Exercises: kin selection, part I

(1) Evaluate the relatedness between diploid half-siblings; namely, siblings having only one parent in common.

(2) Consider a population in which individuals can help a related neighbour. Suppose that the level of helping is an evolving phenotype that varies between zero and one. Helping increases the survival of its recipient but reduces the survival of its actor. Specifically, a focal individual with level x of helping that interacts with a relative who expresses level x_{r} of helping survives with probability,

$$s_{\mathrm{J}}(x, x_{\mathrm{r}}) = s_{\mathrm{b}} + x_{\mathrm{r}} - x^2,$$

where:

- s_{b} is the baseline probability of survival;
- x_{r} is the increase in the survival probability of the focal individual when its relative expresses a level x_{r} of helping;
- $-x^2$ is the reduction in the survival probability of the focal resulting from expressing helping.

Assuming that the fitness of this focal individual is proportional to its survival (i.e. $w(x, x_{\mathrm{r}}) = k \times s_{\mathrm{J}}(x, x_{\mathrm{r}})$ for some constant k):

(i) Calculate the direct and indirect fitness effects from expressing helping.

(ii) Which category of social behaviour helping belongs to?

(iii) Find the singular strategy of helping and determine whether this strategy is convergence stable.

(iv) How does the singular strategy vary when interactions are between: full siblings, half-siblings, cousins, and non-relatives?