Challenge: Neural networks slow at scale, hard to use

Deep learning allows for extremely accurate video analysis

But it’s extremely slow (<5 fps)

It would take a P100 two days to analyze 8 hours of video!

Requires a PhD in ML to use!

FrameQL: A declarative interface for video analytics

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>timestamp</td>
<td>float</td>
<td>Time stamp</td>
</tr>
<tr>
<td>mask</td>
<td>(float, float)</td>
<td>Polygon containing the object of interest, typically a rectangle</td>
</tr>
<tr>
<td>class</td>
<td>string</td>
<td>Object class (e.g. bus, car, person)</td>
</tr>
<tr>
<td>sceneid</td>
<td>int</td>
<td>Unique identifier for a continuous time segment when the object is visible</td>
</tr>
<tr>
<td>globalid</td>
<td>int</td>
<td>Unique global identifier for object (e.g. license plate number)</td>
</tr>
<tr>
<td>content</td>
<td>image</td>
<td>The pixel content of the object</td>
</tr>
</tbody>
</table>

Red birds in bottom left

SELECT timestamp
FROM birdfeeder
WHERE class = 'bird'
AND color(content) = red
AND xmax(mask) < 600
GROUP BY sceneid
HAVING COUNT(timestamp) > 15

Simple optimizations can lead to >15x speedups

Counting cars

SELECT COUNT(*)
FROM taipei-street
WHERE class = 'car'

Blazelt can rewrite queries using specialized networks

SELECT *
FROM night-street

No speedups possible in this case

Blazelt architecture

Blazelt can automatically compose multiple optimizations for large speedups

Blazelt operators

Classed-based filtering
- NoScope style specialization
- Filter based on class

Content-based filtering
- Filter based on content
- E.g. filter by red pixels

Temporal filtering
- Subsample based on issued query
- “Birds in the scene for 3s” -> sample every 1.5s

Predicate reordering
- Choose predicate order based on selectivity and cost of filter
- Estimate via held-out set

Query rewriting
- Can directly answer query via specialization!
- E.g. count number of cars in scene

Evaluation

Factor Analysis: finding red birds

Query rewriting: aggregate approximate counts

Blazelt can completely rewrite queries using specialized neural networks for OOM speedups