
This file contains the supplementary material for the article “**Novel fractional swarming with key term separation for input nonlinear control autoregressive systems**”

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Table S1. Parameter estimates with level of estimation accuracy for $\epsilon = 0.2$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.6087	0.8088	0.8418	0.6123	0.9982	0.4973	9.301×10^{-5}
	30	1.6013	0.8012	0.8518	0.6496	1.0002	0.5001	1.282×10^{-7}
	70	1.6002	0.8001	0.8502	0.6498	1.0000	0.5000	3.767×10^{-9}
	110	1.6001	0.8001	0.8501	0.6499	1.0000	0.5000	1.342×10^{-9}
	150	1.6001	0.8002	0.8501	0.6499	1.0000	0.5000	8.909×10^{-10}
60	10	1.5971	0.8027	0.8839	0.7259	0.9646	0.4831	1.648×10^{-4}
	30	1.5981	0.7977	0.8470	0.6495	0.9979	0.4991	2.706×10^{-6}
	70	1.5981	0.7981	0.8470	0.6495	0.9981	0.4990	7.521×10^{-7}
	110	1.5981	0.7981	0.8472	0.6495	0.9990	0.4993	4.089×10^{-7}
	150	1.5981	0.7981	0.8472	0.6490	0.9989	0.4993	3.830×10^{-7}
30	10	1.5185	0.7537	0.9435	0.7139	0.7311	0.3440	2.743×10^{-3}
	30	1.5367	0.7283	0.8392	0.6592	0.8819	0.4443	1.594×10^{-3}
	70	1.5293	0.7398	0.8235	0.6541	0.9105	0.4386	8.709×10^{-4}
	110	1.5293	0.7398	0.8235	0.6541	0.9105	0.4386	8.709×10^{-4}
	150	1.5489	0.7199	0.8310	0.6838	0.9652	0.4862	8.261×10^{-4}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0

Table S2 Parameter estimates with level of estimation accuracy for $\epsilon = 0.3$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.5826	0.7822	0.8294	0.7079	0.9977	0.5002	3.500×10^{-4}
	30	1.6011	0.8012	0.8495	0.6472	1.0024	0.5016	1.228×10^{-6}
	70	1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	2.517×10^{-9}
	110	1.6000	0.8000	0.8499	0.6500	1.0001	0.5000	4.023×10^{-10}
	150	1.6000	0.8000	0.8499	0.6500	1.0001	0.5000	4.023×10^{-10}
60	10	1.5894	0.7804	0.8800	0.7227	0.9180	0.4558	5.190×10^{-4}
	30	1.5856	0.7900	0.8465	0.6681	0.9961	0.5002	2.892×10^{-5}
	70	1.6004	0.8024	0.8481	0.6502	1.0018	0.5005	1.852×10^{-6}
	110	1.6013	0.8008	0.8520	0.6478	1.0013	0.5007	9.355×10^{-7}
	150	1.6018	0.8004	0.8514	0.6474	1.0014	0.5007	3.417×10^{-7}
30	10	1.4527	0.7072	0.9859	0.8614	0.9115	0.4608	2.634×10^{-3}
	30	1.4854	0.6787	0.9017	0.7212	0.9381	0.4820	1.110×10^{-3}
	70	1.4731	0.7209	0.7896	0.8094	0.9077	0.4549	8.245×10^{-4}
	110	1.4731	0.7209	0.7896	0.8094	0.9077	0.4549	8.245×10^{-4}
	150	1.4731	0.7209	0.7896	0.8094	0.9077	0.4549	8.245×10^{-4}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0

Table S3. Parameter estimates with level of estimation accuracy for $\epsilon = 0.4$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.5224	0.7406	0.7482	0.7671	0.8383	0.4125	1.771×10^{-3}
	30	1.5945	0.7920	0.8280	0.6313	1.0211	0.5100	5.782×10^{-5}
	70	1.6019	0.8014	0.8491	0.6444	1.0020	0.5008	7.288×10^{-7}
	110	1.6000	0.8000	0.8504	0.6500	1.0001	0.5001	8.614×10^{-9}
	150	1.6001	0.8001	0.8500	0.6498	1.0001	0.5000	1.474×10^{-9}
60	10	1.6070	0.8158	0.8768	0.6264	0.9780	0.4889	5.350×10^{-4}
	30	1.6009	0.7999	0.8560	0.6583	0.9853	0.4918	1.391×10^{-5}
	70	1.5972	0.7976	0.8467	0.6515	0.9988	0.4992	1.374×10^{-6}
	110	1.5972	0.7976	0.8490	0.6525	0.9983	0.4992	6.358×10^{-7}
	150	1.5975	0.7978	0.8478	0.6485	0.9994	0.4994	5.878×10^{-7}
30	10	1.4796	0.7433	1.1070	0.9418	0.8185	0.4192	4.657×10^{-3}
	30	1.4777	0.7440	0.9184	0.7793	0.9475	0.4749	1.951×10^{-3}
	70	1.4848	0.7276	0.8856	0.7307	0.8839	0.4418	7.029×10^{-4}
	110	1.4874	0.7182	0.9114	0.7327	0.8847	0.4403	6.364×10^{-4}
	150	1.4853	0.7195	0.9115	0.8271	0.8841	0.4504	4.669×10^{-4}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0

Table S4. Parameter estimates with level of estimation accuracy for $\epsilon = 0.6$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.4944	0.6989	0.6918	0.8716	0.8018	0.3823	2.600×10^{-3}
	30	1.5560	0.7699	0.8374	0.7009	1.0380	0.5267	5.222×10^{-4}
	70	1.6039	0.8019	0.8454	0.6206	1.0221	0.5131	4.093×10^{-5}
	110	1.5993	0.8006	0.8474	0.6453	1.0034	0.5013	5.659×10^{-6}
	150	1.5988	0.7989	0.8504	0.6538	0.9977	0.4989	3.923×10^{-7}
60	10	1.5363	0.7544	0.7001	0.6828	0.9230	0.4556	1.035×10^{-3}
	30	1.5985	0.7977	0.8712	0.6796	0.9786	0.4881	6.566×10^{-5}
	70	1.5987	0.8004	0.8530	0.6613	0.9953	0.4981	6.208×10^{-6}
	110	1.5983	0.7980	0.8510	0.6507	1.0019	0.5017	2.901×10^{-6}
	150	1.5993	0.7988	0.8529	0.6493	1.0018	0.5016	2.005×10^{-6}
30	10	1.5729	0.7846	0.6509	0.6011	0.9108	0.4207	3.031×10^{-3}
	30	1.4959	0.6782	0.8858	0.5694	0.9724	0.5041	1.806×10^{-3}
	70	1.6439	0.8330	0.8308	0.5620	0.9768	0.4731	1.245×10^{-3}
	110	1.6532	0.8082	0.8428	0.5606	0.9733	0.4744	1.047×10^{-3}
	150	1.6456	0.8206	0.8569	0.5782	0.9697	0.4745	8.641×10^{-4}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0

Table S5. Parameter estimates with level of estimation accuracy for $\epsilon = 0.7$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.6516	0.8459	0.8882	0.6406	0.9946	0.5080	8.964×10^{-4}
	30	1.6134	0.8140	0.8333	0.5571	1.0914	0.5501	5.705×10^{-4}
	70	1.5918	0.7965	0.8599	0.6654	1.0027	0.5049	3.884×10^{-5}
	110	1.5975	0.7988	0.8442	0.6581	0.9980	0.4981	7.549×10^{-6}
	150	1.5996	0.7996	0.8505	0.6523	0.9998	0.4998	4.359×10^{-7}
60	10	1.5379	0.7536	0.8662	0.8731	0.9539	0.5005	3.161×10^{-3}
	30	1.5548	0.7640	0.8056	0.7392	0.9364	0.4606	3.634×10^{-4}
	70	1.5909	0.7922	0.8411	0.6737	0.9657	0.4819	6.586×10^{-5}
	110	1.5969	0.7992	0.8652	0.6709	0.9907	0.4966	2.899×10^{-5}
	150	1.5973	0.7989	0.8568	0.6621	0.9932	0.4977	6.060×10^{-6}
30	10	0.9630	0.6498	0.9915	1.0078	0.7575	0.3931	8.101×10^{-3}
	30	1.4915	0.6132	0.6979	0.5424	0.9577	0.4900	3.479×10^{-3}
	70	1.4594	0.7067	0.8696	0.8080	0.8860	0.4517	1.411×10^{-3}
	110	1.4594	0.7067	0.8696	0.8080	0.8860	0.4517	1.411×10^{-3}
	150	1.5317	0.7363	0.8862	0.8224	0.8942	0.4508	8.911×10^{-4}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0

Table S6. Parameter estimates with level of estimation accuracy for $\mathcal{E} = 0.8$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.4893	0.6961	0.8214	0.6076	1.0127	0.5125	1.949×10^{-3}
	30	1.5035	0.6990	0.7335	0.6550	0.9920	0.5013	8.636×10^{-4}
	70	1.6121	0.8189	0.8949	0.6826	1.0135	0.5169	2.978×10^{-4}
	110	1.6023	0.8058	0.8563	0.6431	0.9988	0.5008	4.728×10^{-5}
	150	1.6013	0.8052	0.8432	0.6429	1.0036	0.5008	3.097×10^{-5}
60	10	1.5501	0.7813	0.8858	0.7430	0.9879	0.4896	1.562×10^{-3}
	30	1.5821	0.7811	0.8301	0.6435	1.0407	0.5259	2.753×10^{-4}
	70	1.5910	0.7919	0.8749	0.6173	1.0418	0.5237	2.710×10^{-4}
	110	1.5910	0.7919	0.8749	0.6173	1.0418	0.5237	2.710×10^{-4}
	150	1.5919	0.7942	0.8142	0.6408	1.0029	0.4976	6.719×10^{-5}
30	10	1.4736	0.6264	0.5145	0.6526	1.1225	0.5607	7.399×10^{-3}
	30	1.5109	0.7018	0.8396	0.4839	0.9789	0.4715	2.738×10^{-3}
	70	1.3610	0.5303	0.8343	0.6517	0.9815	0.5055	2.501×10^{-3}
	110	1.4887	0.6304	0.8557	0.5879	0.9875	0.5020	2.327×10^{-3}
	150	1.4964	0.7269	0.8039	0.6037	0.9696	0.4857	2.044×10^{-3}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0

Table S7. Parameter estimates with level of estimation accuracy for $\mathcal{E} = 0.9$

η	Flight	y_1	y_2	x_1	x_2	a_1	a_2	Fitness
90	10	1.2498	0.4918	0.4699	0.7434	0.8710	0.4386	5.045×10^{-3}
	30	1.3786	0.5866	0.4702	0.7271	0.8625	0.4184	3.516×10^{-3}
	70	1.5969	0.7992	0.9164	0.6919	0.9689	0.4984	6.363×10^{-4}
	110	1.6172	0.8206	0.9074	0.6749	0.9667	0.4789	3.472×10^{-4}
	150	1.6172	0.8206	0.9074	0.6749	0.9667	0.4789	3.472×10^{-4}
60	10	1.1189	0.3588	0.2838	0.6396	0.9282	0.4744	7.915×10^{-3}
	30	1.5154	0.7096	0.7089	0.6098	0.9019	0.4333	2.205×10^{-3}
	70	1.5648	0.7779	0.9443	0.8397	0.8971	0.4586	1.101×10^{-3}
	110	1.6214	0.8124	0.8261	0.5407	1.0862	0.5463	5.597×10^{-4}
	150	1.6214	0.8124	0.8261	0.5407	1.0862	0.5463	5.597×10^{-4}
30	10	1.3617	0.5793	0.5899	0.7001	0.8281	0.4000	6.194×10^{-3}
	30	1.1980	0.4575	0.6454	0.6933	0.7660	0.3634	3.589×10^{-3}
	70	1.3249	0.4435	0.8427	0.6346	0.9174	0.4814	3.374×10^{-3}
	110	1.3249	0.4435	0.8427	0.6346	0.9174	0.4814	3.374×10^{-3}
	150	1.3942	0.4911	0.6914	0.5578	0.8940	0.4451	2.784×10^{-3}
Actual		1.6000	0.8000	0.8500	0.6500	1.0000	0.5000	0