Forecasting from LiDAR via Future Object Detection

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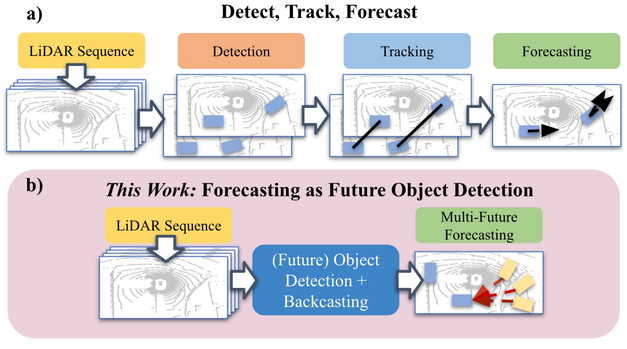
Forecasting Pipeline



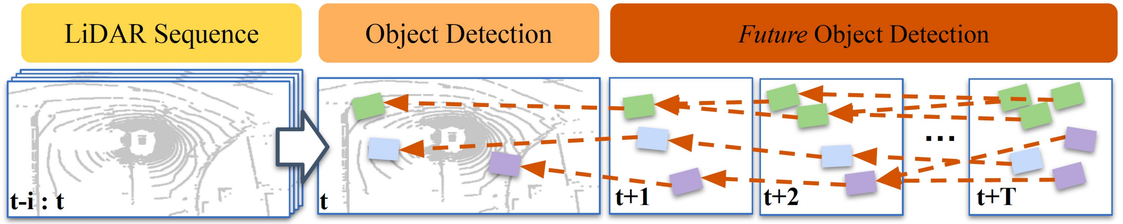
- Instead of joint detection, tracking, and forecasting, we perform joint forecasting-by-detection
- We repurpose the machinery of object detection for forecasting by *future object detection*
- We allow for multiple future prediction and *back-casting*

Forecasting Average Precision

We simply extend Average Precision for the task of forecasting.

- A predicted forecast is a true positive if the center-distance on current *and* future timestep is within distance threshold
- We evaluate multiple futures by taking minimum FDE across top-k future locations

Future Object Detection



- Given *future object detections*, one could produce trajectories using "tracking by association"
- Instead of one-to-one association with bipartite matching, model multiple futures with *many-to-one* matching

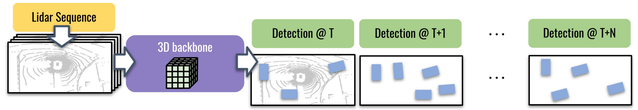
Experimental Results

	ADE@60 (↓)	FDE@60 (↓)	ADE@90 (↓)	FDE@90 (↓)	ADE avg. (↓)	FDE avg. (↓)	$AP_f^{stat.}$ (↑)	$AP_f^{lin.}$ (↑)	$AP_f^{non-lin.}$ (↑)	mAP_f (↑)
Constant Position (CP)	**0.38**	**0.63**	**0.48**	**0.76**	**0.37**	**0.64**	**66.3**	0	0	22.1
PnPNet [33]	0.58	0.93	0.68	1.04	-	-	-	-	-	-
PnPNet w/o Tracker [33]	0.69	1.09	0.75	1.14	-	-	-	-	-	-
Trajectron++ [43]	1.13	2.54	1.25	2.71	1.08	2.42	59.2	8.1	2.8	23.4
SPF2 [49]	-	-	-	-	1.04	1.04	-	-	-	-
Fast and Furious* (FaF) [37]	0.74	1.59	0.83	1.69	0.73	1.56	64.8	**22.2**	**7.5**	**31.5**

	K=1								K=5							
	$AP^{stat.}$		$AP^{lin.}$		$AP^{non-lin.}$		mAP		$AP^{stat.}$		$AP^{lin..}$		$AP^{non-lin.}$		mAP	
	$AP_{det.}$	AP_f	$AP_{det.}$	AP_f	$AP_{det.}$	AP_f	$mAP_{det.}$	mAP_f	$AP_{det.}$	AP_f	$AP_{det.}$	AP_f	$AP_{det.}$	AP_f	$mAP_{det.}$	mAP_f
Detection + Constant Velocity	**70.3**	**66.0**	65.8	21.2	90.0	6.5	**75.4**	31.2	70.3	66.0	65.8	21.2	90.0	6.5	**75.4**	31.2
Detection + Forecast (*cf*. [37])	69.1	64.7	**66.1**	22.2	86.3	7.5	73.8	31.5	69.1	64.7	**66.1**	22.2	86.3	7.5	73.8	31.5
Trajectron++ [43]	**70.3**	59.2	65.8	8.1	90.0	2.8	**75.4**	23.4	70.3	61.7	65.8	9.8	90.0	4.3	75.4	25.3
FutureDet	70.1	65.5	62.9	**24.9**	91.8	**10.1**	74.9	**33.5**	70.1	67.3	62.9	27.7	91.7	11.7	74.9	35.6
FutureDet-PointPillars	70.1	64.1	63.4	24.8	**92.4**	9.6	**75.4**	32.8	**70.7**	**67.5**	63.4	**28.8**	**92.0**	**11.9**	**75.4**	**36.1**
FutureDet + Map	70.2	65.5	62.7	24.3	91.7	9.4	74.9	33.1	70.2	**67.5**	62.7	27.1	91.7	11.0	74.9	35.2

Full paper & code are available at arxiv.org/abs/2203.16297

Network Architecture



- Instead of training a `car` detector, we train an N-class `{currentCar, ..., futureCar}` detector

Multi-Future Forecasting