

m58774

[EE13.2 Test 3]

Reference point cloud upsampling

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■ Problem statement

- In geometry inter prediction, node occupancy is predicted by reference frame.
- Occupancy prediction is sometimes difficult especially when both reference point cloud and current point cloud are sparse.

■ Proposed Methods

- Upsampling is applied to reference point cloud.
- Each point is upsampled according to the direction corresponding to origin.

■ Experimental results

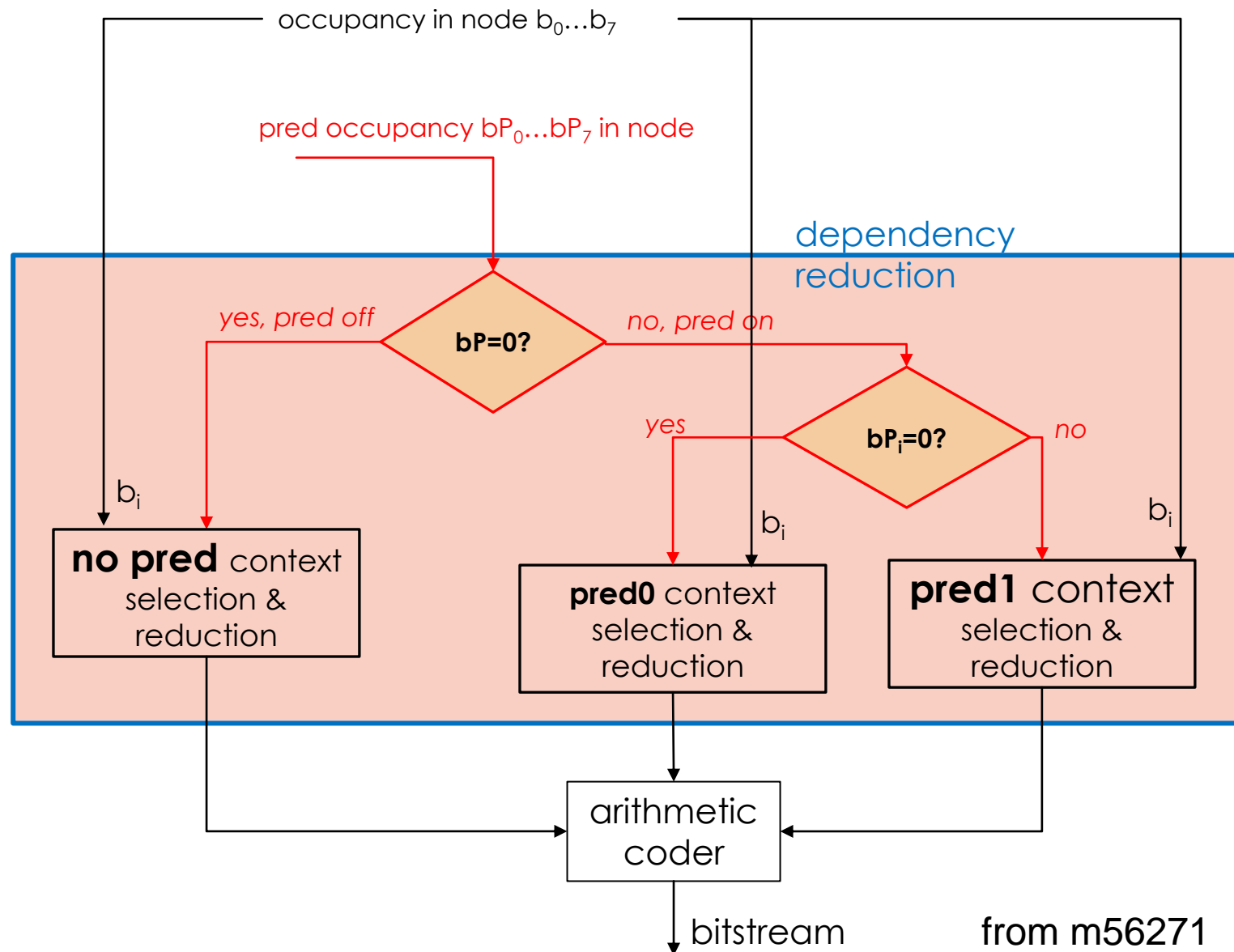
- For lossless, bpip ratio for geometry bits are 100% (Ex. GM) and 102% (In. GM).
- For lossy, BD-rates for D1/D2 are 0.3%/0.3% (Ex. GM) and 0.2%/0.2% (In. GM).
- Coding gains by upsampling are disappeared by Angular mode.

■ Problem statement

- Four context settings for occupancy coding are switched depending on whether reference points exist. (no pred/pred0/pred1/predL)
- “no pred” tends to be selected even if actually points exist.
 - Due to sparsity of (LiDAR) point clouds, geometry noise by acquisition, motion estimation error, etc.

■ Proposal

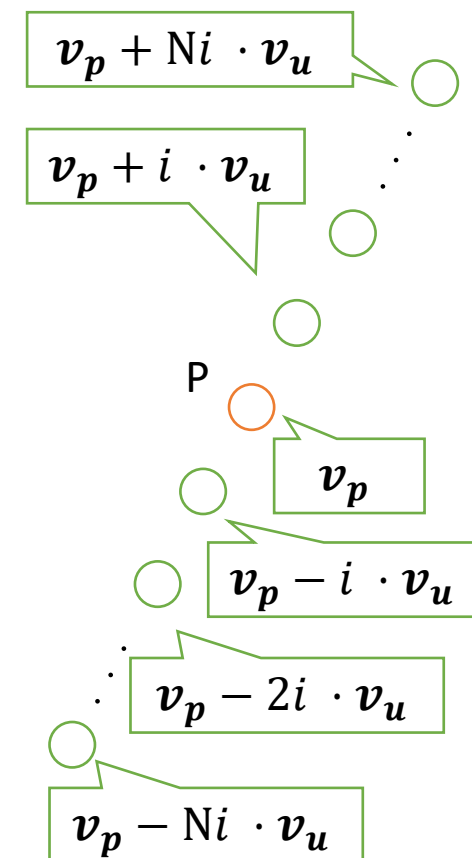
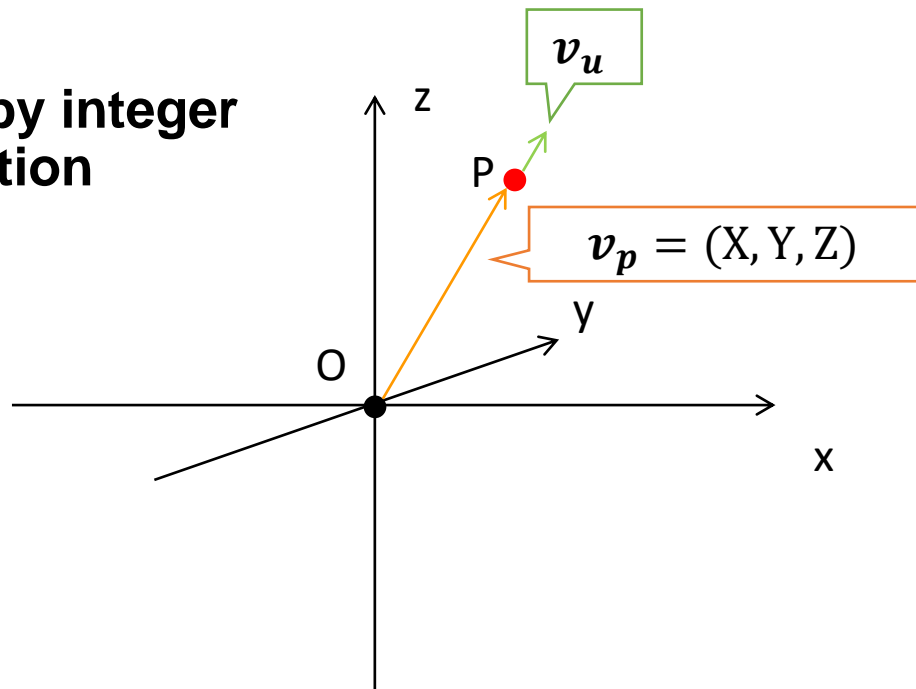
- To improve efficiency of the context modeling, reference point cloud is upsampled.



■ Each point is upsampled according to the direction corresponding to origin.

1. The unit vector v_u of a reference point v_p is calculated as $v_u = v_p / \|v_p\|_2$
2. v_p is upsampled as $v_p \pm n \cdot I \cdot v_u$ ($n = 1, 2, \dots, N$).
 - I : the parameter to control the interval of generated points
 - N : the parameter to control the number of generated points ($2N$ points generated)

These process are done by integer operation and approximation (division is not used).



■ Conditions

- **Anchor : EE13.2 anchor software (InterEMv4)**
 - Octree base, Only use global motion to objects, global motion is externally provided.
 - Angular **ON**, Planar ON.
- **Test : Anchor + Proposed method**
- **Octree – Predlift (CW/C2 condition, Cat3-frame Sequences)**

■ Parameter settings

- **Settings for lossy rate points are derived based on the parameters for lossless and positionQuantizationScale for each point.**

Parameter	r01	r02	r03	r04	r05	r06	Lossless
positionQuantizationScale (defined by CTC)	1/512	1/256	1/64	1/32	1/8	1/4	1
upsampling interval I	0	0	1	1	1	2	8
number of generated points (div2) N	0	0	1	2	8	8	8

■ Results

- Proposed method based on InterEMv4 brings losses for lossless and lossy case.
- On the other hand, proposed method reported in the previous meeting (m58004, based on EMv3) brings coding gains.

Results for lossless

Method	Anchor	Geom. Bpip ratio	Total Bpip ratio	EncT	DecT
Test 3 External GM	InterEMv4 (Ex. GM)	100.0 %	100.0 %	182 %	195 %
Test 3 Internal GM	InterEMv4 (In. GM)	102.9 %	102.3 %	226 %	249 %
m58004 (Ex. GM)	InterEMv3 (Ex. GM)	97.7 %	98.0 %	174 %	182 %

Results for lossy

Method	Anchor	D1 BD-rate	D2 BD-rate	EncT	DecT
Test 3 External GM	InterEMv4 (Ex. GM)	0.3 %	0.3 %	115 %	128 %
Test 3 Internal GM	InterEMv4 (In. GM)	0.2 %	0.2 %	115 %	128 %
m58004 (Ex. GM)	InterEMv3 (Ex. GM)	-0.3 %	-0.3 %	115 %	129 %

- Coding gains of the proposed method disappears due to Angular mode.
 - Large change from EMv3 to EMv4 is Angular mode is enabled.
 - Angular mode has significant coding gains.
 - When Angular is disabled, the proposed method based on EMv4 has the similar performance as the EMv3 case.

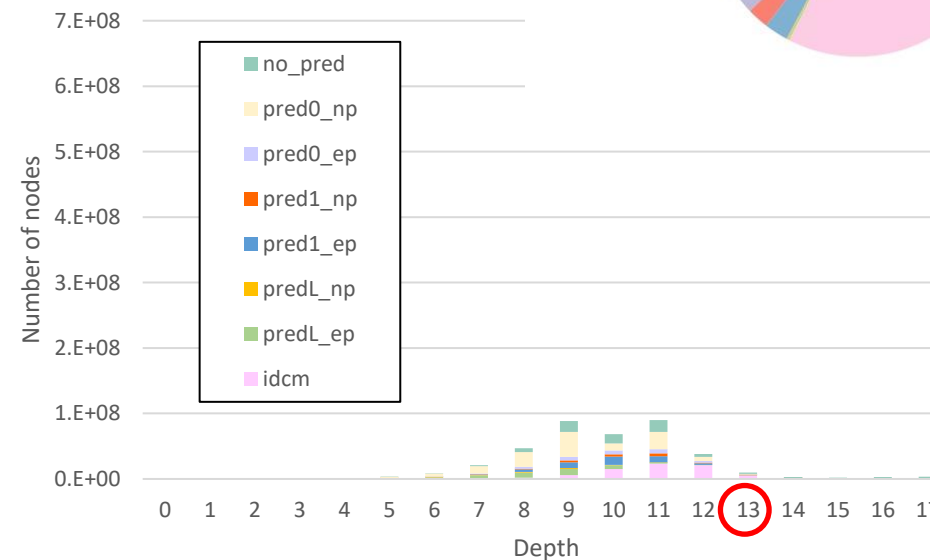
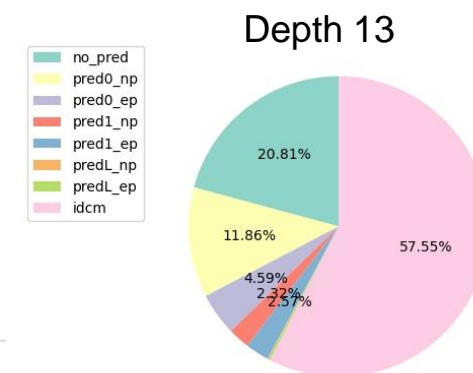
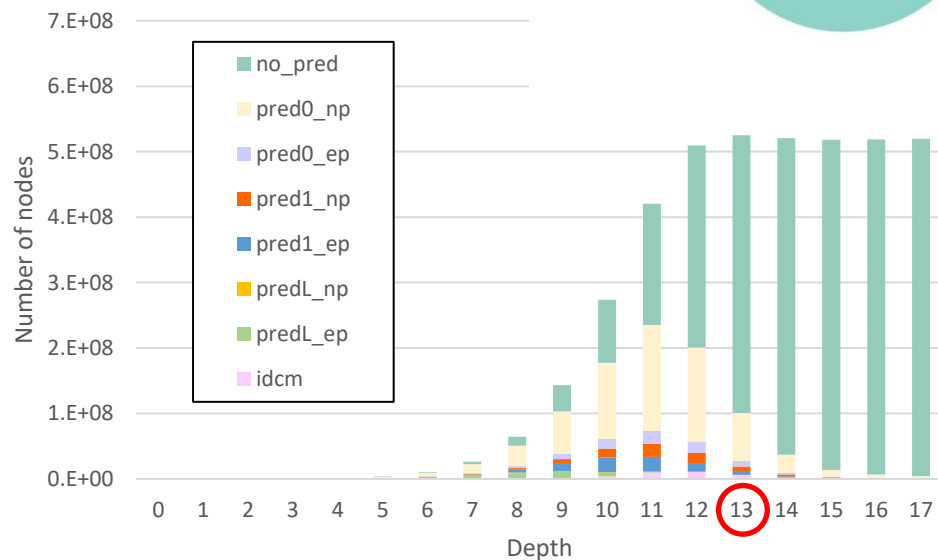
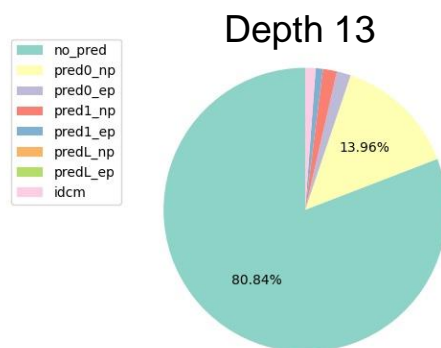
Results for lossless

Method	Anchor	Geom. Bpip ratio	Total Bpip ratio	EncT	DecT
InterEMv4 (Ex. GM) Angular OFF	InterEMv4 (Ex. GM) Angular ON	71.1 %	75.1 %	77 %	78 %
Test 3 External GM Angular ON	InterEMv4 (Ex. GM) Angular ON	100.0 %	100.0 %	182 %	195 %
m58004 (Ex. GM) Angular OFF	InterEMv3 (Ex. GM) Angular OFF	97.7 %	98.0 %	174 %	182 %
Test 3 External GM Angular OFF	InterEMv4 (Ex. GM) Angular OFF	97.7 %	98.0 %	173 %	183 %

■ Context selection (lossless ford01)

● **Anchor** (InterEMv4) Angular **off** vs **Anchor** Angular **on**

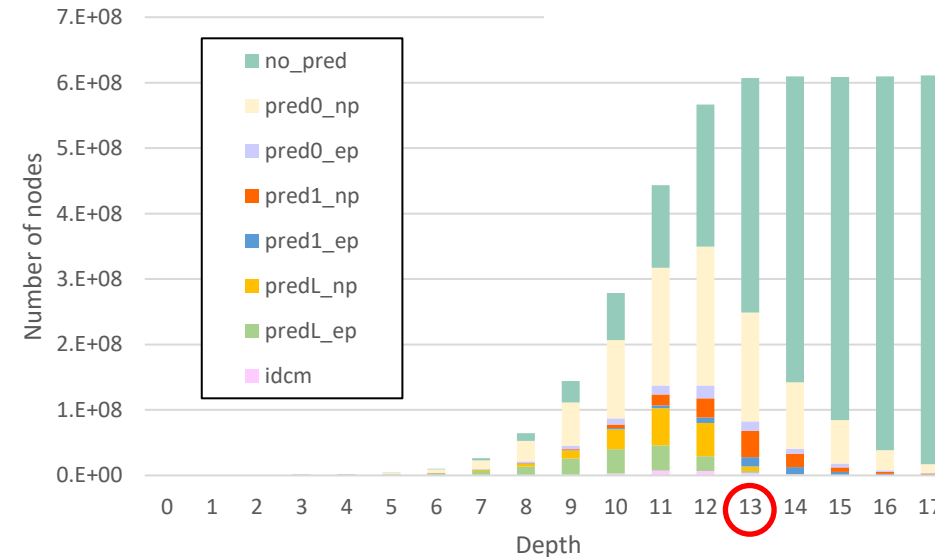
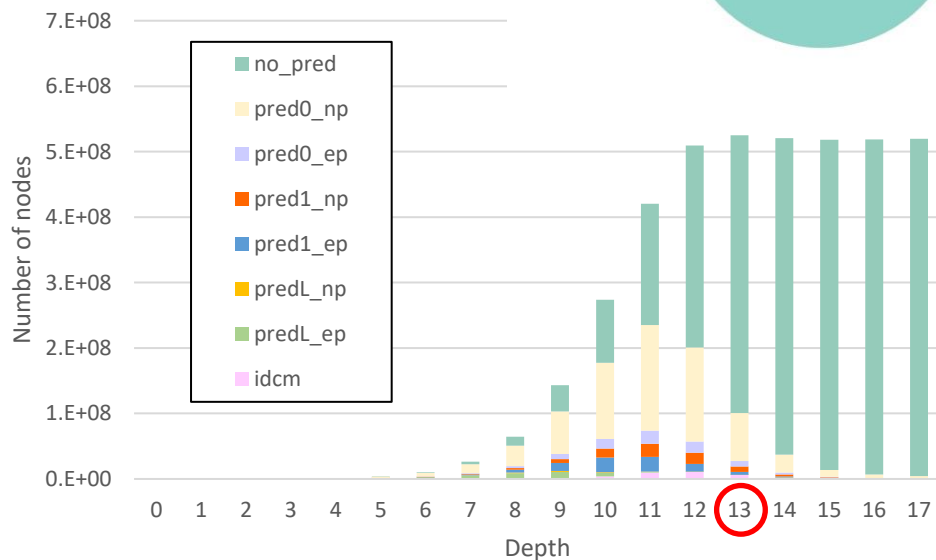
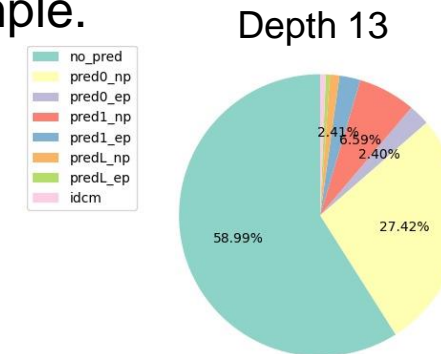
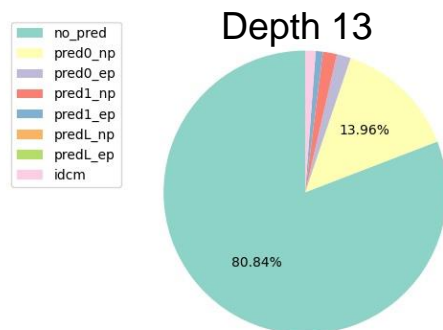
- When angular is on, IDCM nodes (pink) are increased, and total number of nodes are decreased.
- `_np` : no point
- `_ep` : point exists



■ Context selection (lossless ford01)

● **Anchor** (InterEMv4) Angular **off** vs **Upsample** Angular **off**

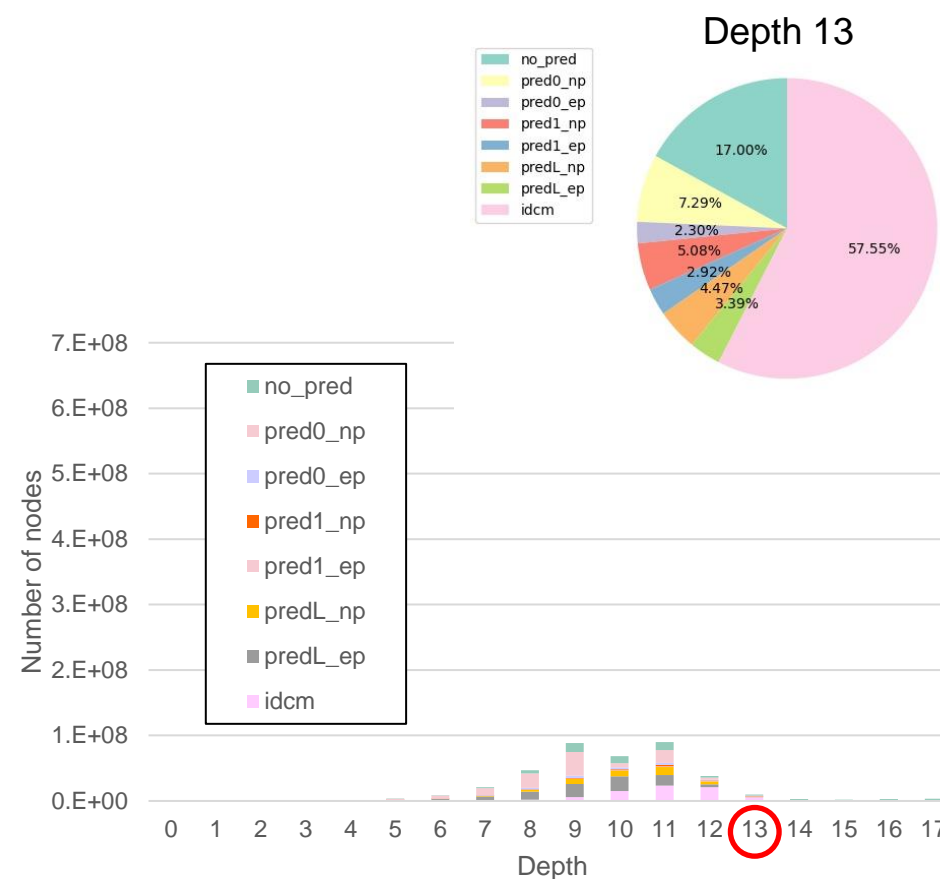
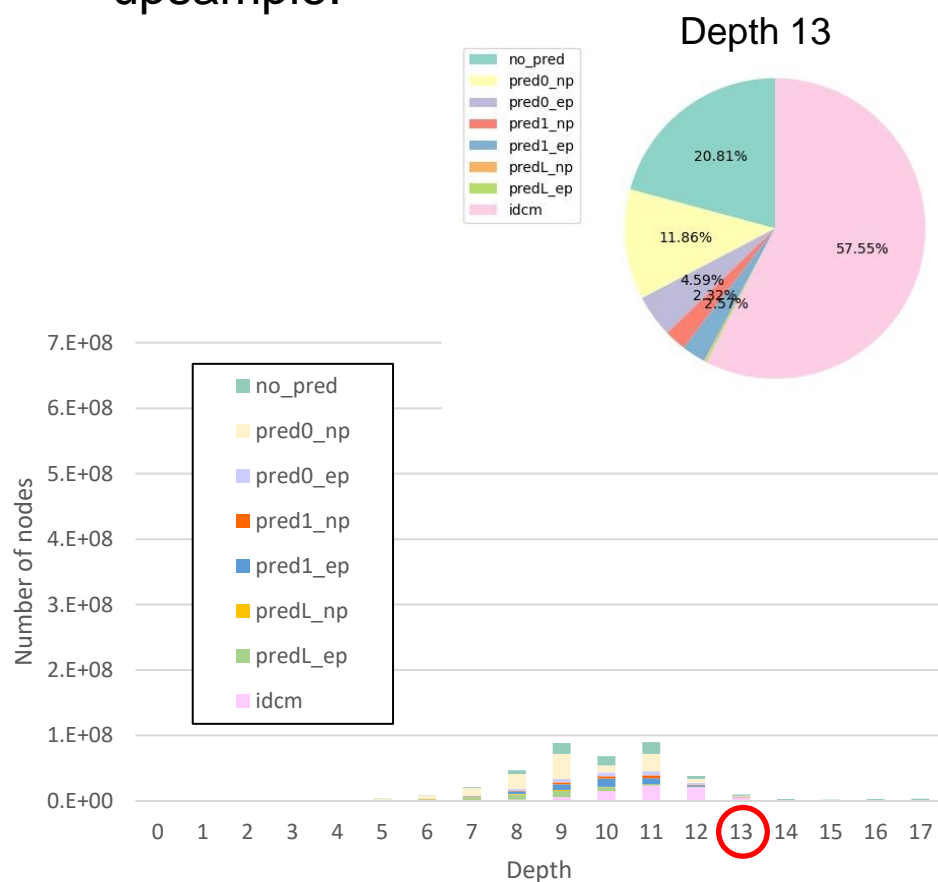
- When angular is off, “no pred” (green) is decreased as expected by upsample.
- “pred0_np” (yellow) and “pred1_np” (red) are increased.



■ Context selection (lossless ford01)

● **Anchor** (InterEMv4) Angular **on** vs **Upsample** Angular **on**

- Number of IDCM nodes (pink) and “no_pred” nodes (green) are not so different between anchor and upsample.



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■ Experimental results

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■ Recommendation

- Stop this study in EE
- Or continue to study in EE as an option when Angular mode is disabled.

Thank Hanyang Univ. for cross-checking.