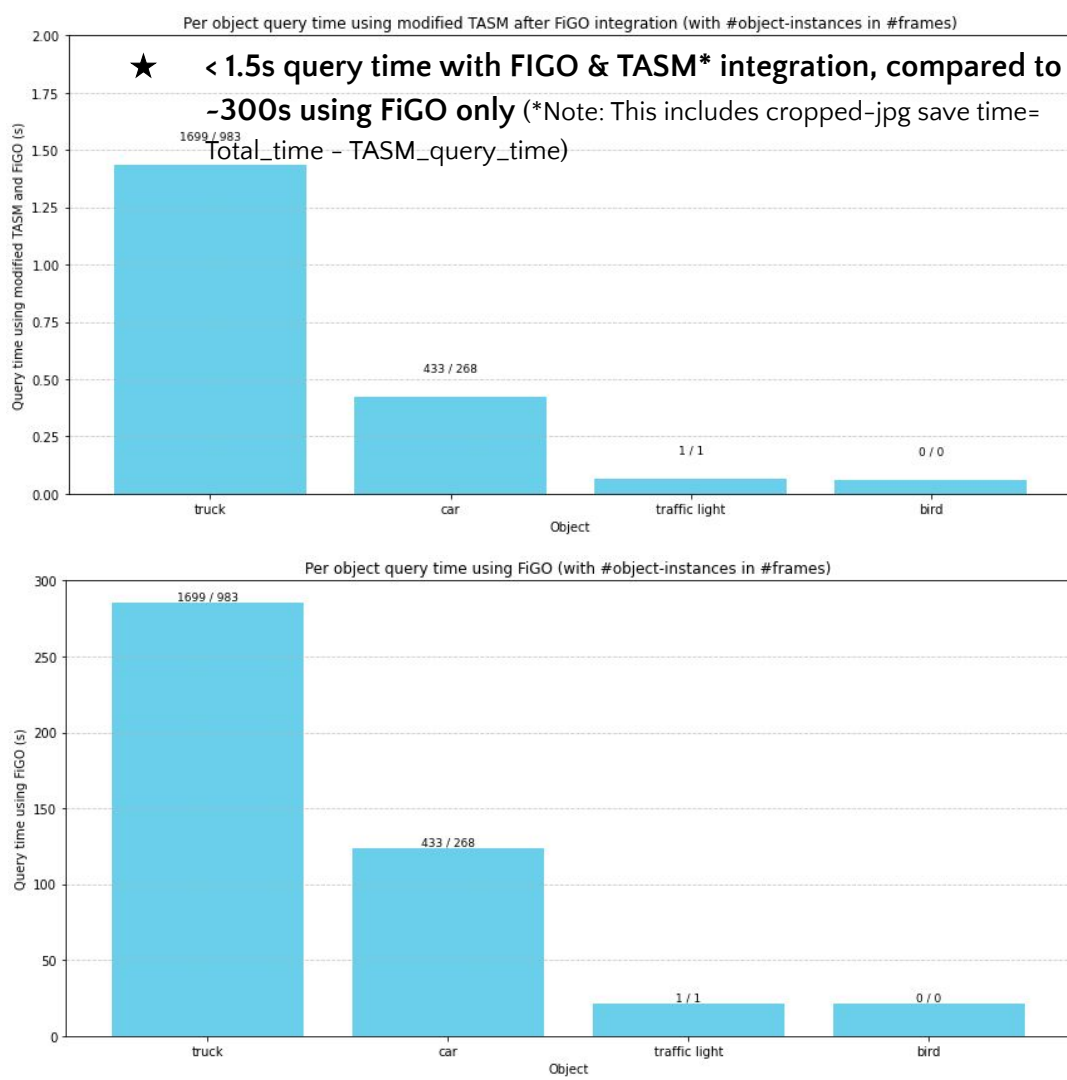
## Query Video



Total 1119 frames

**NOTE:** FiGO query times are **more** for smaller objects (e.g. person) in video as it requires **best model** having **high latency**

## Object Query Times from Query Video (#objects / #frames)



## Query Video

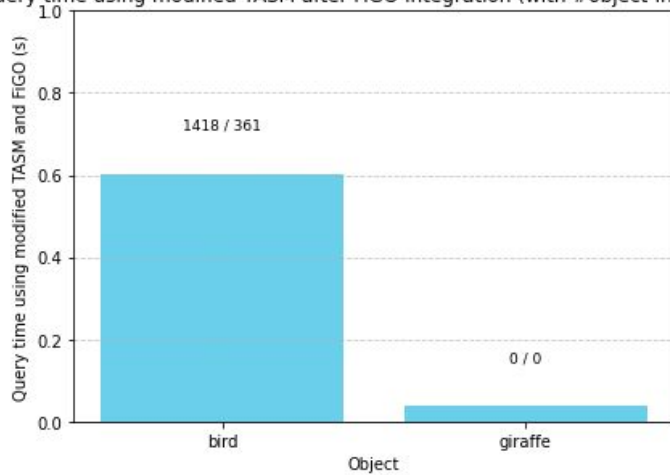


Total **1372** frames  
(Low Object Density)

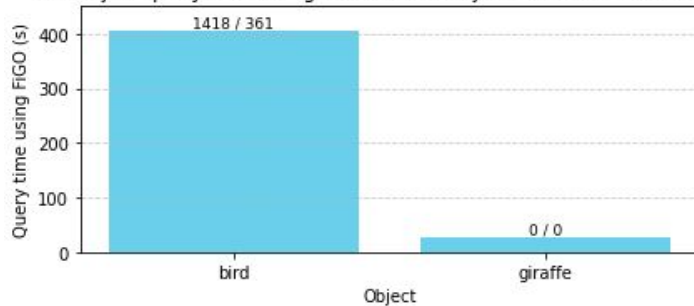
★ < 0.6s query time with FIGO & TASM\* integration, compared to ~400s using FiGO only

Object Query Times from Query Video  
(#objects / #frames)

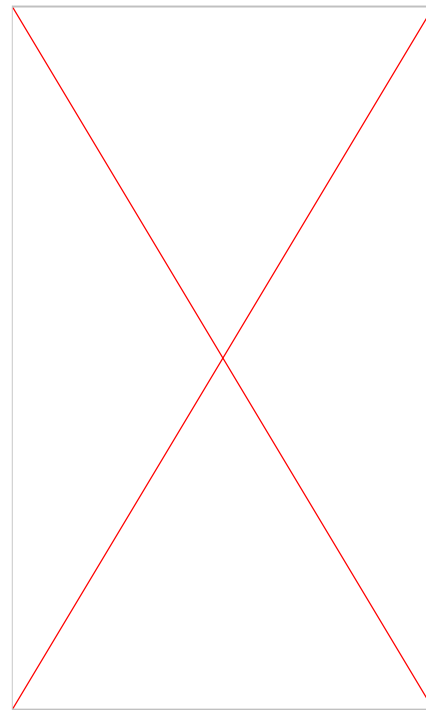
Per object query time using modified TASM after FiGO integration (with #object-instances in #frames)



Per object query time using FiGO (with #object-instances in #frames)



Query Video



Total **361** frames

# Challenges

- GPU differences (Quadro P5000 – **theirs** vs RTX 30/20 series – **ours**)
  - Uniform and non-uniform tile layout storage working now – Huge thanks to **Maureen Daum**
    - **Solution:** Storing video in 8-frame chunks sequentially
  - **But** object retrieval from tiled video storage still fails:
    - Retrieving objects from **chunked + tiled** video storage differs greatly from just **tiled** video storage
    - This needs rethinking the TASM approach and significant code restructuring
    - Even after doing the above, The resultant performance gains to TASM+FiGO integration (proposed in this project) won't differ much in execution time since videos are now chunked so only relevant chunks of the video are read instead of reading it entirely as before
  - Thus for this project untiled video storage split in 8-frame chunks is used.

↑ BOARD	↑ FAMILY	↑ NVENC Generation	Desktop/ Mobile	# OF CHIPS	Total # of NVENC	Max # of concurrent sessions	H.264 (AVCHD) YUV 4:2:0	H.264 (AVCHD) YUV 4:2:2	H.264 (AVCHD) YUV 4:4:4	H.264 (AVCHD) Lossless	H.265 (HEVC) 4K YUV 4:2:0	H.265 (HEVC) YUV 4:2:2	H.265 (HEVC) 4K YUV 4:4:4	H.265 (HEVC) 4K YUV 4:4:4
Quadro P5000	Pascal	6th Gen	D	1	2	Unrestricted	YES	NO	YES	YES	YES	NO	YES	YES

↑ BOARD	↑ FAMILY	↑ NVENC Generation	Desktop/ Mobile	# OF CHIPS	Total # of NVENC	Max # of concurrent sessions	H.264 (AVCHD) YUV 4:2:0	H.264 (AVCHD) YUV 4:2:2	H.264 (AVCHD) YUV 4:4:4	H.264 (AVCHD) Lossless	H.265 (HEVC) 4K YUV 4:2:0	H.265 (HEVC) YUV 4:2:2	H.265 (HEVC) 4K YUV 4:4:4	H.265 (HEVC) 4K YUV 4:4:4
GeForce RTX 3090	Ampere	7th Gen	D	1	1	8	YES	NO	YES	YES	YES	NO	YES	YES

Source: <https://developer.nvidia.com/video-encode-and-decode-gpu-support-matrix-new>

# Contributions

- ★ FiGO and TASM\* integration: **Significant query time reduction** for repeated objects retrieval
  - Stores object-list metadata for each video → Supporting faster query execution for already indexed objects
- ★ **Automated extraction of all object categories present in a video**
  - Obtained iteratively through multiple FiGO+TASM query runs → provide options for valid/useful object queries
- ★ Scalable for storage and **fast object retrieval** from **long duration videos**
  - Due to 8-frame chunked video storage in modified TASM\* only relevant video chunks containing the queried object will be retrieved → Suited for real-world applications like city-scale analysis on CCTV videos using this VDBMS
- ★ FiGO and TASM\* both support multiple object attribute retrieval:
  - object pixels, frame-level object location and object dimensions
- ★ TASM\* now works on consumer grade GPUs
  - Thanks Maureen: for 8-frame chunked sequential video storage to run on RTX 30/20 series GPUs

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(Instructor: Prof. Kamal Karlapalem)

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GitHub: [https://github.com/chirag26495/FiGO\\_TASMst](https://github.com/chirag26495/FiGO_TASMst)