Does Full Waveform Inversion Benefit from Big Data?

Peng Jin[1,2,*], Yinan Feng[1], Shihang Feng[1], Hanchen Wang[1], Yinpeng Chen[3], Benjamin Consolvo[4], Zicheng Liu[3], and Youzuo Lin[1,*]

[1]Earth and Environmental Sciences Division, Los Alamos National Laboratory
[2]College of Information Sciences and Technology, The Pennsylvania State University
[3]Microsoft
[4]Intel
[*]Corresponding Authors: pqj5125@psu.edu, ylin@lanl.gov

Supplementary

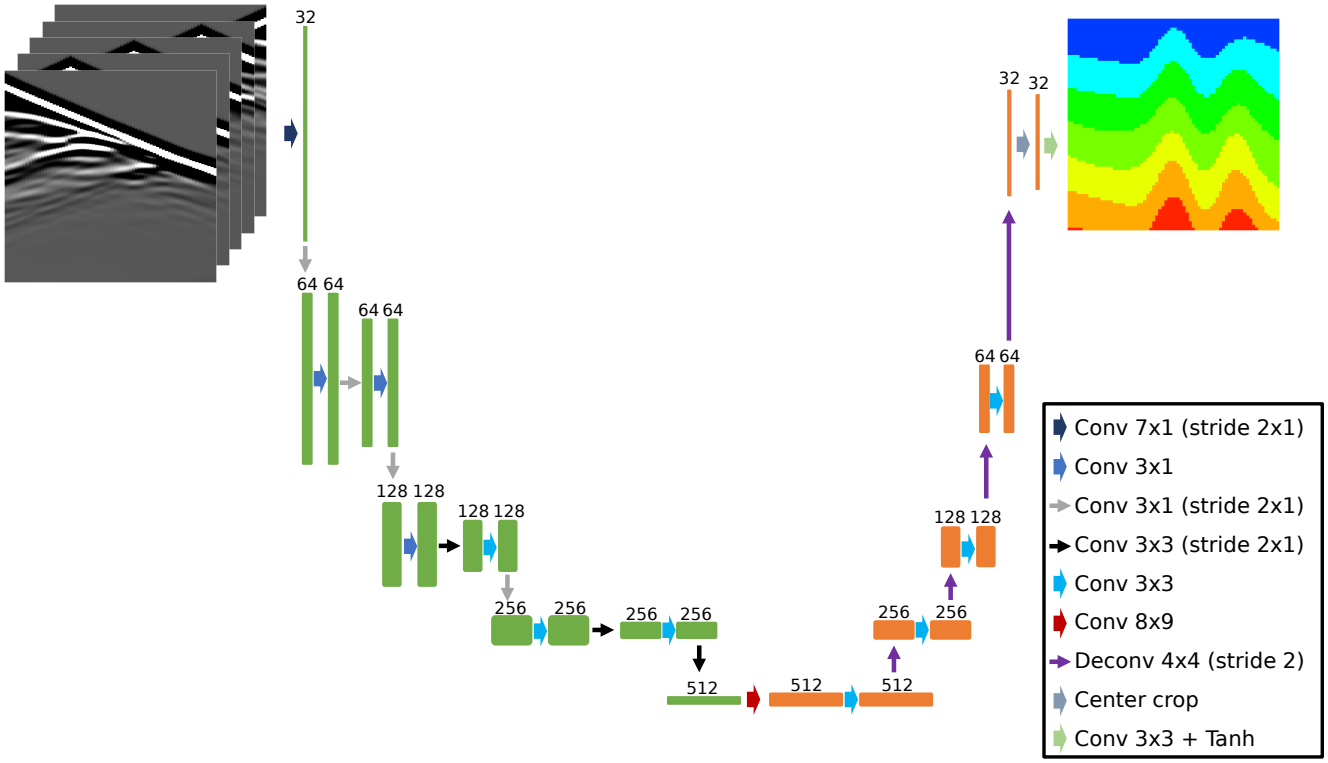


Figure S1. Visualization of the network architecture of InversionNet and BigFWI. Batch normalization layers and activation layers are omitted for simplicity.

Model	Encode Layers	Decode Layers	Latent Length	Parameters
BigFWI-B	14	11	512	24M
BigFWI-M	17	16	512	28M
BigFWI-L	16	14	1024	87M

Table S1. Configurations of BigFWI model variants.

Dataset	InversionNet			BigFWI		
	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑
FlatVel-A	0.0092	0.0163	**0.9930**	**0.0066**	**0.0137**	0.9922
FlatVel-B	**0.0288**	**0.0797**	**0.9582**	0.0298	0.0888	0.9498
CurveVel-A	0.0560	0.1131	0.8405	**0.0415**	**0.0936**	**0.8751**
CurveVel-B	0.1344	0.2697	0.6995	**0.1155**	**0.2471**	**0.7309**
FlatFault-A	0.0138	0.0382	0.9813	**0.0111**	**0.0332**	**0.9841**
FlatFault-B	0.1012	0.1672	0.7267	**0.0855**	**0.1514**	**0.7573**
CurveFault-A	0.0220	0.0607	0.9605	**0.0193**	**0.0556**	**0.9636**
CurveFault-B	0.1610	0.2419	0.5981	**0.1425**	**0.2251**	**0.6292**
Style-A	0.0625	0.1024	0.8839	**0.0592**	**0.0994**	**0.8908**
Style-B	0.0609	0.0971	0.7303	**0.0600**	**0.0962**	**0.7324**

Table S2. Quantitative comparison between the results of InversionNet and BigFWI on OpenFWI-204k.

Dataset	InversionNet			BigFWI-B			BigFWI-M			BigFWI-L		
	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑
FlatVel-A	0.0055	0.0104	0.9964	0.0076	0.0130	0.9943	0.0045	0.0085	0.9965	**0.0041**	**0.0079**	**0.9965**
FlatVel-B	0.0210	0.0632	0.9718	0.0233	0.0696	0.9658	0.0193	0.0621	0.9729	**0.0173**	**0.0584**	**0.9756**
CurveVel-A	0.0409	0.0944	0.8796	0.0343	0.0798	0.9027	0.0272	0.0725	0.9180	**0.0260**	**0.0705**	**0.9199**
CurveVel-B	0.1073	0.2349	0.7527	0.0933	0.2154	0.7808	0.0816	0.2006	0.8053	**0.0772**	**0.1947**	**0.8134**
FlatFault-A	0.0096	0.0278	0.9880	0.0106	0.0286	0.9871	0.0075	0.0229	0.9904	**0.0066**	**0.0208**	**0.9918**
FlatFault-B	0.0843	0.1497	0.7635	0.0710	0.1321	0.8027	**0.0636**	**0.1259**	**0.8137**	0.0644	0.1269	0.8033
CurveFault-A	0.0164	0.0485	0.9712	0.0167	0.0474	0.9712	0.0130	0.0404	0.9771	**0.0117**	**0.0369**	**0.9801**
CurveFault-B	0.1444	0.2248	0.6274	0.1245	0.2027	0.6781	**0.1161**	**0.1954**	**0.6896**	0.1169	0.1960	0.6790
Style-A	0.0567	0.0947	0.8972	0.0514	0.0868	0.9125	**0.0480**	**0.0829**	**0.9187**	0.0483	0.0831	0.9136
Style-B	0.0542	0.0890	0.7646	0.0553	0.0876	0.7567	**0.0538**	**0.0867**	**0.7600**	0.0563	0.0908	0.7429

Table S3. Quantitative comparison between the results of InversionNet and BigFWIs on OpenFWI-408k.

Target Dataset	InversionNet				BigFWI		
	Source	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑
FlatVel-A	FlatVel-B	0.0207	0.0381	0.9723	**0.0137**	**0.0285**	**0.9795**
FlatVel-B	CurveVel-B	0.1076	0.2331	0.7797	**0.0820**	**0.1970**	**0.8345**
CurveVel-A	CurveVel-B	0.0833	0.1458	0.7828	**0.0578**	**0.1114**	**0.8404**
CurveVel-B	FlatFault-B	0.4267	0.5649	0.4234	**0.2543**	**0.4042**	**0.5373**
FlatFault-A	CurveFault-A	0.0394	0.0979	0.9224	**0.0211**	**0.0626**	**0.9618**
FlatFault-B	CurveFault-B	0.1213	0.1895	0.6677	**0.0998**	**0.1630**	**0.7343**
CurveFault-A	FlatFault-B	0.0834	0.1537	0.8364	**0.0398**	**0.0955**	**0.9198**
CurveFault-B	FlatFault-B	0.1898	0.2840	0.5369	**0.1638**	**0.2528**	**0.5905**
Style-A	Style-B	0.1195	0.1655	0.7653	**0.0948**	**0.1372**	**0.8049**
Style-B	Style-A	0.0858	0.1226	0.6817	**0.0801**	**0.1142**	**0.6871**

Table S4. Quantitative comparison between the generalization results of InversionNet and BigFWIs.

Dataset	InversionNet-SA			InversionNet-SB			BigFWI-M			BigFWI-L		
	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑	MAE↓	RMSE↓	SSIM↑
Marmousi (smooth)	0.1410	0.1996	0.7408	0.1456	0.1988	0.5886	**0.0792**	**0.1164**	**0.8356**	0.0823	0.1244	0.7808
Marmousi (original)	0.1783	0.2505	0.4749	0.2161	0.2942	0.3798	**0.1492**	**0.2323**	**0.4936**	0.1549	0.2419	0.4806
Overthrust (smooth)	0.1213	0.1719	0.7511	0.1062	0.1398	0.6898	**0.0722**	**0.1000**	**0.7599**	0.0760	0.1001	0.7491
Overthrust (original)	0.2052	0.2742	0.4177	0.1819	0.2414	0.4252	**0.1549**	**0.2040**	**0.4608**	0.1775	0.2297	0.3938

Table S5. Quantitative comparison betwen the generalization results of InversionNet and BigFWIs on Marmousi and Overthrust.