Data Analytics 4 - Project

Yolo - algorithm with use case

HOCHSCHULE HEIDELBERG
Intelligence in Learning

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Introduction

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- You Only Look Once (YOLO) is an object detection algorithm
- Four versions - v1 in May 2016, v2 in December 2016, v3 in April 2018, v4 in April 2020
- Does not use region proposal based approach like the R-CNN family
- Developed using the Darknet framework
- Github Repo for this project work : https://github.com/rbewoor/DataAnalytics4_Project

How YOLO works

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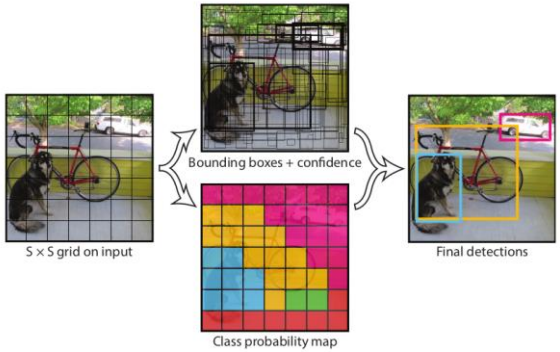
- Divides image into a grid of size S x S where S is an integer
- Each pixel evaluated as possible center point of an object
- All detections are evaluated in one pass - very fast algorithm
- Model is trained to identify C classes of objects
- B is the number of Bounding Boxes detected all over the image (without threshold consideration). Five values are output for each bounding box:
  - Two values for center coordinates
  - Two values for dimensions (height and width)
  - Confidence score
- Can handle multiple bounding boxes and aspect ratios (anchor box concept)
  - Anchor boxes are predefined boxes provided by the user to Darknet which gives the network an idea about the relative position and dimensions of the objects to be detected.
  - These are calculated using the training set Objects.



Source: YOLO v1 paper: https://arxiv.org/abs/1506.02640

How YOLO works

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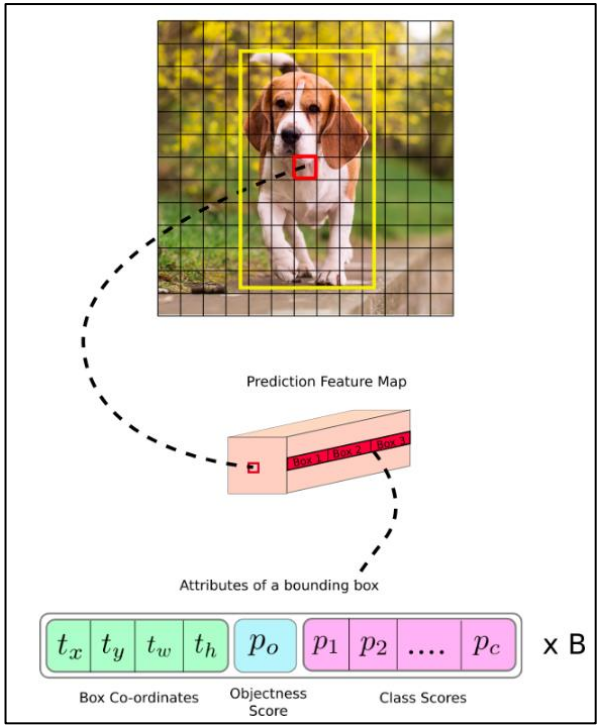
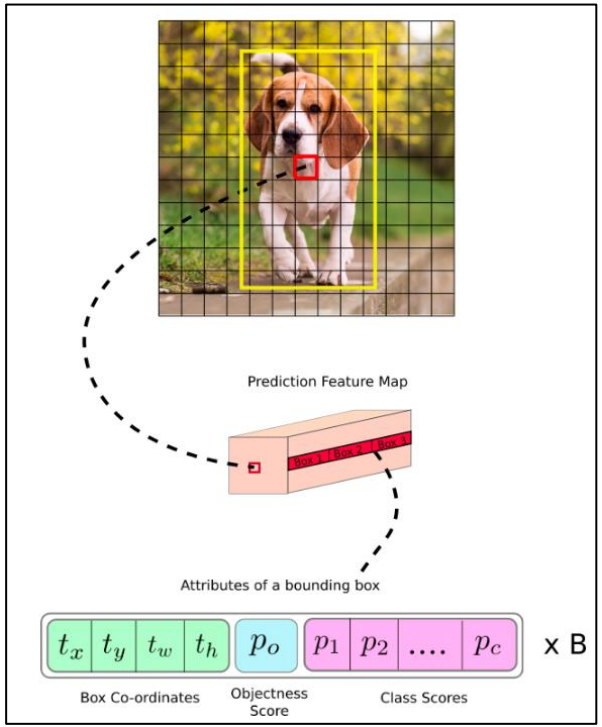
- Usually Non-max suppression used to remove redundant detections
- Total detections per image = (S x S) * (B * (5 + C))
  - Each bounding box has 5 + C attributes
- For example, suppose that:
  - image is divided into 13 x 13 grid (i.e. S = 13)
  - we want to detect 80 classes for COCO (i.e. C = 80)
  - 3 boxes predicted (B = 3)
  - #Detections = (13 x 13) * (3 * (5 + 80)) = 13 x 13 x 255
    = 43,095
- Threshold value used for Confidence Score to evaluate acceptance of object detection



Source: https://medium.com/analytics-vidhya/yolo-v3-theory-explained-33100f6d193

How YOLO works



Source: https://medium.com/analytics-vidhya/yolo-v3-theory-explained-33100f6d193

- Image divided into a grid of S x S grid-boxes
  - Predictions made at 3 scales where a 416 x 416 pixel input image is divided into 13x13, 26x26 and 52x52
- Each grid can predict maximum B objects if it thinks object center lies in the pixels covered by the grid
- Model outputs regressed values for box information: t_x, t_y, t_w, t_h
  - Mathematical formulae applied later to get actual bounding box center coordinates and dimensions: b_x, b_y, b_w, b_h

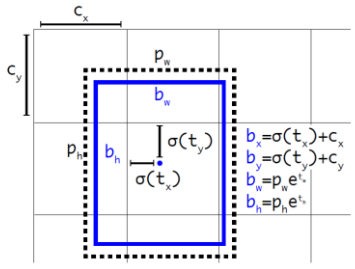


Figure 2. **Bounding boxes with dimension priors and location prediction.** We predict the width and height of the box as offsets from cluster centroids. We predict the center coordinates of the box relative to the location of filter application using a sigmoid function. This figure blatantly self-plagiarized from [15].

Source: Yolo v3 paper: https://arxiv.org/abs/1804.02767

Types of Yolo

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Model Type	YOLO v1	YOLO v2 (aka YOLO9000)	YOLOv3
Salient points	26 total (24 Conv + 2 FC) Problem detecting small objects	30 layers (included batch norm after every Conv) Anchor boxes introduced No FC present Still poor with small objects	106 layers Detection on 3 scales to handle small to large object sizes 9 anchor boxes (3 per scale)

FC: Fully connected layer

Conv: Convolution layer

YOLOv4 is very recent and not been studied in depth

Use Case

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Objective:
Use the YOLO model for desired use case and explain the architecture

Use Case:
Present a set of new images to a pre-trained YOLO v3 model.
For each image, capture the detected **object class** and the **confidence score**.
Store information in a neo4j graph database:

- Relationship format: (i:Image)-[r:HAS]->(o:Object)
- Confidence score is a property of the “HAS” relationship
- Python script: my_yolo3_one_file_to_detect_them_all_6.py

E.g. Image123.jpg HAS the objects:

- car (score 58.98),
- person (score 98.34)
- person (score 93.23)

Neo4j representation

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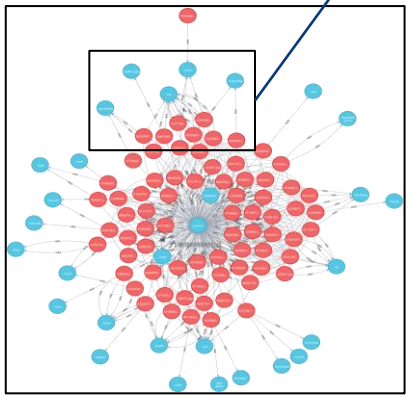
Neo4j db after inserts



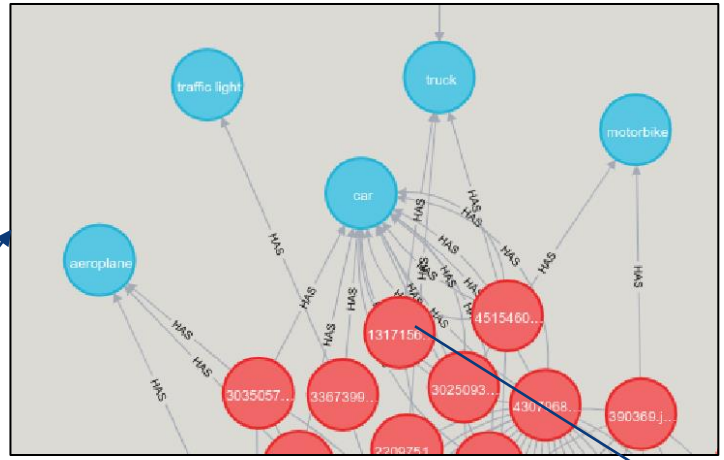


Image - HAS -> Object

Objects found in images: Traffic light, truck, motorbike, car, etc.

Many to many relationship could exist.

Detection output:
1317156_det.jpg

Model description and visualisation

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- Darknet-53 block diagram taken from the YOLO v3 paper:
  - maps to Layers 0 - 74 of the model built using python script my_yolo3_one_file_to_detect_them_all_6.py

- Model description using Keras built in functions:
  - Python script: my_yolo3_model_stats_1.py
  - Textual description with model.summary function
    Link:
    https://github.com/rbewoor/DataAnalytics4_Project/blob/master/model_summary_1.txt
  - Visualisation with Plot_model function
    Link: https://github.com/rbewoor/DataAnalytics4_Project/blob/master/model_vis_1.png

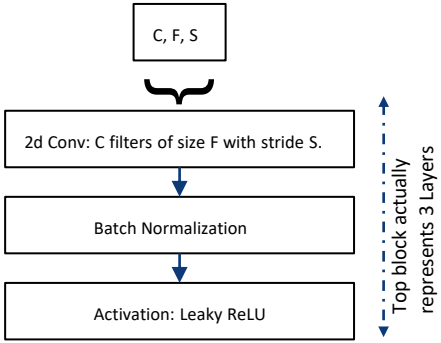
	Type	Filters	Size	Output
	Convolutional	32	3 × 3	256 × 256
	Convolutional	64	3 × 3 / 2	128 × 128
1×	Convolutional	32	1 × 1	
	Convolutional	64	3 × 3	
	Residual			128 × 128
	Convolutional	128	3 × 3 / 2	64 × 64
2×	Convolutional	64	1 × 1	
	Convolutional	128	3 × 3	
	Residual			64 × 64
	Convolutional	256	3 × 3 / 2	32 × 32
8×	Convolutional	128	1 × 1	
	Convolutional	256	3 × 3	
	Residual			32 × 32
	Convolutional	512	3 × 3 / 2	16 × 16
8×	Convolutional	256	1 × 1	
	Convolutional	512	3 × 3	
	Residual			16 × 16
	Convolutional	1024	3 × 3 / 2	8 × 8
4×	Convolutional	512	1 × 1	
	Convolutional	1024	3 × 3	
	Residual			8 × 8

Source: Yolo v3 paper:
https://arxiv.org/abs/1804.02767

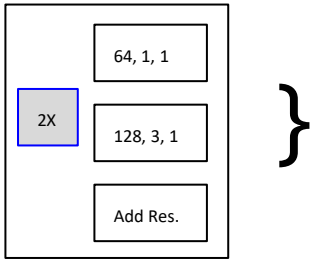
Model description and visualisation

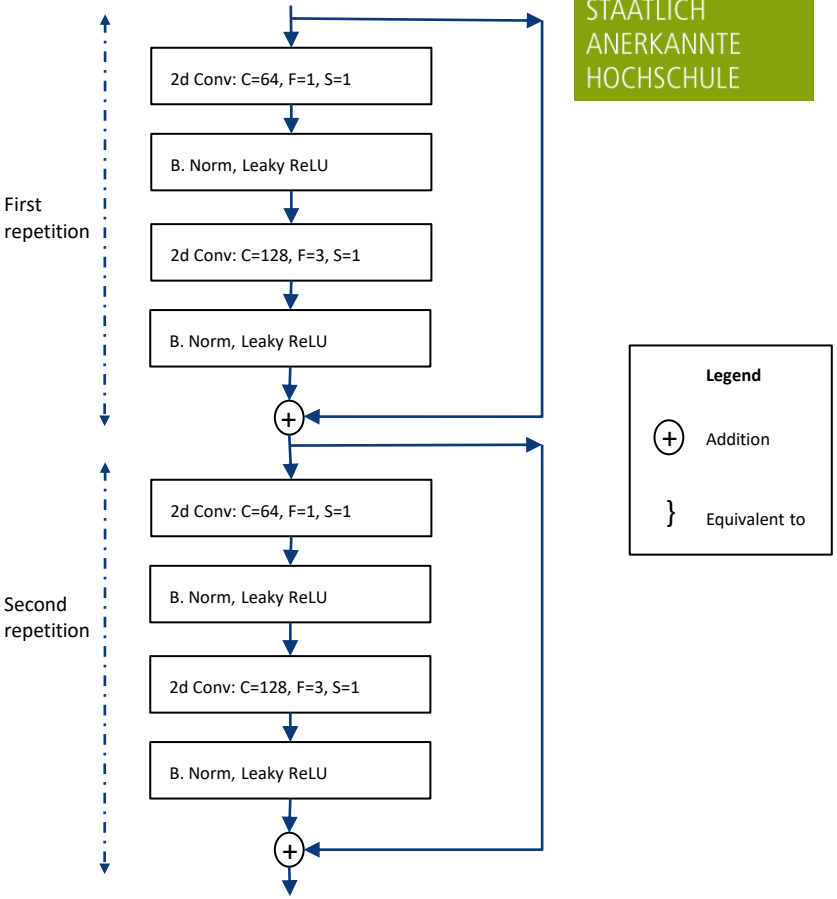
- Series of Convolution, then Batch Normalization, then Leaky ReLU. This is repeated many times.
- Convolution type:
  - Stride = 1, then "same"
  - Stride = 2, then "valid"

- Convolution parameters:
  - C: #Filters
  - F: Filter size
  - S: Stride



- The 2X means the set of operational blocks is repeated two times.





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Model description and visualisation

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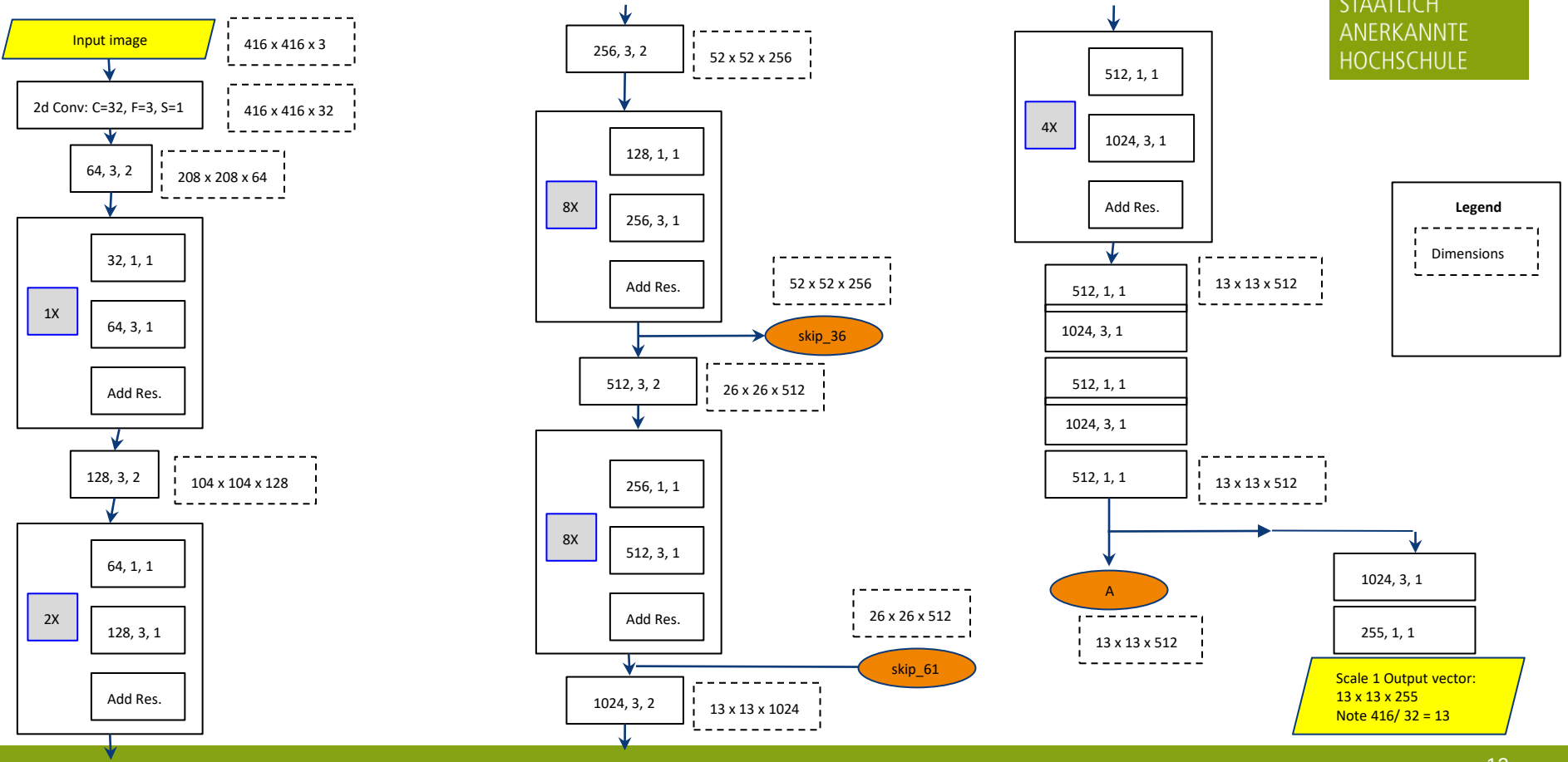

Model description and visualisation

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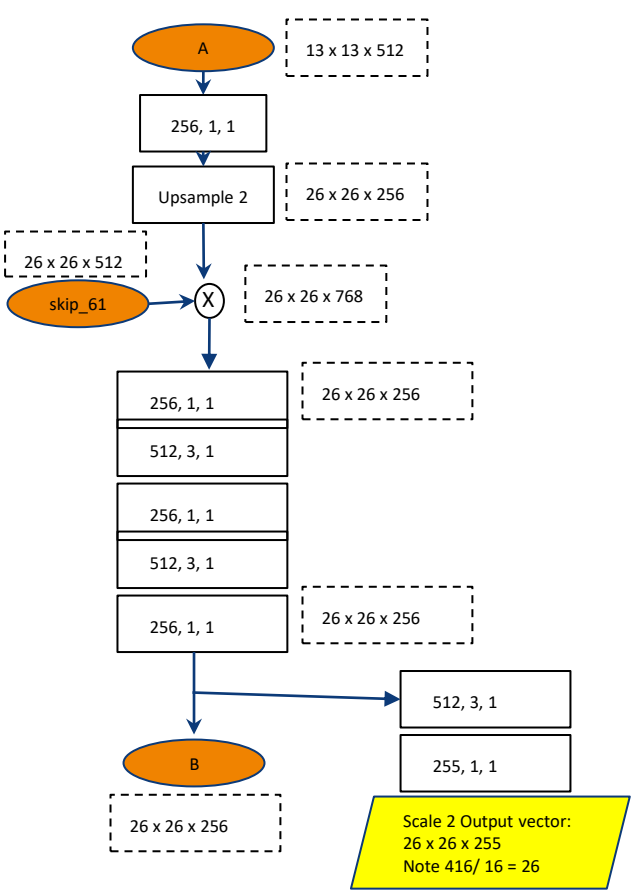

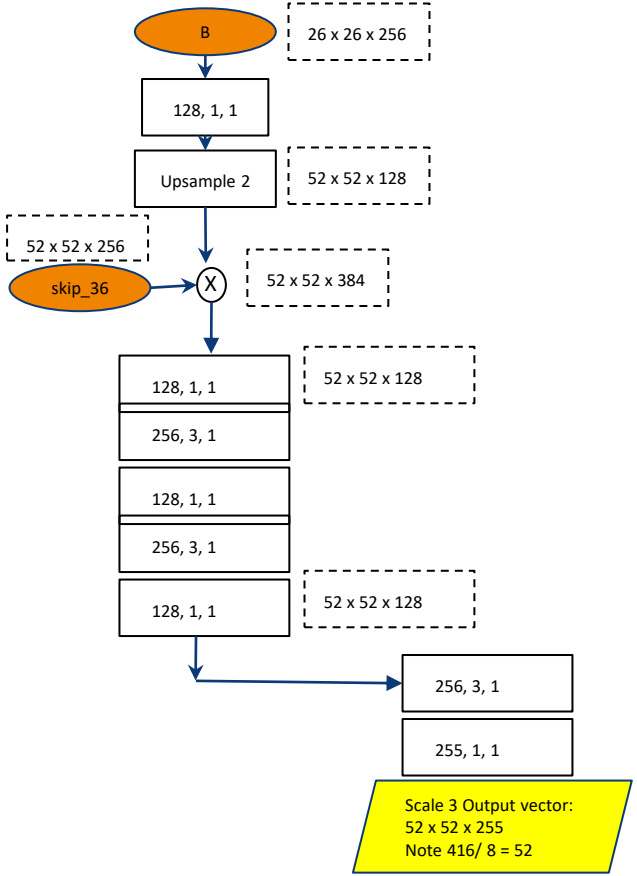

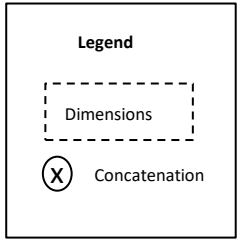

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Demo and Q&A

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- Thank you.