Supplementary Material for QFib: Fast and Efficient Brain Tractogram Compression

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1 Detailed tables.

In this section, we add more details on the tables presented in the articles. They are referenced using the same numbers. We added the 1.0 mm stepsize and the 60k streamlines datasets.

Stepsize δ	0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines	60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Size of input file (GB)												
Deterministic	0.46	3.80	22.8	0.23	1.92	11.5	0.10	0.84	5.01	0.06	0.49	2.94
Probabilistic	0.52	4.36	26.2	0.28	2.35	14.1	0.15	1.26	7.53	0.12	1.03	6.16
Maximum angle (°)												
Deterministic	7.20	7.20	7.20	14.4	14.4	14.4	36.0	36.0	36.0	72.0	72.0	72.0
Probabilistic	14.3	14.3	14.4	28.5	28.6	28.8	70.8	71.5	71.6	142	144	144

Table 1: Size of the files (tck format) and maximum angle of each tractogram.

Stepsize δ		0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines		60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Maximum error ($\times 10^{-2} mm$)													
Quantization	Precision	Deterministic											
Fibonacci	8 bits	4.94	4.94	5.30	10.0	10.3	10.6	32.1	33.2	34.1	75.8	81.0	88.0
	16 bits	0.54	0.50	0.57	0.25	0.28	0.28	0.36	0.39	0.38	1.26	1.39	1.42
Octahedral	8 bits	7.27	7.53	8.03	15.1	16.5	16.5	48.2	46.7	51.0	122	127	129
	16 bits	0.55	0.50	0.56	0.25	0.27	0.29	0.50	0.50	0.52	1.82	1.81	1.91
Quantization	Precision	Probabilistic											
Fibonacci	8 bits	2.94	3.04	2.95	5.33	5.86	5.91	18.2	19.7	20.6	39.4	41.8	44.4
	16 bits	0.12	0.13	0.14	0.13	0.14	0.16	0.66	0.69	0.72	1.90	2.06	2.08
Octahedral	8 bits	4.74	4.79	4.90	8.48	8.55	9.38	29.6	29.8	31.7	63.0	63.6	67.1
	16 bits	0.12	0.13	0.14	0.16	0.17	0.19	0.82	0.87	0.93	2.51	2.66	2.83
Average error ($\times 10^{-3} mm$)													
Quantization	Precision	Deterministic											
Fibonacci	8 bits	10.4	2.54	0.52	25.7	9.10	2.04	79.5	55.8	9.76	184	153	38.9
	16 bits	0.23	0.10	0.03	0.26	0.10	0.03	1.09	0.47	0.11	3.99	3.04	0.57
Octahedral	8 bits	14.7	3.12	0.55	37.0	12.4	2.29	116	66.8	18.8	270	216	64.6
	16 bits	0.23	0.10	0.03	0.27	0.10	0.03	1.19	0.64	0.15	4.39	3.27	1.01
Quantization	Precision	Probabilistic											
Fibonacci	8 bits	11.2	1.35	0.22	21.3	5.01	0.83	57.9	19.2	3.73	112	46.5	8.66
	16 bits	0.14	0.04	0.01	0.37	0.08	0.01	2.04	0.63	0.16	6.53	2.87	0.48
Octahedral	8 bits	13.4	2.69	0.45	35.0	5.21	1.11	84.4	37.5	6.26	148	68.8	15.3
	16 bits	0.16	0.04	0.01	0.43	0.08	0.02	2.31	0.94	0.20	7.28	2.94	0.59

Table 2: Maximum and average errors of our method depending on the dataset, precision in bits and quantization method.

Stepsize δ		0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines		60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Compression ratios (in percentage)													
Method	Precision	Deterministic											
`qfib`	8 bits	91.4	91.4	91.4	91.1	91.1	91.1	90.4	90.4	90.4	89.6	89.5	89.5
	16 bits	83.1	83.1	83.1	82.8	82.8	82.8	82.2	82.3	82.2	81.5	81.4	81.4
`zfib`	same*	78.5	N/A	N/A	78.4	78.4	N/A	96.7	96.6	96.8	96.2	96.3	96.3
	0.2 mm	98.1	98.1	98.1	95.9	95.9	96.0	87.5	87.5	87.5	74.2	74.2	N/A
Method	Precision	Probabilistic											
`qfib`	8 bits	91.4	91.4	91.4	91.2	91.2	91.2	90.8	90.8	90.8	90.7	90.7	90.6
	16 bits	83.1	83.1	83.1	82.9	82.9	82.9	82.6	82.6	82.6	82.5	82.4	82.4
`zfib`	same*	78.1	N/A	N/A	78.0	78.1	N/A	86.8	87.1	N/A	87.4	87.6	88.5
	0.2 mm	96.0	96.0	N/A	88.7	88.7	N/A	69.9	69.9	N/A	67.9	67.9	N/A

same*: same error than `qfib` when using an 8 bit octahedral quantization (Table.2).

Table 3: Compression ratios of `qfib` and `zfib`. The N/A values are the ones for which the algorithm was not able to perform the compression and decompression.

Stepsize δ		0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines		60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Compression time (s)													
Deterministic	`qfib` (fibo)	2.94	24.1	144	1.50	12.8	74.8	0.66	5.49	32.0	0.42	3.28	19.04
	`qfib` (octa)	0.94	7.83	46.5	0.50	3.81	22.6	0.21	1.67	9.76	0.12	0.98	6.00
	`zfib`	84.1	702	4243	46.3	387	2284	45.7	387	2373	57.8	475.2	N/A
Probabilistic	`qfib` (fibo)	3.40	27.9	167	1.90	15.3	90.6	1.04	8.27	49.7	0.85	6.82	40.6
	`qfib` (octa)	1.09	8.61	54.7	0.60	4.86	29.0	0.31	2.53	15.5	0.25	2.05	12.7
	`zfib`	104	910	N/A	127	1052	N/A	174	1418	N/A	147	1252	N/A
Decompression time (s)													
Deterministic	`qfib` (fibo)	0.61	4.98	30.1	0.32	2.61	15.4	0.15	1.14	6.79	0.09	0.70	3.97
	`qfib` (octa)	0.44	3.56	20.7	0.25	1,90	11.3	0.11	0.88	5.30	0.06	0.47	3.09
	`zfib`	1.46	12.1	72.7	1.54	12.9	77.1	2.05	17.3	103	2.53	20.9	N/A
Probabilistic	`qfib` (fibo)	0.70	5.77	34.9	0.39	3.23	18.9	0.22	1.75	10.3	0.18	1.44	8.37
	`qfib` (octa)	0.47	4.08	24.3	0.25	2.24	13.3	0.14	1.29	7.47	0.20	1.06	6.32
	`zfib`	3.40	28.5	N/A	5.14	43.0	N/A	7.34	60.8	N/A	6.45	53.6	N/A

Table 4: Computation times of `qfib` and `zfib`. With `zfib`, we set the maximal error to 0.2 mm. N/A are the values for which the algorithm was not able to perform the full compression and decompression.

Stepsize δ		0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines		60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Average error of FA (in percentage)													
Method	Bits	Deterministic											
`qfib` fibonacci	8	0.004	0.004	0.004	0.012	0.008	0.009	0.014	0.023	0.023	0.032	0.040	0.042
	16	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.002	0.000	0.001
`qfib` octahedral	8	0.004	0.006	0.006	0.014	0.012	0.012	0.034	0.033	0.036	0.078	0.069	0.069
	16	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.000	0.001	0.001	0.000
`zfib`	-	2.577	2.506	2.527	2.538	2.572	2.553	2.104	2.200	2.219	1.171	1.211	N/A
Method	Bits	Probabilistic											
`qfib` fibonacci	8	0.002	0.002	0.002	0.003	0.004	0.002	0.002	0.003	0.002	0.007	0.005	0.002
	16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000
`qfib` octahedral	8	0.005	0.003	0.003	0.004	0.005	0.003	0.000	0.004	0.006	0.020	0.006	0.005
	16	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.001	0.000
`zfib`	-	0.580	0.575	N/A	0.338	0.347	N/A	0.080	0.077	N/A	0.060	0.068	N/A

Table 5: Comparison of `zfib` and `qfib` for FA computation. We compute the average error in FA computation using a Bresenham-like integration [**?**].

Stepsize δ		0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines		60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Maximum error (absolute value $\times 10^{-2}$)													
Quantization	Precision	Deterministic											
Fibonacci	8 bits	3.07	3.91	3.93	8.23	7.92	8.32	19.5	22.6	22.9	37.9	49.1	51.4
	16 bits	0.23	0.29	0.29	0.11	0.16	0.15	0.18	0.19	0.23	0.59	0.76	0.74
Octahedral	8 bits	4.52	5.89	6.23	12.6	12.0	12.4	31.7	32.7	32.5	54.0	60.5	67.2
	16 bits	0.23	0.30	0.29	0.11	0.15	0.15	0.20	0.25	0.28	0.75	0.83	0.91
Quantization	Precision	Probabilistic											
Fibonacci	8 bits	1.99	2.43	2.25	3.69	3.66	3.93	9.10	11.1	12.4	19.4	23.3	25.9
	16 bits	0.07	0.09	0.09	0.07	0.09	0.09	0.35	0.44	0.48	0.91	1.23	1.32
Octahedral	8 bits	3.09	3.48	3.85	5.53	5.61	6.39	14.4	17.6	17.8	26.7	31.3	36.5
	16 bits	0.07	0.09	0.09	0.08	0.10	0.10	0.39	0.48	0.57	1.21	1.42	1.60
Average error (absolute value $\times 10^{-3}$)													
Quantization	Precision	Deterministic											
Fibonacci	8 bits	0.46	0.45	0.37	0.99	0.99	0.88	2.72	2.69	2.61	6.08	6.10	6.05
	16 bits	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.03	0.13	0.13	0.13
Octahedral	8 bits	0.69	0.67	0.53	1.46	1.45	1.31	3.99	3.95	3.83	8.92	8.95	8.84
	16 bits	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.04	0.14	0.14	0.14
Quantization	Precision	Probabilistic											
Fibonacci	8 bits	0.44	0.44	0.35	0.70	0.70	0.63	1.85	1.87	1.78	3.65	3.64	3.49
	16 bits	0.01	0.01	0.00	0.01	0.01	0.01	0.07	0.07	0.06	0.21	0.21	0.20
Octahedral	8 bits	0.70	0.69	0.54	1.12	1.12	0.99	2.74	2.77	2.63	4.85	4.83	4.64
	16 bits	0.01	0.01	0.01	0.01	0.01	0.01	0.08	0.08	0.07	0.24	0.24	0.23

Table 6: Errors of FA computation between original streamlines and the compressed and decompressed ones using `qfib`.

Stepsize δ	0.1 mm			0.2 mm			0.5 mm			1.0 mm		
Nb. of streamlines	60k	500k	3M	60k	500k	3M	60k	500k	3M	60k	500k	3M
Compression time (s)												
Deterministic	3.42	29.1	166	1.79	14.3	88.3	0.81	6.82	40.8	0.52	4.25	25.8
Probabilistic	3.95	33.0	192	2.16	17.9	103	1.18	9.99	57.9	1.00	8.14	47.0

Table 7: Compression times of our out-of-core algorithm (`qfib`) with an 8 bits octahedral quantization.