

Archivo de material suplementario

Optimización de hiperparámetros en algoritmos de boosting: aplicación en la biosorción de metales tóxicos

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TABLAS SUPLEMENTARIAS

Tabla S1. Datos experimentales de biosorción de Cd(II) por *Chlorella vulgaris* [1-4] y predicciones resultantes de diferentes modelos de *boosting*.

Características					Objetivo	Predicción de q_{eq} Cd(II) (mmol g ⁻¹)				
Co Ni(II) (mM)	Co Cd(II) (mM)	T (°C)	pH	Biomasa (g L ⁻¹)	q_{eq} Cd(II) (mmol g ⁻¹)	Adaboost	Catboost	Gradient-boost	Light-GBM	XGboost
0	0	20	2	0.75	0	0	-0.0040	-0.0043	-0.0048	0.0015
0	0.8896	20	2	0.75	0.0962	0.2835	0.2692	0.287	0.2963	0.2851
0	0	20	3	0.75	0	0	0.0121	-0.0043	-0.0048	0.0015
0	0.8896	20	3	0.75	0.2835	0.2835	0.2931	0.287	0.2963	0.2851
0	0	25	3.5	1	0	0	-0.0029	0.0018	-0.0053	0.0015
1.7033	0	25	3.5	1	0	0	-0.0072	0.0004	0.0016	0.0003
0	0	20	4	0.75	0	0	0.0251	0.0092	0.0169	0.0015
0	0	25	4	1	0	0	0.0113	0.0006	0.0064	0.0015
0	0	30	4	0.75	0	0	0.0165	-0.0001	-0.0009	0.0015
0	0	40	4	0.75	0	0	-0.0118	-0.0001	-0.0064	0.0009
0	0	50	4	0.75	0	0	-0.0094	-0.0035	0.0031	0.0006
0	0.2170	30	4	0.75	0.1628	0.1553	0.1496	0.1627	0.1729	0.1619
0	0.2215	20	4	0.75	0.1975	0.1628	0.1962	0.1926	0.1697	0.189
0	0.2215	25	4	1	0.1770	0.1597	0.1676	0.18	0.1944	0.1645
0	0.2322	40	4	0.75	0.1352	0.1473	0.1214	0.145	0.1601	0.1422
0	0.2331	50	4	0.75	0.1112	0.1459	0.1098	0.1129	0.1098	0.1303
0	0.4323	50	4	0.75	0.1690	0.1993	0.1671	0.1694	0.1708	0.1797
0	0.4492	30	4	0.75	0.2811	0.2940	0.2864	0.2796	0.2740	0.2760
0	0.4555	40	4	0.75	0.2224	0.3139	0.2419	0.2533	0.2974	0.2081

Características					Objetivo	Predicción de q_{eq} Cd(II) (mmol g ⁻¹)				
Co Ni(II) (mM)	Co Cd(II) (mM)	T (°C)	pH	Biomasa (g L ⁻¹)	q_{eq} Cd(II) (mmol g ⁻¹)	Adaboost	Catboost	Gradient-boost	Light-GBM	XGboost
0	0.4581	20	4	0.75	0.3300	0.3300	0.3489	0.331	0.3862	0.3356
0	0.4715	25	4	1	0.3211	0.3254	0.3236	0.3219	0.3496	0.3333
0	0.6574	50	4	0.75	0.2384	0.3232	0.2739	0.3043	0.2443	0.2636
0	0.6779	20	4	0.75	0.4625	0.4509	0.4436	0.4606	0.3862	0.4428
0	0.6894	40	4	0.75	0.3069	0.3236	0.3245	0.3095	0.3205	0.3206
0	0.6921	30	4	0.75	0.4021	0.3960	0.3888	0.4002	0.3883	0.3983
0	0.8878	40	4	0.75	0.3736	0.3558	0.3763	0.3738	0.3673	0.3688
0	0.8896	20	4	0.75	0.5446	0.5303	0.5236	0.5389	0.5205	0.5300
0	0.8967	50	4	0.75	0.3131	0.3421	0.3135	0.3132	0.3119	0.3225
0	0.9047	25	4	1	0.5071	0.4907	0.4967	0.5069	0.4962	0.498
0	0.9074	20	4	0.75	0.5542	0.5424	0.5579	0.5561	0.5670	0.530
0	0.9190	30	4	0.75	0.4662	0.4739	0.4778	0.4664	0.4757	0.4763
0	1.3273	40	4	0.75	0.4573	0.4632	0.4565	0.4556	0.4437	0.4589
0	1.3451	50	4	0.75	0.3736	0.3736	0.3771	0.374	0.3826	0.3657
0	1.3522	30	4	0.75	0.5480	0.5502	0.5435	0.5499	0.5448	0.5450
0	1.3629	25	4	1	0.6031	0.5817	0.5978	0.6009	0.5929	0.5917
0	1.3638	20	4	0.75	0.6503	0.6503	0.6582	0.6525	0.6684	0.6280
0	1.7667	20	4	0.75	0.7588	0.7227	0.7466	0.7573	0.7416	0.6280
0	1.8001	50	4	0.75	0.4555	0.5621	0.4562	0.4894	0.4843	0.4646
0	1.8077	30	4	0.75	0.5960	0.5762	0.6035	0.5964	0.5980	0.5917
0	1.8148	40	4	0.75	0.5364	0.5561	0.5338	0.5367	0.5454	0.5332
0.4190	0	25	4	1	0	0	0.0065	0.0006	0.0067	0.0015
0.4292	1.2979	25	4	1	0.5257	0.4792	0.5068	0.5316	0.5162	0.4903
0.4292	1.3415	25	4	1	0.5258	0.4755	0.5293	0.5269	0.5330	0.4948
0.4343	0.8416	25	4	1	0.4350	0.4034	0.439	0.4355	0.4363	0.4346
0.4514	0.2295	25	4	1	0.1583	0.1487	0.1602	0.1722	0.1821	0.1571
0.4514	0.4279	25	4	1	0.2669	0.2331	0.2558	0.265	0.2527	0.2501
0.8704	0.4243	25	4	1	0.2429	0.2331	0.2382	0.2432	0.2386	0.2433
0.8823	1.3202	25	4	1	0.4937	0.4744	0.4871	0.4957	0.4998	0.4903
0.8823	1.3371	25	4	1	0.4937	0.4742	0.5077	0.4936	0.4949	0.4948
0.8959	0.8095	25	4	1	0.3945	0.3979	0.3935	0.3949	0.3890	0.3920
0.8976	0	25	4	1	0	0	0.0141	-0.0005	0.0010	0.0003
0.9130	0.2420	25	4	1	0.1503	0.1478	0.1625	0.1503	0.1693	0.1514
1.6607	0.2375	25	4	1	0.1397	0.1477	0.1467	0.1396	0.1384	0.1408
1.7033	0	25	4	1	0	0	0.0065	-0.0005	0.0006	0.0003
1.7220	1.2855	25	4	1	0.4439	0.4599	0.4385	0.4422	0.4316	0.4434
1.7220	1.3735	25	4	1	0.4439	0.4366	0.45	0.4452	0.4505	0.4481
1.7646	0.8104	25	4	1	0.3576	0.3731	0.3506	0.3574	0.3552	0.3637
1.7714	0	25	4	1	0	0	0.0051	-0.0005	0.0010	0.0003
1.7885	0.4083	25	4	1	0.2171	0.2288	0.1845	0.2202	0.1819	0.1514
2.5600	0.4297	25	4	1	0.1993	0.2242	0.1962	0.2002	0.1970	0.2002
2.5686	0.2260	25	4	1	0.1245	0.1469	0.1224	0.1244	0.1229	0.1408
2.6043	0	25	4	1	0	0	0.0019	-0.0006	-0.0045	0.0003
2.6282	1.3727	25	4	1	0.4243	0.4361	0.4221	0.4232	0.4249	0.4132
2.6299	0.8718	25	4	1	0.3238	0.3439	0.3354	0.3252	0.3294	0.3181
0	0	15	4.5	1	0	0	0.0007	0.0004	0.0018	0.0015
0	0	25	4.5	1	0	0	-0.0017	0.001	-0.0006	0.0015
0	0	35	4.5	1	0	0	-0.0019	-0.0036	-0.0010	0.0009
0	0	45	4.5	1	0	0	0.0026	-0.0038	0	0.0009



Características					Objetivo	Predicción de q_{eq} Cd(II) ($mmol\ g^{-1}$)				
Co Ni(II) (mM)	Co Cd(II) (mM)	T (°C)	pH	Biomasa ($g\ L^{-1}$)	q_{eq} Cd(II) ($mmol\ g^{-1}$)	Adaboost	Catboost	Gradient-boost	Light-GBM	XGboost
0.7222	0	25	4.5	1	0	0	0.0012	0.0067	0.0031	0.0015
0.8176	0	45	4.5	1	0	0	0.0047	0.0003	0.0003	-0.0002
0.8891	0	35	4.5	1	0	0	0.0002	0.0001	0.0007	-0.0002
0.8925	0	15	4.5	1	0	0	0.0026	-0.0014	0.0013	0.0003
1.2008	0	25	4.5	1	0	0	0.0009	0	-0.0047	0.0003
1.2604	0	35	4.5	1	0	0	0.0011	0.0007	-0.0071	-0.0002
1.3013	0	45	4.5	1	0	0	-0.0013	0.0005	0	-0.0002
1.3303	0	15	4.5	1	0	0	-0.0038	-0.0004	0.0007	0.0003
1.7067	0	25	4.5	1	0	0	-0.0043	0	0.0041	0.0003
1.7391	0	45	4.5	1	0	0	0.0057	0.0005	0.0014	-0.0002
1.7527	0	35	4.5	1	0	0	-0.0014	0.0007	0.0017	-0.0002
1.7714	0	15	4.5	1	0	0	-0.0079	-0.0004	0.0025	0.0003
2.5260	0	25	4.5	1	0	0	-0.0082	-0.0061	0.0045	0.0003
2.6060	0	45	4.5	1	0	0	0.0007	0.0037	0.0007	-0.0002
2.6605	0	35	4.5	1	0	0	-0.0034	0.0003	-0.0016	-0.0002
2.6997	0	15	4.5	1	0	0	-0.0049	0.0002	-0.0003	0.0003
4.1731	0	35	4.5	1	0	0	0.0100	0.0035	-0.0016	-0.0002
4.1850	0	15	4.5	1	0	0	0.0036	0.0002	-0.0003	0.0003
4.2582	0	45	4.5	1	0	0	0.0161	0.0033	-0.0020	-0.0002
4.4115	0	25	4.5	1	0	0	0.0023	-0.0009	0.0007	0.0003
0	0	20	5	0.75	0	0	0.0116	0.0047	0.0102	0.0015
0	0	25	5	1	0	0	0.0017	-0.0018	0.0063	0.0015
0	0.8896	20	5	0.75	0.5193	0.5193	0.5051	0.5178	0.4930	0.5179
1.7033	0	25	5	1	0	0	-0.0060	-0.0028	0.0117	0.0003
0	0	25	5.5	1	0	0	0.0047	0.0075	-0.0249	0.0015
1.7032	0	25	5.5	1	0	0	-0.0030	0.0022	-0.0171	0.0003
0	0	20	6	0.75	0	0	-0.0069	-0.0039	-0.0210	0.0015
0	0.8896	20	6	0.75	0.3768	0.3768	0.3896	0.3796	0.4176	0.3778

Tabla S2. Datos experimentales de biosorción de Ni(II) por *Chlorella vulgaris* [1-4] y predicciones resultantes de diferentes modelos de *boosting*.

Características					Objetivo	Predicción de q_{eq} Ni(II) (mmol g ⁻¹)				
Co Ni(II) (mM)	Co Cd(II) (mM)	T (°C)	pH	Biomasa (g L ⁻¹)	q_{eq} Ni(II) (mmol g ⁻¹)	Adaboost	Catboost	Gradient-boost	Light-GBM	XGboost
0	0	20	2	0.75	0	0	0.0047	0.0006	0.0026	-0.0002
0	0.8896	20	2	0.75	0	0	0.0062	0.0017	-0.0014	0.0011
0	0	20	3	0.75	0	0	0.0023	0.0006	0.0026	-0.0002
0	0.8896	20	3	0.75	0	0	0.0038	0.0017	-0.0014	0.0011
0	0	25	3.5	1	0	0	-0.0048	-0.0058	-0.0005	-0.0074
1.7033	0	25	3.5	1	0.5868	0.5868	0.5948	0.5937	0.6168	0.6132
0	0	20	4	0.75	0	0	0.0048	0.0050	0.0026	-0.0024
0	0	25	4	1	0	0	0.0151	0.0066	0.0022	-0.0096
0	0	30	4	0.75	0	0	-0.0012	0.0001	-0.0007	0.0006
0	0	40	4	0.75	0	0	0.0024	-0.0008	-0.0007	0.002
0	0	50	4	0.75	0	0	-0.0052	0.0007	-0.0022	0.0052
0	0.2170	30	4	0.75	0	0	0.0016	-0.0009	0.0026	-0.0054
0	0.2215	20	4	0.75	0	0	-0.0099	-0.0007	0.0026	-0.0013
0	0.2215	25	4	1	0	0	-0.0181	0.0005	-0.0014	-0.0085
0	0.2322	40	4	0.75	0	0	-0.0098	-0.0021	-0.0005	0.0016
0	0.2331	50	4	0.75	0	0	-0.0040	-0.0005	-0.0008	0.0027
0	0.4323	50	4	0.75	0	0	0.0042	0.0005	0.0054	0.0019
0	0.4492	30	4	0.75	0	0	-0.0039	-0.0007	0.0032	0.0009
0	0.4555	40	4	0.75	0	0	-0.0003	-0.0011	-0.0229	0.0008
0	0.4581	20	4	0.75	0	0	0.0020	0.0006	-0.0105	-0.0021
0	0.4715	25	4	1	0	0	-0.0039	0.0017	-0.0104	-0.0093
0	0.6574	50	4	0.75	0	0	0.0064	0.0004	0.0091	0.0019
0	0.6779	20	4	0.75	0	0	0.0044	0.0006	-0.0006	-0.0021
0	0.6894	40	4	0.75	0	0	-0.0018	0.0001	-0.0035	-0.0021
0	0.6921	30	4	0.75	0	0	0.0045	0.0003	0.0036	-0.002
0	0.8878	40	4	0.75	0	0	0.0016	-0.0011	0.0036	-0.0096
0	0.8896	20	4	0.75	0	0	0.0039	0.0006	-0.0005	-0.0011
0	0.8967	50	4	0.75	0	0	0.0008	0.0004	-0.0050	-0.0041
0	0.9047	25	4	1	0	0	-0.0149	0.0006	-0.0150	-0.0092
0	0.9074	20	4	0.75	0	0	-0.0033	0.0006	-0.0063	0.004
0	0.9190	30	4	0.75	0	0	-0.0093	-0.0016	-0.0077	-0.0007
0	1.3273	40	4	0.75	0	0	0.0015	-0.0011	-0.0060	-0.0007
0	1.3451	50	4	0.75	0	0	0.0059	0.0004	0.0003	0.0004
0	1.3522	30	4	0.75	0	0	-0.0015	-0.0016	0.0106	0.0022
0	1.3629	25	4	1	0	0	-0.0073	0.0006	-0.0013	-0.0064
0	1.3638	20	4	0.75	0	0	0.0009	-0.0014	0.0067	0.0068
0	1.7667	20	4	0.75	0	0	0.0033	0.0014	-0.0036	0.0068
0	1.8001	50	4	0.75	0	0	0.0052	0.0012	0.0029	0.0032
0	1.8077	30	4	0.75	0	0	-0.0027	-0.0008	0.0053	0.0022
0	1.8148	40	4	0.75	0	0	0.0009	-0.0003	0.0116	0.0021
0.4190	0	25	4	1	0.2879	0.2879	0.2806	0.2806	0.2891	0.2839
0.4292	1.2979	25	4	1	0.1277	0.1771	0.1396	0.1779	0.1368	0.1856
0.4292	1.3415	25	4	1	0.1277	0.1771	0.1165	0.1779	0.1364	0.1856
0.4343	0.8416	25	4	1	0.1771	0.1771	0.1740	0.1789	0.1806	0.1739
0.4514	0.2295	25	4	1	0.2691	0.2879	0.3028	0.2351	0.2802	0.2252
0.4514	0.4279	25	4	1	0.2214	0.2214	0.2327	0.2223	0.2203	0.2085
0.8704	0.4243	25	4	1	0.3321	0.3321	0.3380	0.3301	0.3260	0.3703



Características					Objetivo	Predicción de q_{eq} Ni(II) (mmol g ⁻¹)				
Co Ni(II) (mM)	Co Cd(II) (mM)	T (°C)	pH	Biomasa (g L ⁻¹)	q_{eq} Ni(II) (mmol g ⁻¹)	Adaboost	Catboost	Gradient-boost	Light-GBM	XGboost
0.8823	1.3202	25	4	1	0.2061	0.2061	0.2068	0.2067	0.2078	0.2043
0.8823	1.3371	25	4	1	0.2061	0.2061	0.2068	0.2067	0.2074	0.2043
0.8959	0.8095	25	4	1	0.2725	0.2725	0.2803	0.2705	0.2750	0.2975
0.8976	0	25	4	1	0.4684	0.5868	0.518	0.5137	0.5005	0.4350
0.9130	0.2420	25	4	1	0.4020	0.4020	0.4127	0.4020	0.4086	0.3744
1.6607	0.2375	25	4	1	0.5519	0.5519	0.5336	0.5519	0.5471	0.5425
1.7033	0	25	4	1	0.6566	0.6648	0.6559	0.6573	0.6168	0.6340
1.7220	1.2855	25	4	1	0.3032	0.3032	0.3192	0.3048	0.3037	0.2915
1.7220	1.3735	25	4	1	0.3032	0.3032	0.2900	0.3007	0.2941	0.2915
1.7646	0.8104	25	4	1	0.3935	0.3935	0.3948	0.3973	0.4056	0.4032
1.7714	0	25	4	1	0.6881	0.6866	0.6909	0.6896	0.7056	0.7055
1.7885	0.4083	25	4	1	0.4888	0.5519	0.5600	0.5297	0.4602	0.5878
2.5600	0.4297	25	4	1	0.5706	0.5706	0.5472	0.5665	0.521	0.5609
2.5686	0.2260	25	4	1	0.6711	0.6711	0.6921	0.6767	0.7072	0.6825
2.6043	0	25	4	1	0.8193	0.8193	0.8001	0.8135	0.8103	0.8097
2.6282	1.3727	25	4	1	0.3492	0.3492	0.3619	0.3538	0.3804	0.3502
2.6299	0.8718	25	4	1	0.4803	0.4803	0.4819	0.4757	0.4741	0.4847
0	0	15	4.5	1	0	0	-0.017	-0.009	-0.0273	-0.0339
0	0	25	4.5	1	0	0	0.0395	0.0078	0.0056	0.0295
0	0	35	4.5	1	0	0	0.0551	0.0008	0.0196	0.0403
0	0	45	4.5	1	0	0	0.1099	0.0141	0.0357	0.0621
0.7222	0	25	4.5	1	0.5314	0.603	0.4937	0.5067	0.5355	0.3230
0.8176	0	45	4.5	1	0.6030	0.603	0.5747	0.6037	0.5807	0.5867
0.8891	0	35	4.5	1	0.6166	0.6166	0.5947	0.6149	0.6168	0.5892
0.8925	0	15	4.5	1	0.4258	0.4258	0.4282	0.4306	0.4271	0.4182
1.2008	0	25	4.5	1	0.6132	0.6132	0.5894	0.6136	0.6214	0.6131
1.2604	0	35	4.5	1	0.6813	0.6813	0.6814	0.6825	0.676	0.7034
1.3013	0	45	4.5	1	0.7324	0.7324	0.7438	0.7304	0.7395	0.7252
1.3303	0	15	4.5	1	0.5178	0.5178	0.5262	0.518	0.5198	0.5462
1.7067	0	25	4.5	1	0.7154	0.7043	0.7389	0.7099	0.7272	0.7173
1.7391	0	45	4.5	1	0.8210	0.8210	0.8234	0.822	0.8238	0.8115
1.7527	0	35	4.5	1	0.7886	0.7886	0.7815	0.7893	0.7850	0.7897
1.7714	0	15	4.5	1	0.6013	0.6013	0.6000	0.6007	0.6293	0.6040
2.5260	0	25	4.5	1	0.8057	0.6915	0.7857	0.7533	0.7611	0.7371
2.6060	0	45	4.5	1	0.9147	0.8908	0.9413	0.9126	0.9148	0.8817
2.6605	0	35	4.5	1	0.8908	0.8908	0.8872	0.8957	0.9128	0.8864
2.6997	0	15	4.5	1	0.6983	0.6983	0.6992	0.6969	0.7582	0.7111
4.1731	0	35	4.5	1	0.993	0.8908	0.9732	0.9437	0.9128	0.8864
4.1850	0	15	4.5	1	0.8193	0.8193	0.8112	0.8207	0.7582	0.8124
4.2582	0	45	4.5	1	1.0254	0.8908	1.0212	0.9664	0.9148	0.9622
4.4115	0	25	4.5	1	0.9470	0.9470	0.9469	0.9443	0.8899	0.9333
0	0	20	5	0.75	0	0	-0.0097	0.0007	0.0036	-0.0011
0	0	25	5	1	0	0	0.0024	0.0048	0.0006	0.0143
0	0.8896	20	5	0.75	0	0	-0.0016	-0.0017	0.0056	0.0001
1.7033	0	25	5	1	0.6932	0.6800	0.6821	0.6862	0.6693	0.6689
0	0	25	5.5	1	0	0	-0.0108	-0.0157	0.0056	0.0143
1.7032	0	25	5.5	1	0.6554	0.6687	0.6689	0.6602	0.6693	0.6689
0	0	20	6	0.75	0	0	-0.0130	-0.0017	0.0036	-0.0011
0	0.8896	20	6	0.75	0	0	0.0052	-0.0008	0.0006	0.0001



Tabla S3. Descripción de hiperparámetros optimizados en los diferentes algoritmos de *boosting* [5-10].

Algoritmo de <i>boosting</i>	Hiperparámetro	Descripción
Adaboost	n_estimators	Número de estimadores débiles (árboles de decisión) en el ensamble.
	learning_rate	Factor que controla la magnitud de la contribución de cada árbol al modelo final, influyendo en la velocidad y calidad del aprendizaje. Valores más bajos requieren más estimadores, pero pueden dar mejor rendimiento.
	max_depth	Profundidad máxima de los árboles individuales. Limita la complejidad del modelo.
	min_samples_split	Número mínimo de muestras requeridas para dividir un nodo interno.
	min_samples_leaf	Número mínimo de muestras requeridas para estar en un nodo hoja.
Catboost	Iterations	Similar a n_estimators, número de árboles en el modelo
	depth	Profundidad máxima de los árboles
	learning_rate	Tasa de aprendizaje, similar a la de otros algoritmos de <i>boosting</i>
	random_strength	Factor de aleatoriedad para divisiones en los árboles
	bagging_temperature	Controla la intensidad del bagging (valores más altos = más intenso)
Gradient Boost	n_estimators	Número de etapas de <i>boosting</i> a realizar
	max_depth	Profundidad máxima de los estimadores de regresión individuales
	learning_rate	Tasa de aprendizaje, similar a la de otros algoritmos de <i>boosting</i>
	min_samples_split	Número mínimo de muestras para dividir un nodo interno.
	min_samples_leaf	Número mínimo de muestras requeridas para estar en un nodo hoja.
LightGBM	n_estimators	Número de árboles a construir
	num_leaves	Número máximo de hojas en un árbol
	subsample	Fracción de muestras a usar para entrenar cada árbol
	colsample_bytree	Fracción de características a considerar al construir cada árbol
	min_child_samples	Número mínimo de datos necesarios en un nodo hoja
	learning_rate	Reduce la contribución de cada árbol similar a la de otros algoritmos de <i>boosting</i>
XGBoost	n_estimators	Número de árboles de decisión
	lambda	Término de regularización L2 en los pesos de las hojas y características. Ayuda a prevenir el sobreajuste al penalizar la complejidad del modelo.
	max_depth	Profundidad máxima de un árbol
	eta	Tasa de aprendizaje, similar al <i>learning rate</i> en otros algoritmos

FIGURAS SUPLEMENTARIAS

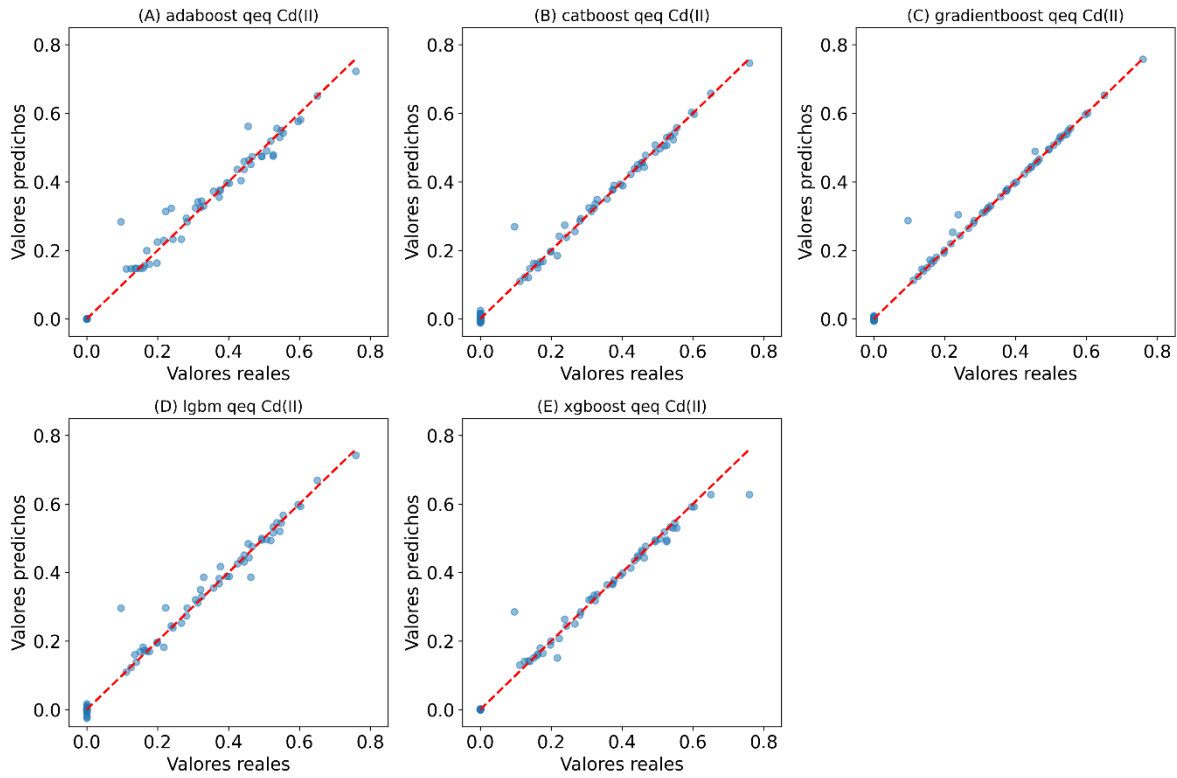


Figura S1. Correlación entre valores experimentales y predichos de la capacidad de biosorción de Cd(II) por diferentes modelos de *boosting* optimizados: A) AdaBoost, B) CatBoost, C) GradientBoost, D) LightGBM y E) XGBoost.

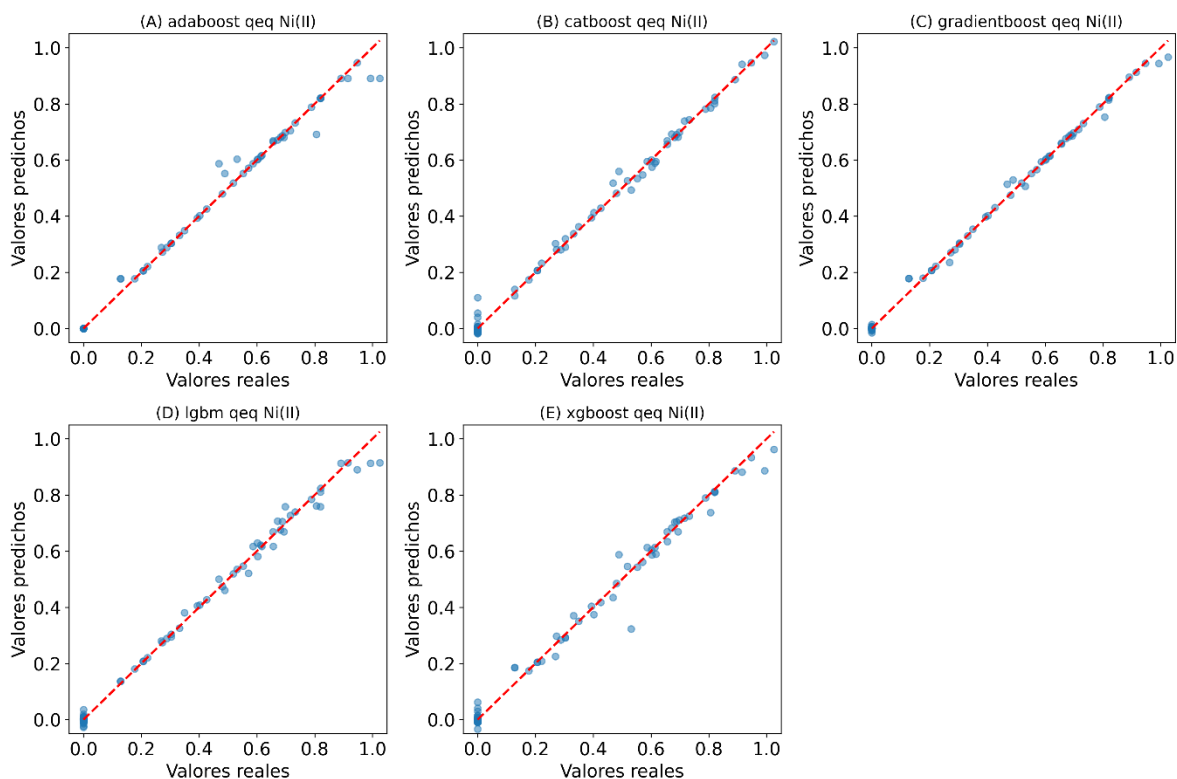


Figura S2. Correlación entre valores experimentales y predichos de la capacidad de biosorción de Ni(II) por diferentes modelos de *boosting* optimizados: A) AdaBoost, B) CatBoost, C) GradientBoost, D) LightGBM y E) XGBoost.

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