**Mathematical Modeling of Bush Fires**

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**Goals for the teacher:** give students the opportunity

* To reflect on the mathematical patterns behind bush fires and possible mechanisms that generate them,
* To enjoy the search for hidden structures, and appreciate the power of having a good model.

**Goals for the students**: recognize patterns, discover mechanisms that generate them, and see the need to express them in a powerful language useful for automatizing decisions

**Mission:** design an automaton that commands autonomous drones to put out bush fires

**Materials:** Dominos, one whistle, grid marked carton boards, post it (reds, black, blue, yellow) to put on the cells of the boards; paper notebook, color pencils and one red umbrella per student.

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| **Time** | **Teacher activity** | **Student activity/response** |
| 0-5 min  5-15 min  15-20 min  20-30 min  30-40 min  40-45 min | 1st stage: Help students discover there are patterns in bus fire propagations   * Are there patterns in the propagation of bush fires? * Are there important hidden variables involved? Do students have experience with hidden variables?   2nd stage: Help students realize that there are propagation patterns **similar** to other propagation phenomena.   * Let´s pretend to be a domino and emulate the domino effect. Each one is a domino tile standing up. What are the “states” of each tile or student? * Are bush fires like other propagation phenomena? For example, what does it have in common with the domino effect? * What is the same and what is different between bush fires and domino effects?   3rd stage: help students realize that there are **mechanisms** that generate the propagation   * Does the domino effect emerge from a simple and LOCALIZED mechanism? * Is this mechanism operating SIMULTANEOUSLY all over? * Let´s pretend to be a tree at a cell or position, falling when burned. What are the states at each cell? * Does the bush fire propagation emerge from a simple and LOCALIZED mechanism?   4th stage: help students realize that there are **controlling variables** to controlbush fires   * How can we control a bush fire with water? * What are the states at each cell? * How about controlled burning? * What is the whole mechanism? Is it localized? Does it operate simultaneously all over?   5th stage: Help students realize they need to express mechanism with **rules** to be able to predict and **automatize**   * Let´s pretend one student is a drone. How would you write the instructions to decide what to do considering the delay in arriving at the location? * Imagine now you are not present. What would be the instructions? * Can you predict what will happen? * How can we design a bush fire automaton that commands autonomous drones to put out bush fires?   6th stage: Help students **reflect** on the modeling process   * Are there other important factors in bush fire propagation? * What have we learned? | **Anticipated student response:** students describe that bush fires travel, expand, shrink, and depend on wind direction and strength.  **Anticipated student response:** Students emulate a domino and fire, and some of them realize fires propagate in two dimensions and not just one as in domino.  **Anticipated student response:** students discuss mechanisms and some of them describe interactions between neighboring cells.  **Anticipated student response:** students describe effect of water, and some of them realize the strategy of controlled burns, and are able to represent these actions with post it.  **Anticipated student response:** students understand they need to write the coordinates, but will have difficulty expressing commands using generic cells.  **Anticipated student response:** students will reflect on the limitation of the model, on the need to be able to predict propagation and have a way (language) to express conditions in any possible situation. |