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CVPR
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Neural Map Prior for Autonomous Driving






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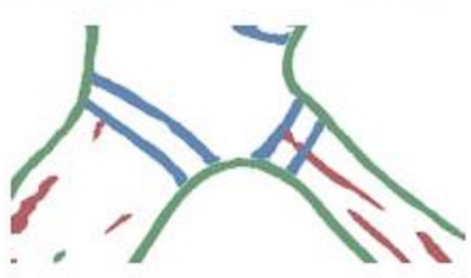
Motivation

Challenging weather like rain makes online HD map predictions harder

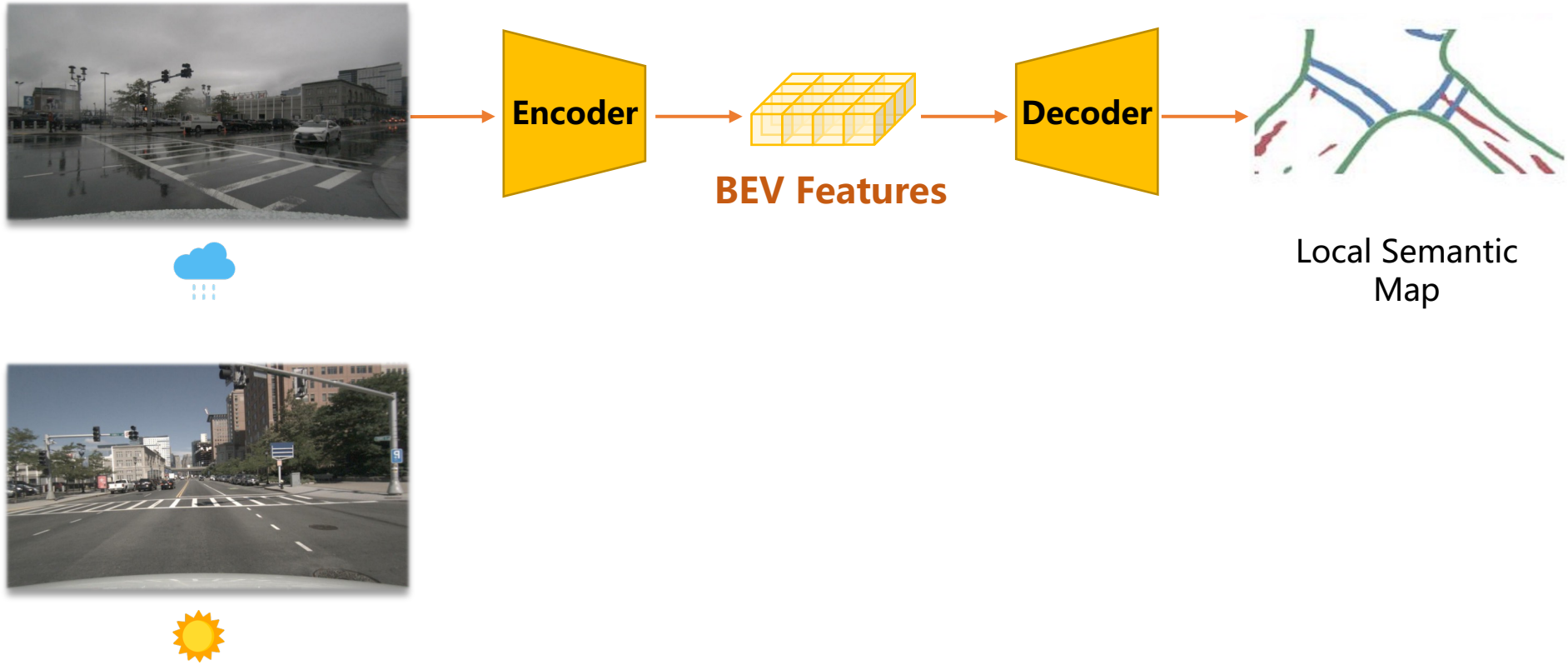


Motivation

Remember the road from previous trips through the same area on sunny days

Method

Neural Map Prior (NMP): A novel hybrid mapping



Method

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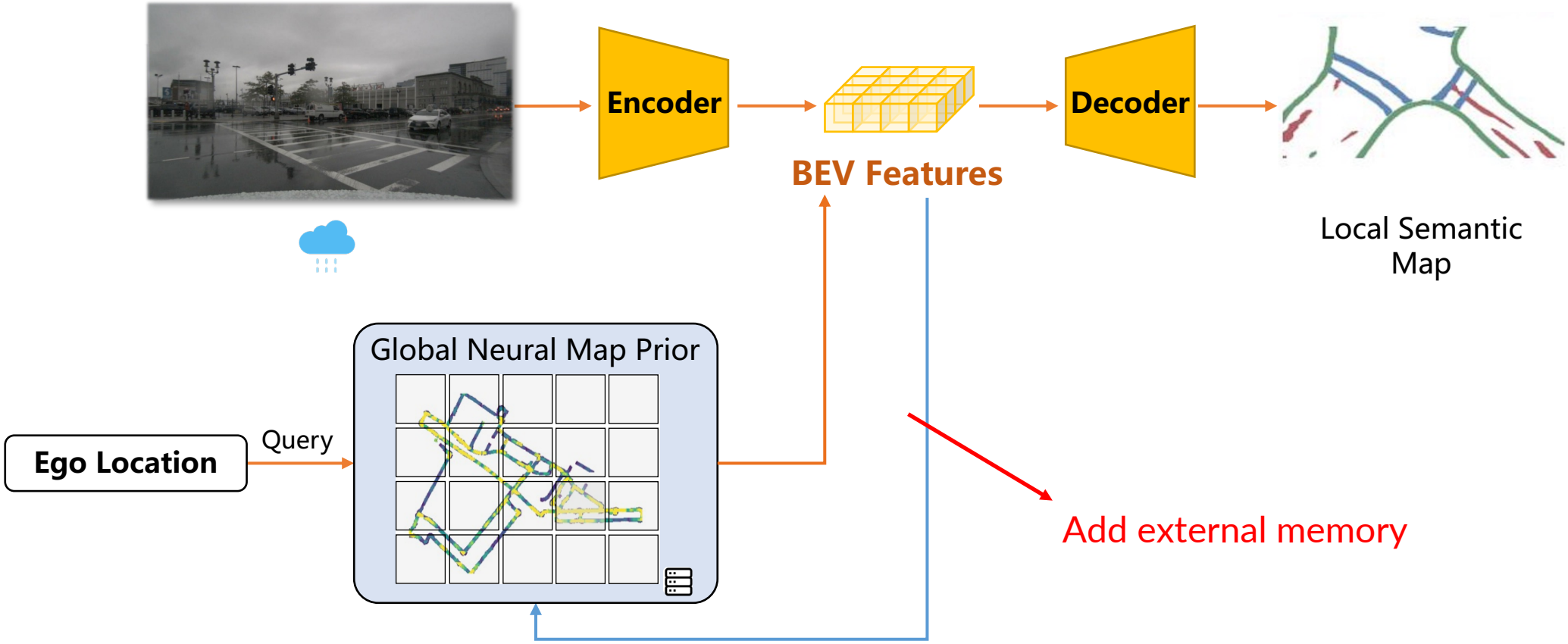
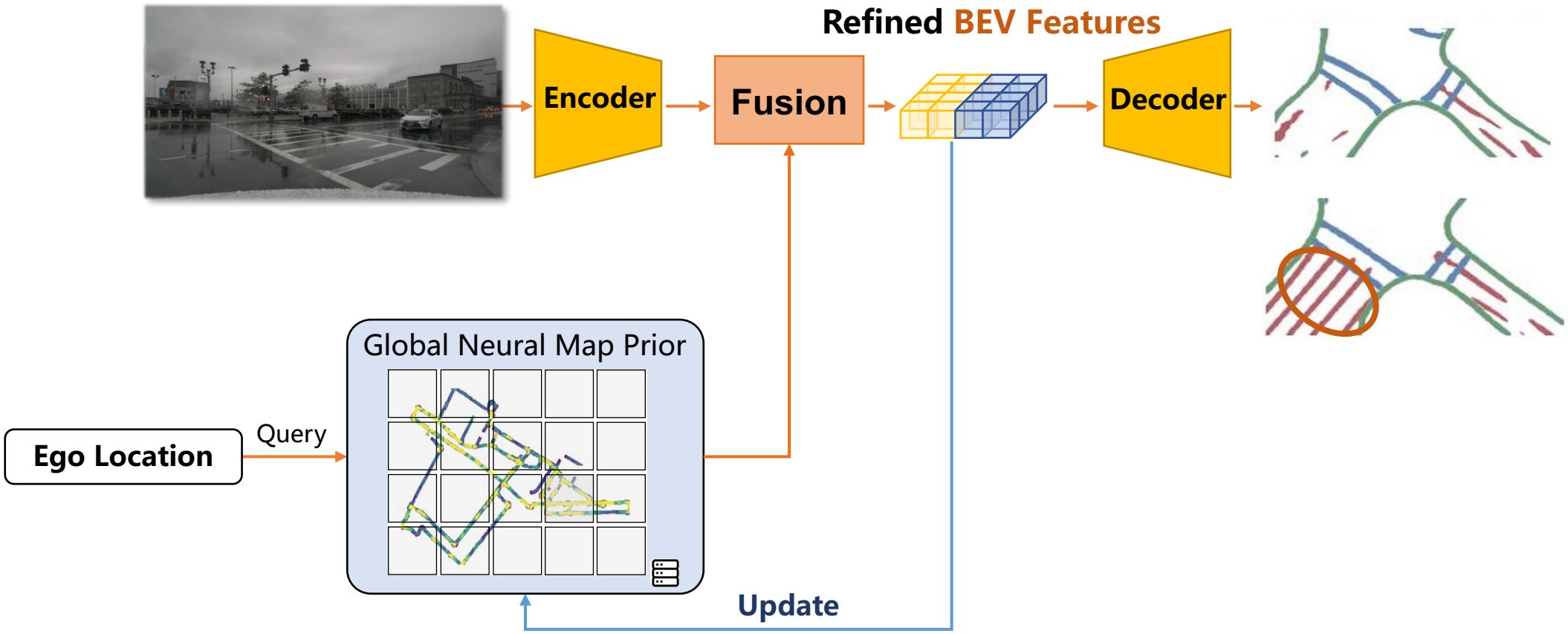
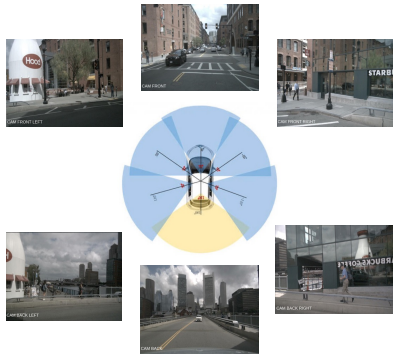


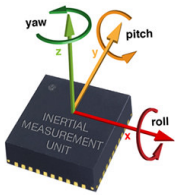
Method

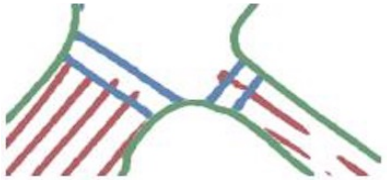
Neural Map Prior (NMP): A novel hybrid mapping



Model Architecture



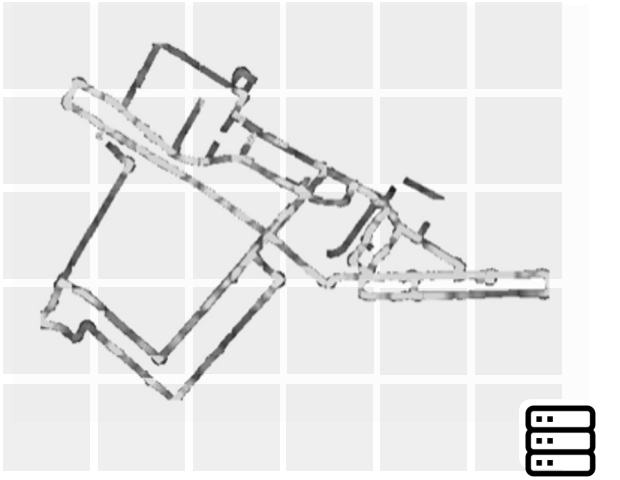




Input: Posed Images

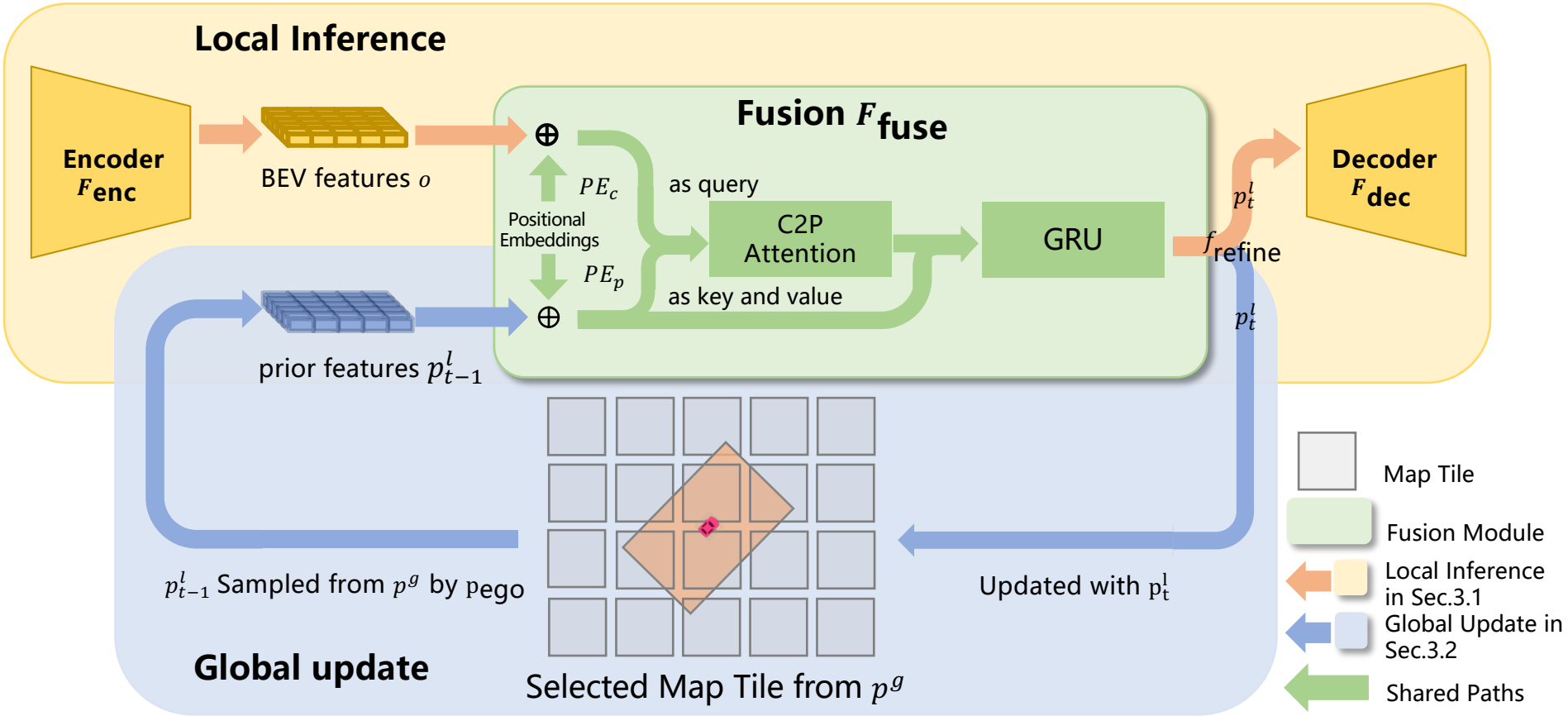
Onboard sensors: Surround-view cameras, GPS/IMU

Output: BEV Semantic Map

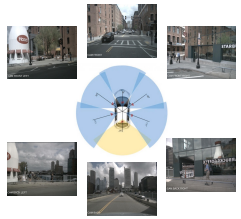


Map Tiles Storage

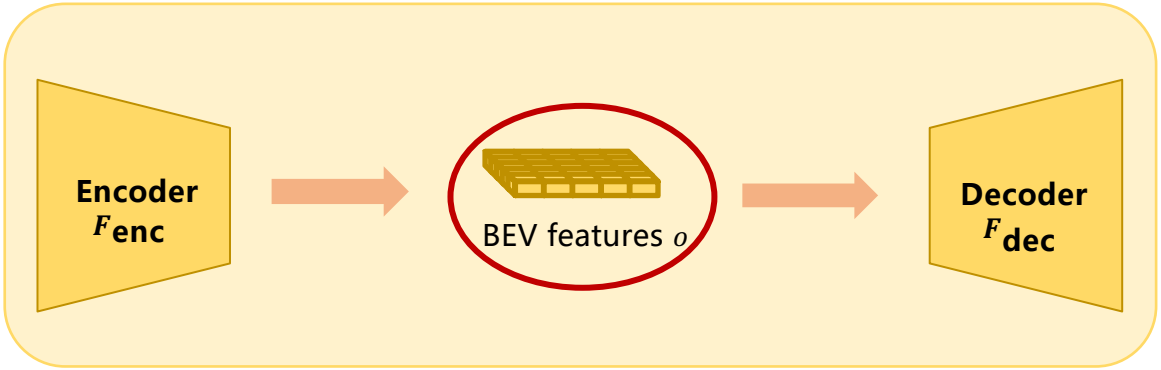
Model Architecture

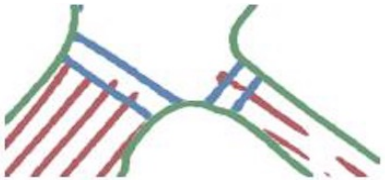


Model Architecture



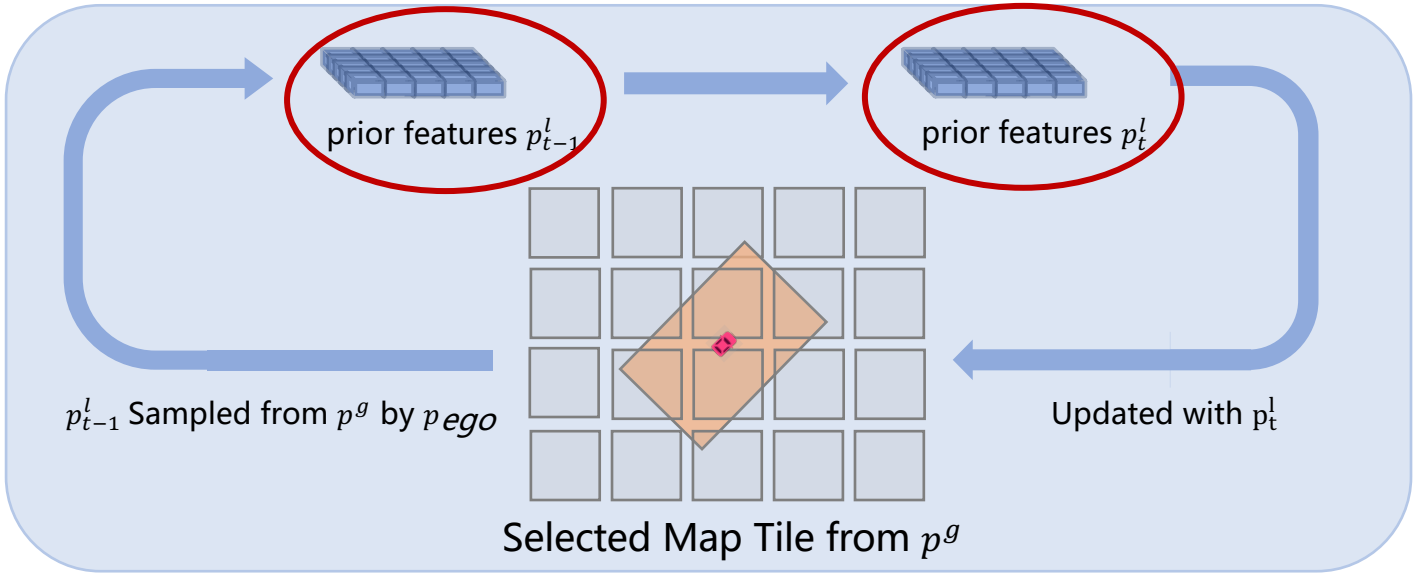
Surrounding camera images





Local Semantic Map

Model Architecture



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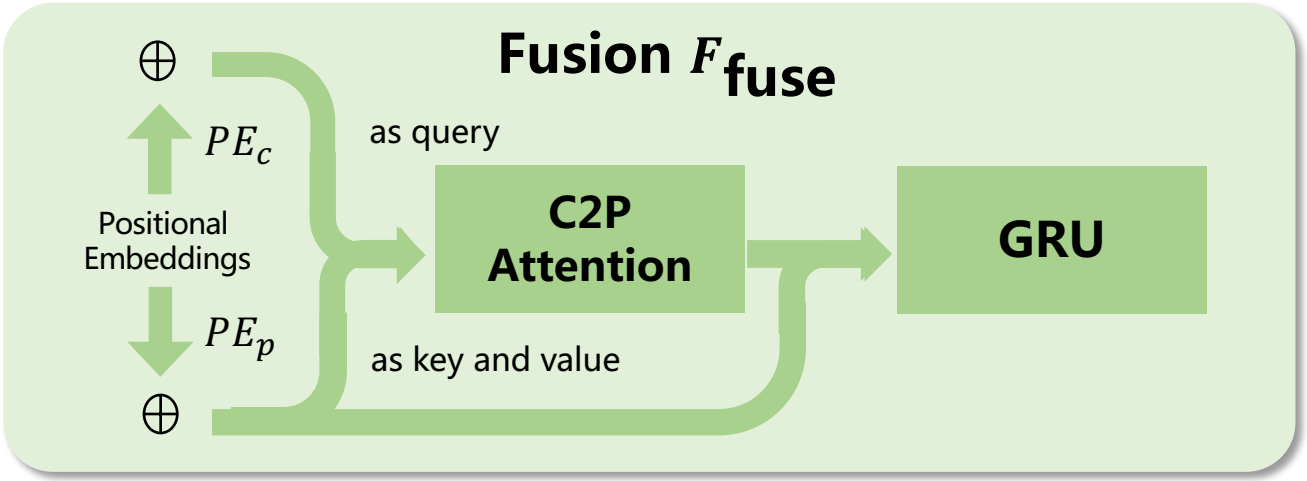

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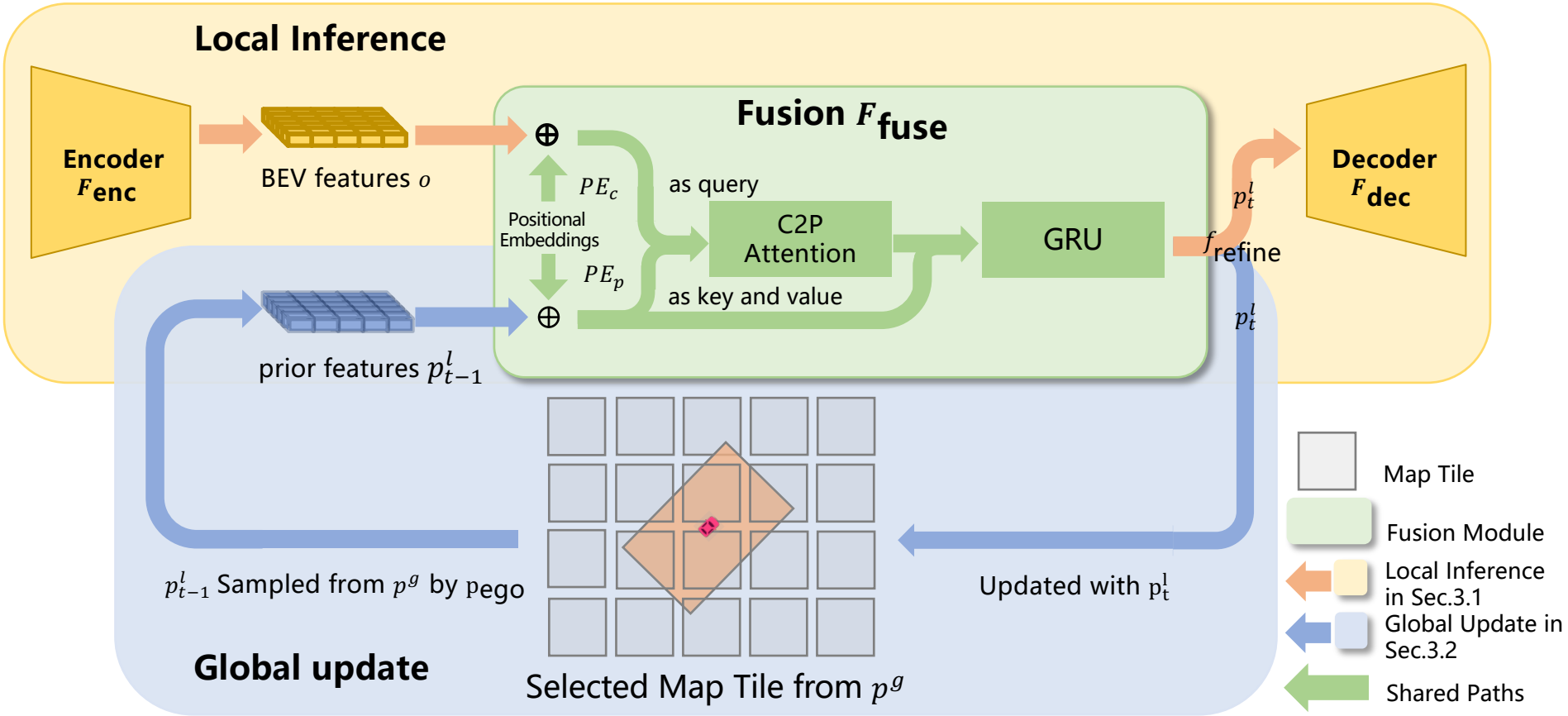


Evaluation Metrics

Mean Intersection-over-union (mIoU)

Measure semantic-level.

Mean Average Precision (mAP)

Measure instance-level.

NMP helps online map inference

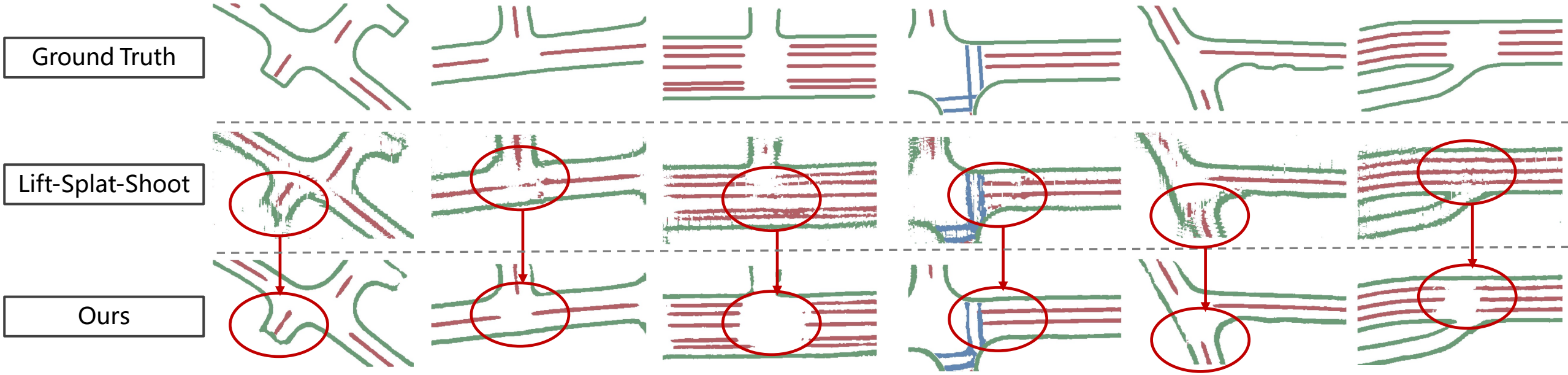
- NMP improves map segmentation and detection performance
- NMP can be applied to other map learning frameworks

Model	mIoU			
	Divider	Crossing	Boundary	All
HDMapNet	41.04	16.23	40.93	32.73
HDMapNet + NMP	**44.15**	**20.95**	**46.07**	**37.05**
△ mIoU	+3.11	+4.72	+5.14	+4.32
LSS	45.19	26.90	47.27	39.78
LSS + NMP	**50.20**	**30.66**	**53.56**	**44.80**
△ mIoU	+5.01	+3.76	+6.29	+5.02
BEVFormer	49.51	28.85	50.67	43.01
BEVFormer + NMP	**55.01**	**34.09**	**56.52**	**48.54**
△ mIoU	+5.50	+5.24	+5.95	+5.53

Model	Average Precision			
	$AP_{Divider}$	$AP_{Crossing}$	$AP_{Boundary}$	mAP
VectorMapNet	47.3	36.1	39.3	40.9
VectorMapNet + NMP	**49.6**	**42.9**	**41.9**	**44.8**
△ AP	+2.3	+6.8	+2.6	+3.9

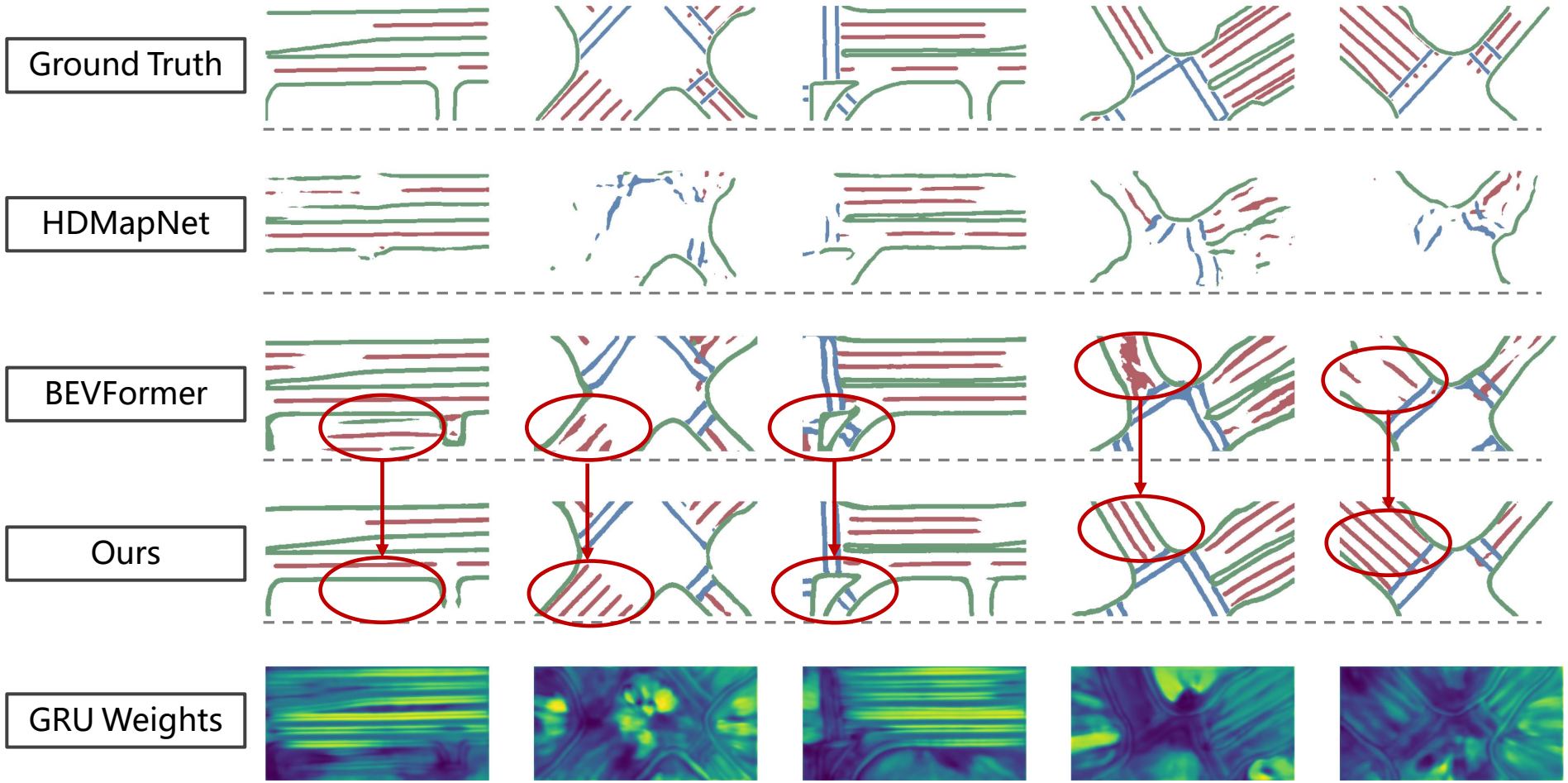
NMP helps online map inference

- Lift-Splat-shoot: https://arxiv.org/abs/2008.05711

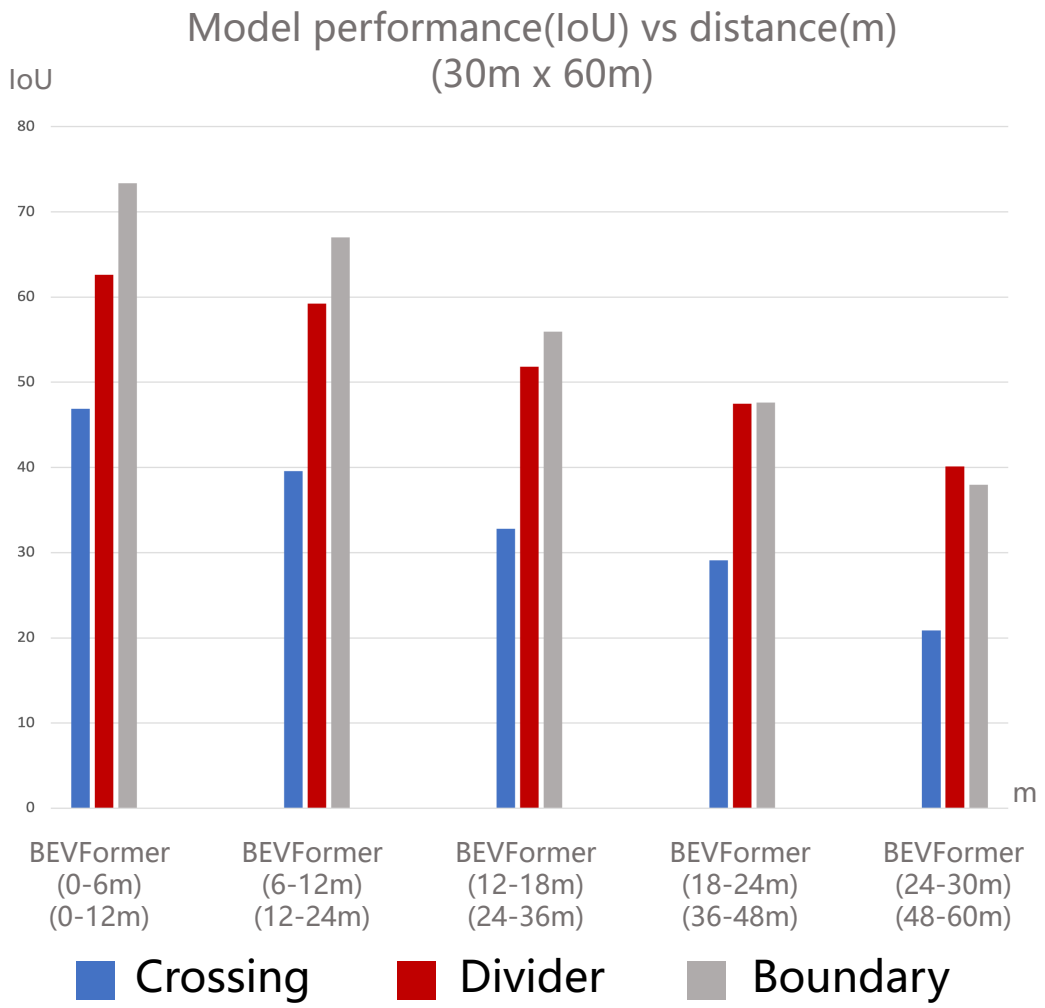


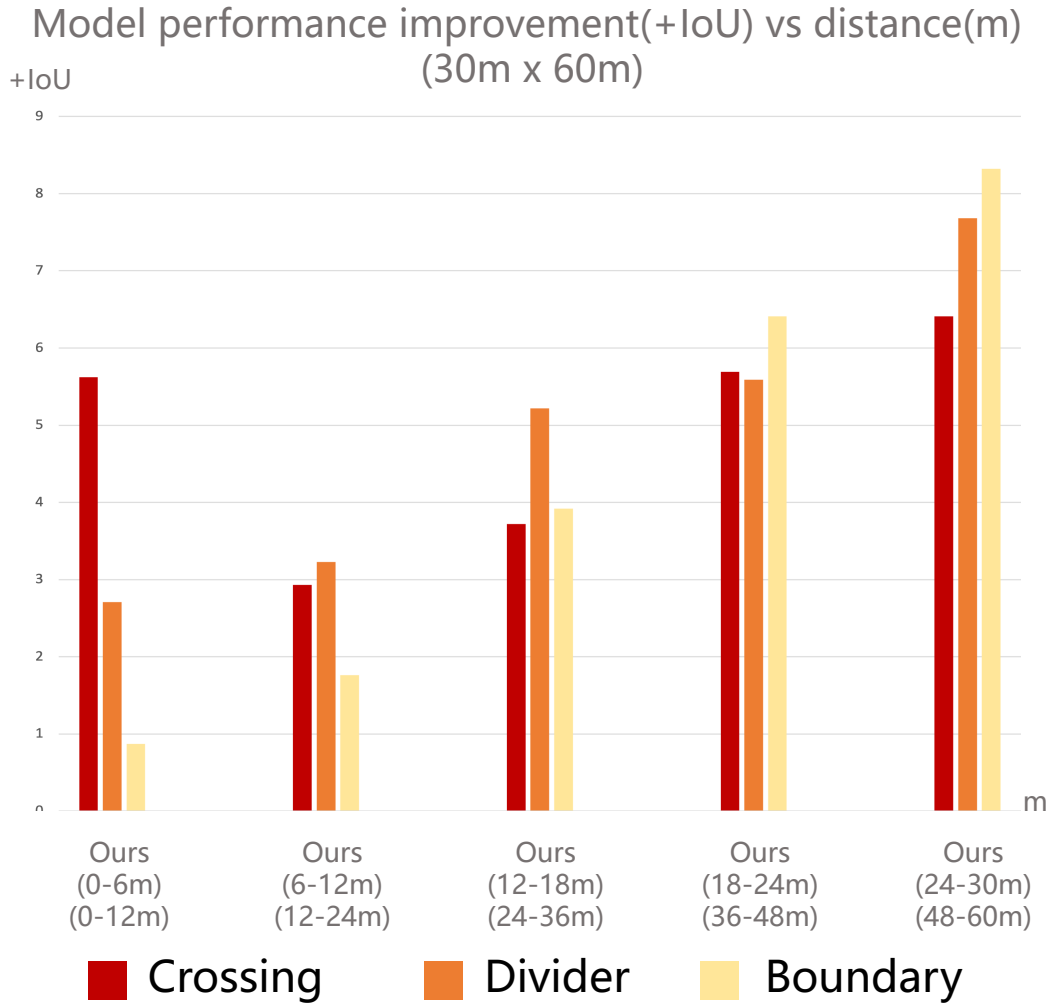
NMP helps online map inference

- HDMapNet: https://arxiv.org/abs/2107.06307
- BEVFormer: http://arxiv.org/abs/2203.17270



NMP helps to see further





NMP helps in bad weathers

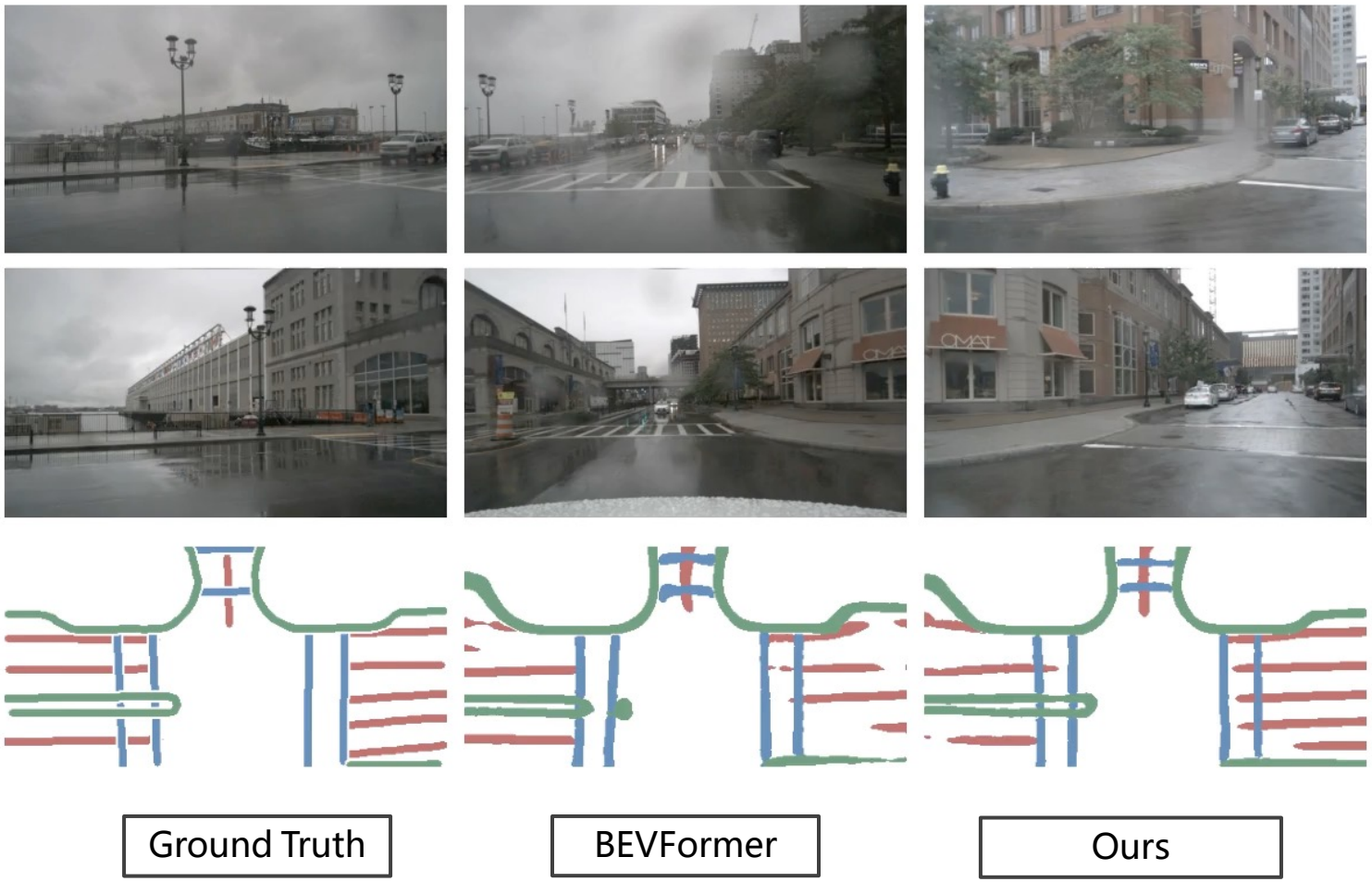
- NMP provides more significant improvements in rain and night driving conditions

Weather	+ NMP	mIoU			
		Divider	Crossing	Boundary	All
Rain	X	50.25	26.90	44.54	40.56
	✓	**54.64**	**30.62**	**54.19**	**46.48**
△ mIoU		+4.39	+3.72	+9.65	+5.92
Night	X	51.02	21.17	48.99	40.39
	✓	**54.66**	**33.78**	**55.92**	**48.12**
△ mIoU		+3.64	+12.61	+6.93	+7.73
NightRain	X	55.76	00.00	47.60	34.45
	✓	**61.22**	00.00	**50.84**	**37.35**
△ mIoU		+5.46	+00.00	+3.24	+2.90
Normal	X	49.27	29.49	52.11	43.62
	✓	**53.46**	**35.27**	**57.75**	**48.82**
△ mIoU		+4.19	+5.78	+5.64	+5.20

NMP helps in bad weathers

Ground Truth | BEVFormer | Ours

NMP helps in bad weathers

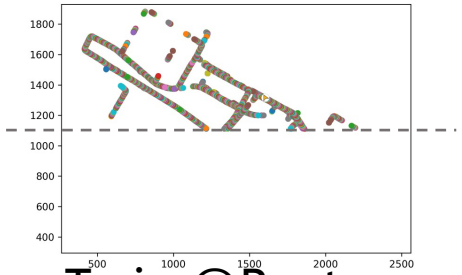


Generalization

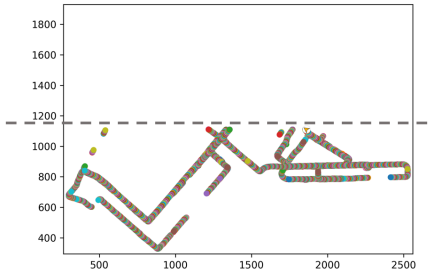
- NMP can alleviate the poor generalization problem in map learning to a certain extent

Data Split	+ NMP	mIoU			
		Divider	Crossing	Boundary	All
Boston Split	X	26.35	15.32	25.06	22.24
	✓	**33.04**	**21.72**	**32.63**	**29.13**
△ mIoU		+6.69	+6.40	+7.57	+6.89
Original Split	X	49.51	28.85	50.67	43.01
	✓	**55.01**	**34.09**	**56.52**	**48.54**
△ mIoU		+5.50	+5.24	+5.95	+5.53

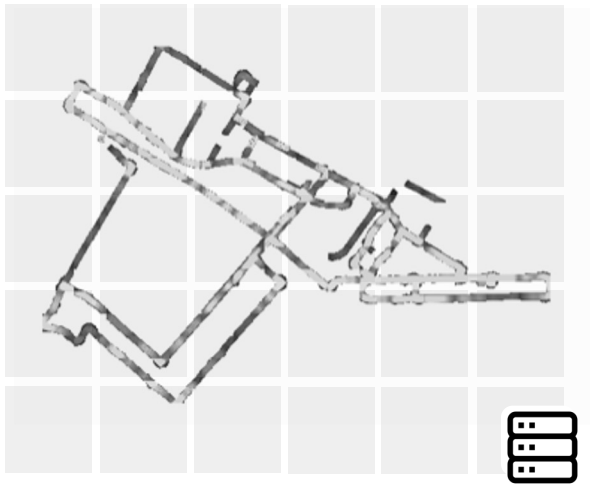
Val @Boston



Train @Boston



Map Tiles



Map Tiles Storage

- Tiling is a common technique utilized on a variety of digital platforms
  - Geographic Information Systems (GIS)
  - Digital Mapping Services (such as Google Maps and Bing Maps)
- Reduces memory requirements therefore less communication overhead

Neural Map Prior Summary

- Project Page: https://tsinghua-mars-lab.github.io/neural_map_prior/
- Paper Link: https://arxiv.org/pdf/2304.08481.pdf

✓ Improves the ability to deal with occlusions and bad weather

✓ Provides perception beyond the visible range

✓ Enables continuous map updating and refinement