**Simulation paper outline: The evolution of kin preference**

**Abstract**

**Introduction**

**Methods (copies from Julian’s document in dropbox)**

The first step at every generation step of the model is group formation: Groups are formed by accretion, based on kinship in the following manner. Individuals start trying to get into the last non-empty group, and from then on backwards. If they do not find a group, the form a new one. The process stops when the last group has been ocupied (by one individual). We assume that in the initial

population all individuals are related.

Let i denote the cooperative tendency of individual i, and gi denote her kin-interaction preference. These two traits very from 0 to 1. The larger i is the more individual i cooperates, and the larger gi is the higher the preference of individual i to interact with highly related individuals. Let j denote the group that i is trying to join. The probability that i joins group j is:

Pij =

\_

1 : if j is empty

h(j) \_ k(rij ; \_ gj) : otherwise

where h(j) is one if group j is below the optimal group size (\_=c), zero if the size of j is above the expected stable group size, and linearly decreasing in between. Function h ensures that the group size does not explode, and is slightly above the optimal group size (as often observed in the biological world). Function k weights the kinship preferences of the group, we assume that the joiner always wants to join the group. The term k(rij ; \_ gj) considers the kinship

preferences of the group, \_g is the average kinship preference inside group j, and rij is the average relatedness of individual i to the members of group j.

Function k is de\_ned as follows:

Figure 1: Kinship weighting function.

For t equal to zero relatedness does not play a role, that is, individuals have no preference for kin interactions. For t equal to 1 we get the equivalent of sibs- only. For t = 0:5 we get a linear function that aproximates the kin-preference case, always letting in brothers and letting in cousins with a probability close to 1=4, second cousins with probability 1=16 and so on. Once the group formation process has taken place, we proceed to determine the number of o\_spring that each individual will contribute to the pool, using the following function:

fi (n; ; i) = ere􀀀cnn (1 + \_ ( 􀀀 i)) (1)

Here, n is the size of the group the individual is in, therefore it will be assumed to be a positive real value, n \_ 0. Parameter i is the cooperative tendency of the individual itself. The resulting value of n, depends on each individual preference for kin interaction.

**Results**

*Correlations and counter correlations within runs*

Cooperation and group size are correlated, relatedness and kin preference area correlated, but that kin preference and relatedness are counter-correlated with cooperation and group size

Figure 1: representative graph

*Test for white noise*

Significant values of the Fisher's κ statistic allow us to reject the null hypothesis that fluctuations in the series are due to white noise. We tested whether the oscillations apparent in figure 1 were simply due to whitenoise or whether there was intrinsic periodicity.

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Fisher’s κ** | **P value** |
| Average cooperation | 672.3 | <<0.00001 (2.11e-293) |
| Average group size | 1380.3 | <<0.00001 (reported as 0) |
| Relatedness | 730.1 | <<0.00001 (2.11e-319) |
| Kin preference | 1757.4 | <<0.00001 (reported as 0) |

*Anova tests*

We used the ANOVA to test for the effect of the various parameters, their second- and third-order polynomial terms and their interactions. We customized the test for each response variable by dropping all nonsignificant terms (P>0.05) terms and their interactions. The of the reduced models was excellent, with r2 values of 92% (see table x)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Kin Preference | Relatedness | Group size | Ave Coop |
| r | 88.4 | 90.6 | 15.8 | 11.1 |
| c | 0 | 0.5 | 63.3 | 6.4 |
| β | 2.3 | 0 | 4.7 | 29.9 |
| Interactions | 1.5 | 0 | 10.6 | 36.9 |
| Total (r2) | 92.2 | 91.1 | 94.4 | 84.3 |

Table x:

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**Discussion**

**Figures**

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**Fig 1:** Time series showing oscillations for R=0.1, c=0.06, β=0.2. Lines shown are cubic spline fits with flexibility parameter λ= 0.001 on the original data. The first 10000 records of the re run were removed to ensure that the cycle had reached equilibrium.

D:\RFile\RplotFULL.tiff

**Fig 2:** Graphs of the average of cooperation, group size, relatedness and kin preference for each run with the first 10000 generations removed. Curves are cubic spline fits with λ=0.001 (**Leticia**: I changed λ to be 0.001 because it appears that when β=0.8 and C=0.02 average cooperation is a step function (orange triangles), which is a lost on the graphs if λ=0.01.)