**Moran eigenvector filtering**: intended to remove spatial autocorrelation from the residuals of generalised linear models. It uses brute force eigenvector selection to reach a subset of such vectors to be added to the RHS of the GLM model to reduce residual autocorrelation to below the specified alpha value.

The eigenvectors for inclusion are chosen by calculating the empirical Moran's I values for the initial model plus each of the doubly centred symmetric spatial weights matrix eigenvectors in turn. Then the first eigenvector is chosen as that with the lowest Moran's I value. The procedure is repeated until the lowest remaining Moran's I value has a permutation-based probability value above alpha.

Create neighbours matrix – (0-30 m)

markedplants.nb1 <- dnearneigh(subset(allplants,!is.na(pl\_id)&!is.na(phen)), 0, 30) markedplants.listw1 <- nb2listw(markedplants.nb1)

ME.model1 <-ME(formula1, listw=markedplants.listw1, data=subset(allplants,!is.na(pl\_id)&!is.na(phen)),family=binomial,alpha=0.05,verbose=T)

ME.model1

Eigenvector ZI pr(ZI)

0 NA NA 0.01

1 1 NA 0.01

2 2 NA 0.81

> ME.model2

Eigenvector ZI pr(ZI)

0 NA NA 0.10

1 2 NA 0.21

2 200 NA 0.24

Models with only marked plants

Response: probability of having eggs (n=589)

|  |  |
| --- | --- |
| Nagelkerke R2 = 0.27 | Model with eigenvectors 1 and 2 - Nagelkerke R2 = 0.33 |
| Estimate Std. Error z value Pr(>|z|)  (Intercept) -0.8754 0.1308 -6.692 2.20e-11 \*\*\*  phen 0.8944 0.1364 6.559 5.42e-11 \*\*\*  Mrub\_sum 0.3298 0.1081 3.050 0.00229 \*\*  pldens\_2 -1.1043 0.1833 -6.025 1.69e-09 \*\*\*  phen\_n2 -0.2120 0.1330 -1.593 0.11108  phen:Mrub\_sum 0.2109 0.1462 1.442 0.14916  phen:phen\_n2 -0.1359 0.1380 -0.984 0.32501  pldens\_2:phen\_n2 -0.3358 0.1450 -2.316 0.02058 \* | Estimate Std. Error z value Pr(>|z|)  (Intercept) -0.89083 0.13651 -6.526 6.76e-11 \*\*\*  phen 0.98926 0.14929 6.626 3.44e-11 \*\*\*  Mrub\_sum 0.19863 0.11162 1.780 0.07514 .  pldens\_2 -0.79755 0.19588 -4.072 4.67e-05 \*\*\*  phen\_n2 -0.38448 0.14448 -2.661 0.00779 \*\*  phen:Mrub\_sum 0.18917 0.14799 1.278 0.20114  phen:phen\_n2 -0.07735 0.14910 -0.519 0.60391  pldens\_2:phen\_n2 -0.28705 0.14375 -1.997 0.04583 \*  ME.model1$vectors[, 1]) 0.49370 0.12435 3.970 7.18e-05 \*\*\*  ME.model1$vectors[, 2]) 0.42609 0.09749 4.371 1.24e-05 \*\*\* |
|  |  |
| Moran I statistic standard deviate = 14.494, p-value < 2.2e-16 (30 m) | Moran I statistic standard deviate = 1.4889, p-value = 0.06826 (30 m) |

Response: number of eggs in plants with eggs (n=220)

|  |  |
| --- | --- |
| Nagelkerke R2 = 0.32 | Model with eigenvector 1 - Nagelkerke R2 = 0.35 |
| Estimate Std. Error z value Pr(>|z|)  (Intercept) 1.81699 0.06096 29.807 < 2e-16 \*\*\*  phen 0.32903 0.06169 5.334 9.63e-08 \*\*\*  Mrub\_sum 0.16105 0.06317 2.549 0.010792 \*  pldens\_2 -0.39355 0.10339 -3.806 0.000141 \*\*\*  phen\_n2 -0.13530 0.06162 -2.196 0.028117 \*  phen:Mrub\_sum 0.10498 0.05467 1.920 0.054849 .  phen:phen\_n2 0.07027 0.06117 1.149 0.250717  pldens\_2:phen\_n2 -0.07565 0.06285 -1.204 0.228743 | Estimate Std. Error z value Pr(>|z|)  (Intercept) 1.81385 0.06051 29.976 < 2e-16 \*\*\*  phen 0.31961 0.06166 5.183 2.18e-07 \*\*\*  Mrub\_sum 0.19208 0.06373 3.014 0.002577 \*\*  pldens\_2 -0.38064 0.10275 -3.705 0.000212 \*\*\*  phen\_n2 -0.10848 0.06242 -1.738 0.082240 .  phen:Mrub\_sum 0.10674 0.05394 1.979 0.047815 \*  phen:phen\_n2 0.06287 0.06094 1.032 0.302257  pldens\_2:phen\_n2 -0.07169 0.06247 -1.147 0.251188  (ME.model2$vectors[, 1]) 0.11855 0.05409 2.192 0.028396 \* |
|  |  |
| Moran I statistic standard deviate = 3.0878, p-value = 0.001008 (30 m) | Moran I statistic standard deviate = 1.8487, p-value = 0.03225 (30 m) |
|  |  |
|  |  |
|  |  |

Models with all plants

Response: probability of having eggs (n=8848)

|  |  |
| --- | --- |
| Nagelkerke R2 = 0.41 | Model with eigenvectors - Nagelkerke R2 = 0.44 |
| Estimate Std. Error z value Pr(>|z|)  (Intercept) -4.32565 0.11251 -38.447 < 2e-16 \*\*\*  phen 1.37326 0.07632 17.994 < 2e-16 \*\*\*  Mrub\_sum 0.03710 0.05099 0.728 0.4669  pldens\_2 -1.92550 0.09032 -21.318 < 2e-16 \*\*\*  phen\_n2 -0.78411 0.11385 -6.887 5.68e-12 \*\*\*  phen:Mrub\_sum 0.14309 0.06191 2.311 0.0208 \*  phen:phen\_n2 0.01769 0.06653 0.266 0.7904  pldens\_2:phen\_n2 -0.48041 0.08258 -5.818 5.96e-09 \*\*\* | Estimate Std. Error z value Pr(>|z|)  (Intercept) -4.32288 0.11515 -37.542 < 2e-16 \*\*\*  phen 1.47906 0.08023 18.436 < 2e-16 \*\*\*  Mrub\_sum -0.04478 0.05273 -0.849 0.3958  pldens\_2 -1.58185 0.09816 -16.115 < 2e-16 \*\*\*  phen\_n2 -0.98386 0.11717 -8.397 < 2e-16 \*\*\*  phen:Mrub\_sum 0.13277 0.06502 2.042 0.0411 \*  phen:phen\_n2 0.11764 0.06843 1.719 0.0856 .  pldens\_2:phen\_n2 -0.38271 0.08263 -4.632 3.63e-06 \*\*\*  vector1 0.28227 0.02955 9.554 < 2e-16 \*\*\*  vector2 0.39318 0.04766 8.250 < 2e-16 \*\*\* |
| Moran I statistic standard deviate = 96.191, p-value < 2.2e-16 (30 m) | Moran I statistic standard deviate = -0.046661, p-value = 0.5186 (30 m) |
|  |  |

Response: number of eggs in plants with eggs (n=731)

|  |  |
| --- | --- |
| Nagelkerke R2 = 0.27 | |
|  | |
| Estimate Std. Error z value Pr(>|z|)  (Intercept) 1.49565 0.03710 40.312 < 2e-16 \*\*\*  phen 0.23331 0.03675 6.348 2.18e-10 \*\*\*  Mrub\_sum 0.11571 0.03055 3.787 0.000152 \*\*\*  pldens\_2 -0.39557 0.05551 -7.126 1.04e-12 \*\*\*  phen\_n2 -0.11050 0.03772 -2.929 0.003400 \*\*  phen:Mrub\_sum 0.06673 0.03040 2.195 0.028193 \*  phen:phen\_n2 -0.03441 0.03513 -0.980 0.327265  pldens\_2:phen\_n2 -0.12066 0.03720 -3.243 0.001181 \*\* | |
| Moran I statistic standard deviate = 0.96653, p-value = 0.1669 (30 m) |
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