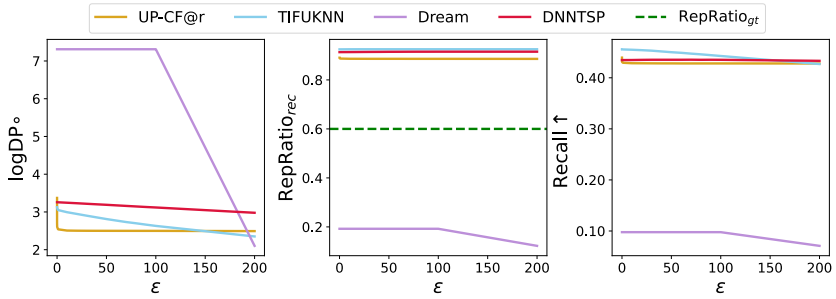
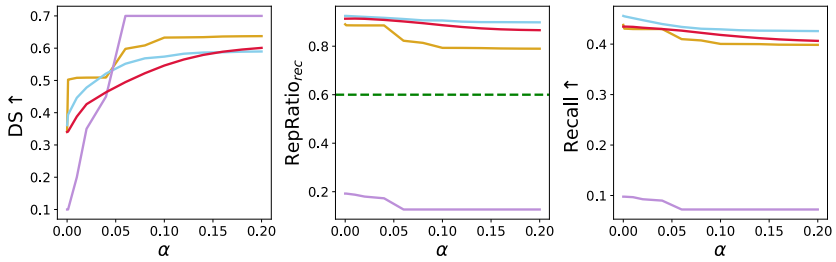
Appendix

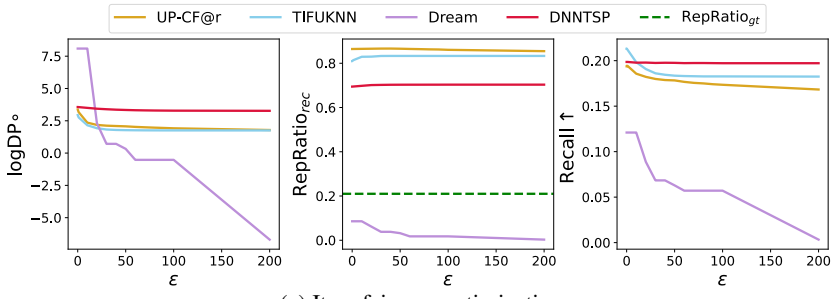


(a) Item fairness optimization

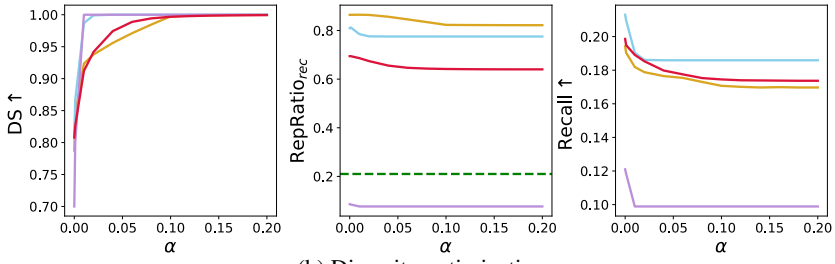


(b) Diversity optimization

Fig. 3: Performance of item fairness and diversity optimization without considering $RepRatio_{rec}$ on Instacart.



(a) Item fairness optimization



(b) Diversity optimization

Fig. 4: Performance of item fairness and diversity optimization without considering $RepRatio_{rec}$ on TaFeng.

Table 4: The performance of RADiv and RAIF algorithms on Dunnhumby ($RepRatio_{gt} = 0.43$). *Ori.* indicates the original baskets obtained from each method. *RD* indicates RADiv. *RF* refers to RAIF. In ablation study, *D*, *F*, *R* indicate optimizing only for diversity, item fairness, and repeat bias, respectively. RepR indicates $RepRatio_{rec}$ (best close to $RepRatio_{gt}$). RepBias and logDP (best close to zero).

Meth.	Diversity optimization						Item fairness optimization					
	Type	Recall↑	DS↑	RepR	RepBias	mDR↑	Type	Recall↑	logDP	RepR	RepBias	mFR↓
TIFUKNN	N	**0.2227**	0.2662	0.8691	0.4391	-0.0865	N	**0.2227**	3.6680	0.8691	0.4391	2.0536
	D	0.2101	**0.5024**	0.8157	0.3857	0.0583	F	0.2205	**3.4719**	0.8740	0.4440	**1.9580**
	R	0.2088	0.2755	0.7131	0.2873	-0.0059	R	0.2213	3.6793	**0.8632**	**0.4332**	2.0563
	RD	0.2040	**0.5024**	**0.7045**	**0.2745**	**0.1139**	RF	0.2194	3.481	0.8686	0.4386	1.9598
UP-CF@r	N	**0.2168**	0.2238	0.9945	0.5645	-0.1704	N	**0.2168**	3.5031	0.9945	0.5645	2.0338
	D	0.2153	0.4276	0.9692	0.5392	-0.0558	F	0.2049	2.5224	0.9945	0.5645	1.5435
	R	0.2104	0.2321	0.9411	0.5111	-0.1395	R	0.2132	3.4776	**0.9187**	**0.4887**	1.9832
	RD	0.2123	**0.4280**	**0.9358**	**0.5058**	**-0.0389**	RF	0.2037	**2.4892**	0.9747	0.5447	**1.5170**
DNNTSP	N	0.1465	0.2512	0.9416	0.5116	-0.1302	N	**0.1465**	3.1376	0.9416	0.5116	1.8246
	D	**0.1466**	**0.4548**	0.9143	0.4843	-0.0148	F	0.1292	**2.3589**	0.9494	0.5194	1.4392
	R	0.1434	0.2519	0.9160	0.4860	-0.1170	R	0.1411	3.1769	**0.8639**	**0.4339**	1.8054
	RD	0.1453	**0.4548**	**0.8981**	**0.4681**	**-0.0067**	RF	0.1244	2.3727	0.9055	0.4755	**1.4241**
Dream	N	0.1085	0.2000	0.3618	-0.0682	0.0659	N	0.1085	7.0173	0.3618	-0.0682	3.5428
	D	0.1063	**0.5503**	0.3098	-0.1202	0.2151	F	0.0745	**1.0075**	0.1127	-0.3173	**0.6624**
	R	**0.1275**	0.2157	0.6321	0.2021	0.0068	R	**0.1341**	6.9063	0.7440	0.3140	3.6102
	RD	0.1133	**0.5503**	**0.4505**	**0.0205**	**0.2649**	RF	0.1006	1.9855	**0.3830**	**-0.0470**	1.0163
TREx	N	**0.2257**	0.2325	0.9953	0.5653	-0.1664	N	0.2257	3.3947	0.9953	0.5653	1.9800
	D	0.2209	0.4079	0.9953	0.5653	-0.0787	F	**0.2258**	3.3116	0.9953	0.5653	1.9385
	R	0.2033	0.2224	**0.6920**	**0.2620**	-0.0198	R	0.2006	3.7244	**0.6443**	**0.2143**	1.9694
	RD	0.1954	**0.4948**	**0.6920**	**0.2620**	**0.1164**	RF	0.1988	**3.1603**	**0.6443**	**0.2143**	**1.6873**

Table 5: The performance of RADiv and RAIF algorithms on TaFeng ($RepRatio_{gt} = 0.21$). *Ori.* indicates the original baskets obtained from each method. *RD* indicates RADiv. *RF* refers to RAIF. In ablation study, *D*, *F*, *R* indicate optimizing only for diversity, item fairness, and repeat bias, respectively. RepR indicates $RepRatio_{rec}$ (best close to $RepRatio_{gt}$). RepBias and logDP (best close to zero).

Meth.	Diversity optimization						Item fairness optimization					
	Type	Recall↑	DS↑	RepR	RepBias	mDR↑	Type	Recall↑	logDP	RepR	RepBias	mFR↓
TIFUKNN	N	**0.2130**	0.8102	0.8094	0.5994	0.1054	N	**0.2130**	2.9426	0.8094	0.5994	1.7710
	D	0.1903	0.9869	0.7851	0.5752	0.2059	F	0.1906	1.9240	0.8299	0.6199	1.2720
	R	0.2128	0.8048	0.7792	0.5692	0.1178	R	0.2001	3.2601	**0.5851**	**0.3751**	1.8176
	RD	0.1895	**0.9897**	**0.7522**	**0.5422**	**0.2238**	RF	0.1841	**1.9128**	0.7417	0.5317	**1.2223**
UP-CF@r	N	0.1941	0.7874	0.8644	0.6544	0.0665	N	**0.1941**	3.3743	0.8644	0.6544	2.0144
	D	0.1730	0.9846	0.8346	0.6246	0.1800	F	0.1733	1.9177	0.8608	0.6508	1.2843
	R	**0.1942**	0.7872	0.8638	0.6538	0.0667	R	0.1861	3.6144	**0.5908**	**0.3808**	1.9976
	RD	0.1732	**0.9870**	**0.8318**	**0.6218**	**0.1826**	RF	0.1712	**1.8187**	0.7600	0.5500	**1.1844**
DNNTSP	N	**0.1986**	0.8079	0.6944	0.4844	0.1617	N	**0.1986**	3.5654	0.6944	0.4844	2.0249
	D	0.1891	0.9121	0.6863	0.4763	0.2179	F	0.1972	3.2709	0.7033	0.4933	1.8821
	R	0.1951	0.8050	0.6164	0.4064	0.1993	R	0.1781	3.7944	**0.4217**	**0.2117**	2.0031
	RD	0.1853	**0.9265**	**0.6059**	**0.3959**	**0.2653**	RF	0.1801	**3.2350**	0.4752	0.2652	**1.7501**
Dream	N	0.1210	0.7000	0.0858	-0.1242	0.2879	N	0.1210	8.0904	0.0858	-0.1242	4.1073
	D	0.0989	**1.0000**	0.0764	-0.1336	0.4332	F	0.0888	**2.3133**	0.0617	-0.1483	**1.2308**
	R	**0.1400**	0.6985	**0.2163**	**0.0063**	0.3461	R	**0.1398**	7.3774	**0.2143**	**0.0043**	3.6908
	RD	0.1194	0.9932	0.1984	-0.0116	**0.4908**	RF	0.1219	2.8182	0.2148	0.0048	1.4115
TREx	N	**0.1971**	0.7979	0.8703	0.6603	0.0688	N	0.1971	2.8936	0.8703	0.6603	1.7770
	D	0.1941	0.8243	0.8703	0.6603	0.0820	F	0.1843	**2.1799**	0.8703	0.6603	1.4201
	R	0.1818	0.7251	**0.3980**	**0.1880**	0.2686	R	**0.2018**	3.1900	**0.7496**	**0.5396**	1.8648
	RD	0.1779	**0.8350**	**0.3980**	**0.1880**	**0.3235**	RF	0.1875	2.2036	**0.7496**	**0.5396**	**1.3716**