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Supplementary Material of the Manuscript "Multi-Featured Collective Perception with EvidenceTheory: Tackling Spatial Correlations"

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Multi-Featured Benchmark Generator

The environmental grid is not predefined and is generated each simulation upon the desired pattern type (Bartashevich and Mostaghim, 2019). To construct the multi-featured environment with $n > 2$ colours , a colour ratio parameter ρ has to be defined prior to the pattern generation. For a binary case with $n = 2$ colours, the parameter ρ was identified as a ratio of black cells to the white ones, given that white is a prevailing colour. For instance, the parameter's values $\rho \in \{0.67, 0.93\}$ correspond to an easier (i.e., 40% black and 60% white) and the most difficult (i.e., 48% black and 52% white) cases, respectively.

In case of multiple features ($n > 2$), for the environment with colour proportions $\vec{f}_\Omega = (f_{\omega_1}, ..., f_{\omega_n})$, we define $\rho(\vec{f}_\Omega)$ as $\rho(\vec{f}_\Omega) := 1 - gini(\vec{f}_\Omega)$, where:

$$gini(\vec{f}_\Omega) = \frac{1}{n-1}\left(n + 1 - 2 \cdot \left(\sum_{i=1}^{n}\sum_{j=1}^{i} f_{\omega_j}\right) \cdot \left(\sum_{i=1}^{n} f_{\omega_i}\right)^{-1}\right) \tag{1}$$

and f_{ω_i} indicates either a ratio or the amount of cells with a specific colour $\omega_i \in \Omega$ in the whole environment, such that $f_{\omega_i} \leq f_{\omega_{i+1}}$. Here, the Gini coefficient $gini(\cdot) \in [0, 1]$ is a measure of the degree of inequality in a distribution (Gini, 1921), indicating how a given feature distribution $\vec{f}_\Omega$ differs from a totally equal one. That is, $gini(\vec{f}_\Omega)$ equals zero in the case when there is an equal amount of all the features, and equals one when there is a definitive distinguish, i.e., complete inequality.

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To keep consistent with the difficulty levels of ρ for the binary case, i.e., $\rho \in \{0.67, 0.93\}$, we need to define colour proportions $\vec{f}_\Omega$ also for $n > 2$ in such a way that $\rho(\vec{f}_\Omega) \in \{0.67, 0.93\}$ regardless of the vector's length $|\vec{f}_\Omega| = n$. According to our definition of $\rho(\vec{f}_\Omega)$, where $gini(\vec{f}_\Omega) = 1 - \rho(\vec{f}_\Omega)$, the easiest case of $\rho(\vec{f}_\Omega) = 0.67$ corresponds then to the Gini value of 0.33, indicating some level of colour disproportion. While $\rho(\vec{f}_\Omega) = 0.93$ implies almost equal colour distribution as intended, since the Gini value is approaching zero in this case, i.e., $gini(\vec{f}_\Omega) = 0.07$. For instance, in the case of $n = 3$ and $\rho(\vec{f}_\Omega) = 0.67$, the vector of colour ratios is then defined as follows: $\vec{f}_\Omega = (0.17, 0.33, 0.5)$.

References

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