**Polar Bears and Climate Change**

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**What It Models:**

This model shows the effects of climate change on the lives of polar bears. As the Earth grows warmer each day, the glaciers and ice are slowly melting into water. Polar bears are one of the thousands of species heavily affected by melting ice since ice is their home. To show how ice melting impacts polar bears, the model begins with polar bears inhabiting chunks of ice. The polar bear population will grow as long as they are on ice. If the ice chunks become too populated, the polar bears will migrate to new ice chunks by swimming in water. If the polar bears are in the water, they have a chance to drown. However, global warming will cause the ice chunks to slowly shrink over time. This means polar bears will have less room to grow and must spend more time in the water finding new places to live, thus, killing off the polar bear population.

**States of a Cell:**

Cells of this model will be represented in strings. Polar bears are “p” cells and will have a grey colour. When polar bears are migrating they take on migrating states, “m” cells. They still share the same colour as polar bears but will take on new rules. Ice cells are “i” cells and have a white colour. The ice cells will initially be placed to form four large ice chunks. The water cells are “w” cells. They are represented by 3 hues of blue.

|  |  |  |
| --- | --- | --- |
| Polar Bear/Migration Cell | Water Cell | Ice Cell |

**Evolution rules:**

* The number of neighbouring polar bears or water cells is in a 5x5 area.
* If there are more than 21 cells of water around a polar bear, it will have a chance to drown. The polar bear will drown by turning into a water cell.
* Polar bears reproduce when there are exactly 4 other polar bears and no water around an ice cell. The ice cell will turn into a bear cell to create a new bear.
* If there are more than 4 polar bears around a polar bear, the polar bear will enter a migrating state and will migrate towards the Northward direction where the climate is colder. It will move -5 to 5 cells at a time horizontally and 0 to 5 cells northwards each frame.
* While migrating, the polar bear will be swimming in water. If it has more than 8 water cells around it, it will have a chance to drown every frame. The polar bear will drown by turning into a water cell.
* If the migrating cell reaches an area with less than 4 polar bears and less than 3 water cells around it, it will stop migrating by becoming a polar bear cell.
* If an ice cell has more than 7 water cells around it, there is a chance the ice will melt. The ice melts by turning into a water cell

**Sample Evolution:**

➖ Polar Bear ➖ Water

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  | D | A |
|  |  | G | E |  |  |
|  | F | B |  |  |  |
|  |  |  |  | H |  |
|  |  |  | C |  |  |
|  |  |  |  |  |  |

➖ Ice

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  | D | A |
|  |  | G | E |  |  |
|  | F | B |  |  |  |
|  |  |  |  |  |  |
|  |  |  | C |  |  |
|  |  |  |  |  |  |

**Reasons for evolution:**

1. Cell D and A, ice cells, become polar bears since there are exactly 4 bears around the cell and no water cells.
2. Cell E becomes a migrating cell since there are more than 4 neighbouring polar bear cells. It shares the same colour as a polar bear cell.
3. Cell B and C had more than 7 water cells around them. Therefore, they had a probability set by the user to melt. These ice cells become water cells by chance.
4. Cell F is a migrating cell that drowns. It has more than 8 water cells thus it has a chance to drown. It drowns by turning into a water cell by chance.
5. Cell G does not have more than 7 water cells so it can’t melt into water. Although it has exactly 4 bears around the cell, it has water cells around it, thus, it can’t turn into a polar bear either. As a result, it remains an ice cell.