# Team Red 2018 IMO workshop: Yannick's equations

See word file for description. There are 5 sets of equations in the source file, but they correspond to only two different models:

- Cancer and Cancerpar are essentially the same, except that Cancerpar has parameters entered indirectly.

- Cancer2, Cancer2rescaled, and Cancer2fully rescaled are the same except that units are changed for some populations for numerical reasons.

I write the equations for Cancer (basic model) and Cancer2 (more sophisticated). $Tumor(t), Tcells(t), IL(t)$ refer to the level of tumor cells, T-cells, and InterLeukins.

**Basic model:**

$$\begin{aligned} \frac{dTumor(t)}{dt} &= Tumor(t)\left[r - d_1 \times Tcells(t)\right] && (1)\\ \frac{dTcells(t)}{dt} &= Tcells(t)\left[a \times IL(t) - d_2\right] && (2)\\ \frac{dIL(t)}{dt} &= b \times Tumor(t) \times Tcells(t) - d_3 \times IL(t) && (3) \end{aligned}$$

**More sophisticated model** (dependence in $t$ omitted):

$$\begin{aligned} \frac{dTumor}{dt} &= Tumor\left[r - d_1 \times Tcells \times \frac{10^9}{10^9 + Tumor}\right] && (4)\\ \frac{dTcells}{dt} &= Tcells\left[a \times IL - d_2\right] + m \times d_2 - \lambda_1 \times Tcells^3 && (5) \end{aligned}$$

$$\frac{dIL}{dt} = b \times Tumor \times Tcells - d_3(IL - IL_{min}) - \lambda_2 IL^3 + \frac{\lambda_3 Tumor}{10^{10} + Tumor} \qquad (6)$$

Parameter values (judging by the R file, and I really do not remember which ones were motivated by some data, which were not, though basically they were not enough motivated and partially chosen to produce not too crazy results):

- $Tumor(0) = Tcells(0) = 10^8$ ; $IL(0) = 100$.
- $r = 10^{-2}; d_1 = 10^{-10}; a = 10^{-3}; d_2 = 3 \times 10^{-2}; b = 10^{-14}; d_3 = 10;$
- With immune memory: $m = 10^7, IL_{min} = 1$; without: $m = 0, IL_{min} = 0;$
- $\lambda_1 = 7 * 10^{-20}; \lambda_2 = 10^{-3}; \lambda_3 = 2 * 10^3.$, or all $\lambda_1 = 0$ (but not clear when...).