Fixing Bug in Forecasts App

The online forecasting app has an apparent bug, where specifying an intervention year later than 2018 combined with specifying a treatment effect on the transition from state 5 (A+N+MCI) to state 7 (early AD) results in incidence rates of AD dementia even higher than with no intervention.

I think I found the bug, and in this document I outline what results look like with the bug fixed. I will compare what results from the original forecasts app look like and compare them with the results from the debugged function.

No intervention, starting in 2018

These two tables should be equivalent. Numbers are in millions of persons. Columns 2 through 5 are prevalence of states 5 and 6 (A+N+MCI, N+MCI), and early and late AD dementia. Columns 6 and 7 are total incidence of AD dementia and incidence from state 5 (A+N+MCI).

Table 1: Original app results with no intervention

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2018	1.71	0.62	1.99	1.55	0.49	0.44
2019	1.75	0.63	2.02	1.58	0.5	0.45
2020	1.79	0.65	2.06	1.61	0.51	0.46
2021	1.83	0.66	2.09	1.64	0.53	0.47
2022	1.88	0.68	2.14	1.68	0.54	0.48
2023	1.94	0.69	2.19	1.71	0.56	0.5
2024	2	0.71	2.25	1.75	0.58	0.52
2025	2.07	0.73	2.31	1.79	0.59	0.53
2026	2.14	0.75	2.38	1.84	0.61	0.55
2027	2.22	0.76	2.45	1.89	0.64	0.57
2028	2.3	0.78	2.54	1.95	0.66	0.59
2029	2.38	0.8	2.62	2.01	0.68	0.61
2030	2.47	0.81	2.71	2.07	0.71	0.64

Table 2: Debugged results with no intervention

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2018	1.71	0.62	1.99	1.55	0.49	0.44
2019	1.75	0.63	2.02	1.58	0.5	0.45
2020	1.79	0.65	2.06	1.61	0.51	0.46
2021	1.83	0.66	2.09	1.64	0.53	0.47
2022	1.88	0.68	2.14	1.68	0.54	0.48
2023	1.94	0.69	2.19	1.71	0.56	0.5
2024	2	0.71	2.25	1.75	0.58	0.52
2025	2.07	0.73	2.31	1.79	0.59	0.53
2026	2.14	0.75	2.38	1.84	0.61	0.55
2027	2.22	0.76	2.45	1.89	0.64	0.57

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2028	2.3	0.78	2.54	1.95	0.66	0.59
2029	2.38	0.8	2.62	2.01	0.68	0.61
2030	2.47	0.81	2.71	2.07	0.71	0.64

Intervention starting in 2018

Here we input a multiplicative treatment effect of 0.75 on the transition from state 5 to 7, starting in 2017. Results from the original app and the debugged version should again be equivalent.

Table 3: Original app with 2018 intervention

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2018	1.71	0.62	1.99	1.55	0.38	0.33
2019	1.86	0.63	1.91	1.58	0.41	0.36
2020	1.98	0.65	1.88	1.6	0.44	0.38
2021	2.08	0.66	1.88	1.61	0.46	0.4
2022	2.17	0.68	1.9	1.61	0.48	0.42
2023	2.26	0.7	1.94	1.63	0.49	0.44
2024	2.34	0.71	2	1.64	0.51	0.45
2025	2.43	0.73	2.05	1.67	0.53	0.47
2026	2.52	0.75	2.12	1.7	0.55	0.49
2027	2.62	0.76	2.19	1.73	0.57	0.51
2028	2.72	0.78	2.27	1.78	0.59	0.52
2029	2.82	0.8	2.35	1.82	0.61	0.54
2030	2.93	0.81	2.43	1.88	0.63	0.56

Table 4: Debugged app with 2018 intervention

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2018	1.71	0.62	1.99	1.55	0.49	0.44
2019	1.86	0.63	1.91	1.58	0.41	0.36
2020	1.98	0.65	1.88	1.6	0.44	0.38
2021	2.08	0.66	1.88	1.61	0.46	0.4
2022	2.17	0.68	1.9	1.61	0.48	0.42
2023	2.26	0.7	1.94	1.63	0.49	0.44
2024	2.34	0.71	2	1.64	0.51	0.45
2025	2.43	0.73	2.05	1.67	0.53	0.47
2026	2.52	0.75	2.12	1.7	0.55	0.49
2027	2.62	0.76	2.19	1.73	0.57	0.51
2028	2.72	0.78	2.27	1.78	0.59	0.52
2029	2.82	0.8	2.35	1.82	0.61	0.54
2030	2.93	0.81	2.43	1.88	0.63	0.56

Intervention starting in 2019

Here we impose a delay on the treatment effect for state 5 to state 7 until 2019. The original app shows inflated incidence numbers, while the debugged version does not.

Table 5: Original app with 2019 intervention on 5 to 7

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2019	1.75	0.63	2.02	1.58	0.5	0.45
2020	1.9	0.65	1.94	1.61	0.54	0.49
2021	2.03	0.66	1.91	1.63	0.58	0.52
2022	2.13	0.68	1.92	1.64	0.61	0.55
2023	2.23	0.7	1.95	1.65	0.63	0.57
2024	2.33	0.71	1.99	1.66	0.66	0.6
2025	2.42	0.73	2.05	1.68	0.69	0.62
2026	2.52	0.75	2.12	1.71	0.71	0.65
2027	2.61	0.76	2.19	1.74	0.74	0.67
2028	2.71	0.78	2.26	1.78	0.76	0.7
2029	2.82	0.8	2.35	1.83	0.79	0.73
2030	2.92	0.81	2.43	1.88	0.82	0.75

Table 6: Debugged app with 2019 intervention on 5 to 7

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2019	1.75	0.63	2.02	1.58	0.5	0.45
2020	1.9	0.65	1.94	1.61	0.42	0.37
2021	2.03	0.66	1.91	1.63	0.45	0.39
2022	2.13	0.68	1.92	1.64	0.47	0.41
2023	2.23	0.7	1.95	1.65	0.49	0.43
2024	2.33	0.71	1.99	1.66	0.51	0.45
2025	2.42	0.73	2.05	1.68	0.53	0.47
2026	2.52	0.75	2.12	1.71	0.55	0.49
2027	2.61	0.76	2.19	1.74	0.57	0.5
2028	2.71	0.78	2.26	1.78	0.59	0.52
2029	2.82	0.8	2.35	1.83	0.61	0.54
2030	2.92	0.81	2.43	1.88	0.63	0.56

The bug in the original also affects the transition from 6 (N+MCI) to 7. The debugged code fixes this.

Table 7: Original app with 2019 intervention on 6 to 7

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2019	1.75	0.63	2.02	1.58	0.5	0.45
2020	1.79	0.69	2.02	1.61	0.52	0.46
2021	1.83	0.74	2.02	1.64	0.53	0.47
2022	1.88	0.79	2.04	1.66	0.55	0.48
2023	1.94	0.84	2.07	1.68	0.57	0.5
2024	2	0.89	2.11	1.71	0.59	0.52
2025	2.07	0.94	2.16	1.73	0.61	0.53
2026	2.14	0.98	2.22	1.76	0.64	0.55
2027	2.22	1.03	2.28	1.79	0.66	0.57
2028	2.3	1.07	2.36	1.83	0.68	0.59
2029	2.38	1.11	2.44	1.88	0.71	0.62
2030	2.47	1.15	2.52	1.93	0.73	0.64

Table 8: Debugged app with 2019 intervention on 6 to 7

Year	MCI & A & N[5]	MCI & N[6]	Early AD[7]	Late AD[8]	Total Incidence	Incidence from State 5
2019	1.75	0.63	2.02	1.58	0.5	0.45
2020	1.79	0.69	2.02	1.61	0.47	0.46
2021	1.83	0.74	2.02	1.64	0.49	0.47
2022	1.88	0.79	2.04	1.66	0.5	0.48
2023	1.94	0.84	2.07	1.68	0.52	0.5
2024	2	0.89	2.11	1.71	0.53	0.52
2025	2.07	0.94	2.16	1.73	0.55	0.53
2026	2.14	0.98	2.22	1.76	0.57	0.55
2027	2.22	1.03	2.28	1.79	0.59	0.57
2028	2.3	1.07	2.36	1.83	0.62	0.59
2029	2.38	1.11	2.44	1.88	0.64	0.62
2030	2.47	1.15	2.52	1.93	0.66	0.64

The fixes also apply to intervention dates later than 2019.