

Scratch.mit.edu



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Scratch.mit.edu

structured visual programming (no GOTO)

Visual code editor with blocks (NO syntax, almost no typing)

Web-based or local visual editor (<https://scratch.mit.edu/download>)

Blocks contain text/commands (not OK for pre-scholar students)

Available data types

Numbers, strings, booleans, simple lists (heterogeneous)

Main features

GLOBAL variables + **Agent** variables + Agent cloning

Procedures: “My blocks” (NO return value! BUT: you can simulate it with a variable)

PARALLEL execution of multiple scripts for the same event

Message based coordination and synchronization

Event-based programming: (touched, hit, key pressed, message received)

Blocks Categories

| | |
|-------------------|--|
| Motion: | move the agent (e.g. the Cat) |
| Looks: | change agent's appearance |
| Sound: | produces/plays sound |
| Control: | if-then-else, conditional/counted loops, ... |
| Event: | definition of callbacks to be executed on events |
| Sensing: | reading attributes or ask for input |
| Operators: | mathematical/logical operations |
| Variables: | variable definition/getter/setter/increment |
| Lists: | list definition/getter/setter and manipulation |

Blocks Shapes

(see <https://en.scratch-wiki.info/wiki/Blocks>)

HAT: event handlers



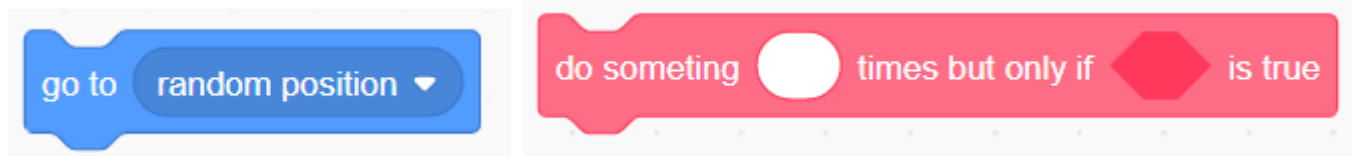
REPORTER: function results/variable values/agent attributes
(numbers, lists or strings)



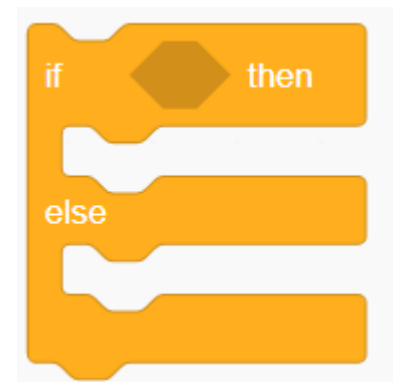
ANGULAR: boolean values/operators/parameters



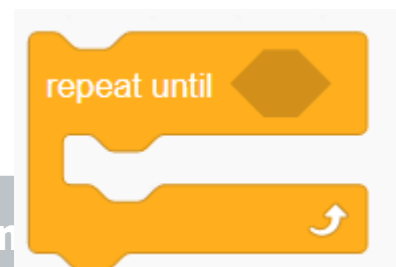
STACK: instructions, to be connected to each other in a sequence



C/BRACKET: grouping instructions/control structures



CAP: end of program/agent death



Scratch blocks



Programming Environment:

Stage + Multiple Agents + Costumes + Sounds

Stage with multiple pictures (containing “global” code and vars)

Switchable background (with `when-switched` event)

Background vectorial editor (with text)

Multiple agents: contain their personal code/variables and can:

Move and draw (Turtle-inspired), change appearance, ask or show text, play music or sounds, interact with each other ...

The agent’s “costume” is vectorial and could contain text (but you cannot separately move the costume’s parts, unless they are separate agents)

Agents can be cloned!!! (each gets a copy of her mum’s variables)

The agent CAN READ/SET her personal and global variables

It CANNOT READ/SET other agent’s variables (share globals if needed)

Programming styles

Event-based

Multiple threads for the same event!

Agents updates itself by reading the other's state and globals

Code modularization: through PROCEDURES (new blocks)

There is no “return” instruction

(can be faked with a global variable)

Procedures are LOCAL to the Agent or Stage

Accept arguments (numbers/lists/booleans)

RECURSION? YES (but no “return”)

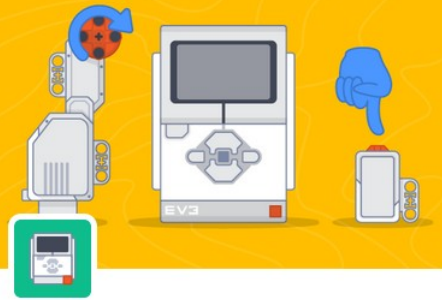
A Scratch 'define' block, which is a pink rounded rectangle. It contains a 'do something' block (a smaller pink rounded rectangle) followed by a circular input field containing the letter 'N', then the text 'times but only if', followed by a diamond-shaped boolean input field containing the word 'boolean', and finally the text 'is true'.

define do something N times but only if boolean is true

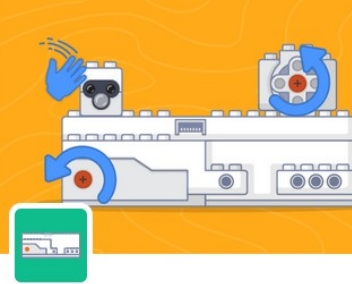
A Scratch 'do something' block, which is a pink rounded rectangle. It contains a circular input field, then the text 'times but only if', followed by a diamond-shaped boolean input field, and finally the text 'is true'.

do something times but only if is true

Extensions



LEGO MINDSTORMS EV3



LEGO BOOST



LEGO Education WeDo 2.0

Lego Mindstorms EV3/WeDo/Boost

Music

Video sensing

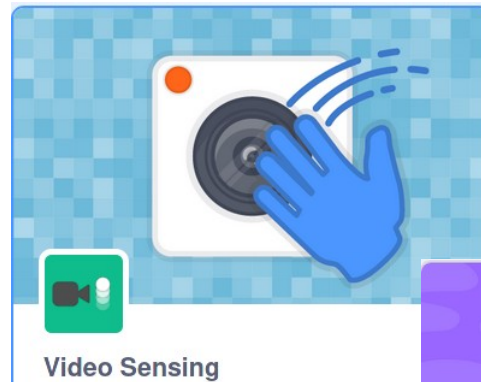
Pen (turtle graphics)

Text-to-speech

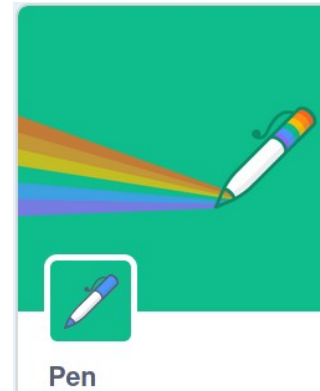
Translate

Micro:Bit microcontroller

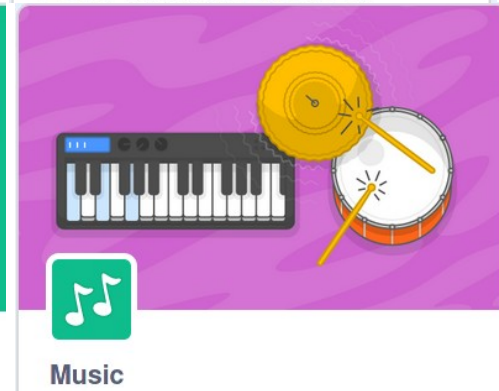
Force/acceleration sensor



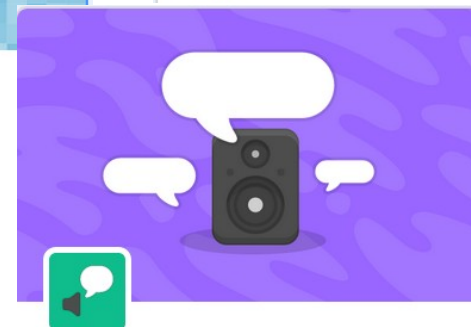
Video Sensing



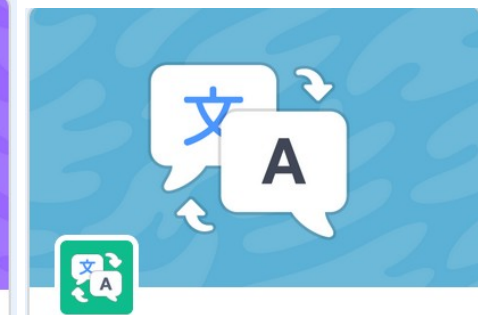
Pen



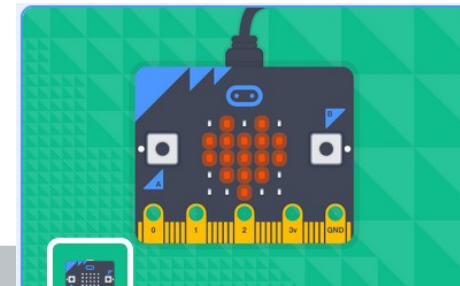
Music



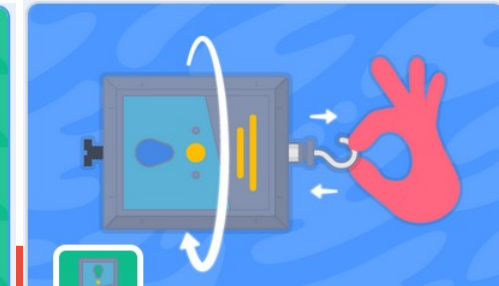
Text to Speech



Translate



micro:bit



Go Direct Force & Acceleration

DEBUGGING

You can show Stage and Agent variables

You can change them at runtime (with a slider if numbers)

You can slow-down execution and highlight the running block

You can try what a block does by clicking on it

You can build an “observer” agent that tracks message “probes”

This way you keep the code separate from the debugger agent

Code Quality: www.DrScratch.org

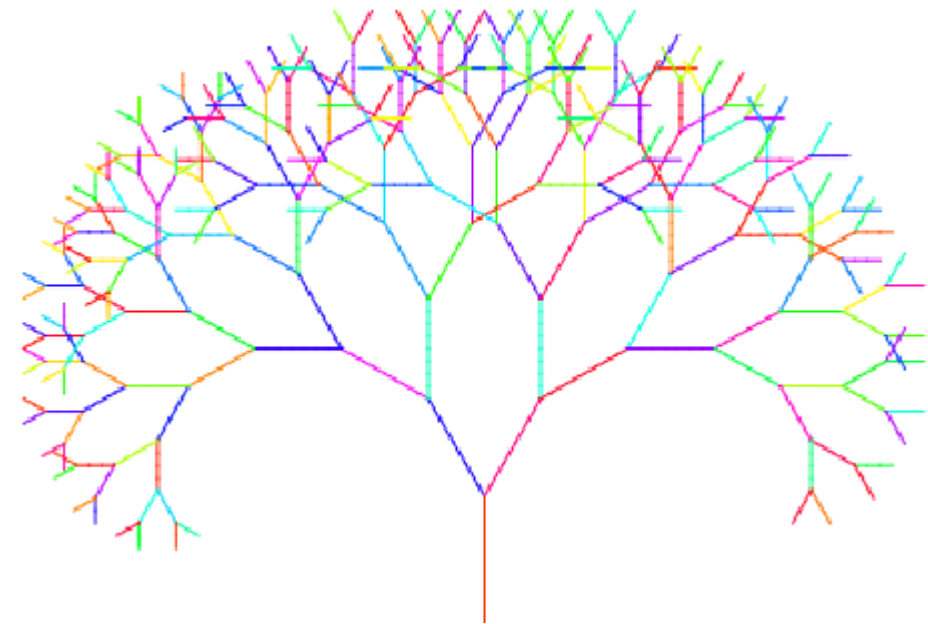
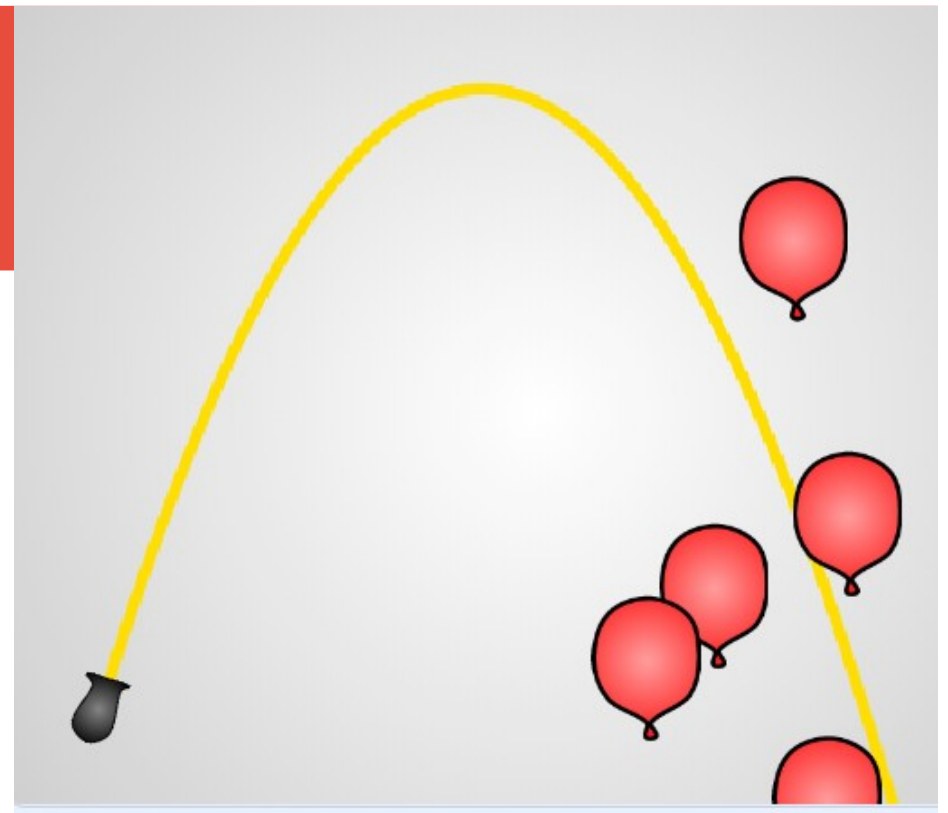
Extracts many nice indicators from the submitted project:

- Flow control: 0=sequence, 1=repeats, 2=if-then-else
- Data representation: 0=no variables, 1=variables, 2=lists
- Abstraction: 0=single program, 1=modularity, 2=clones
- Interactivity: 0=single event, 1=ask/say+mouse, 2=video/audio
- Synchronization: 0=wait time, 1=messages, 2=wait until/when X
- Parallelism: 0=single thread, 1=multi-thread, 2=when X events
- Logic: 0=if-then, 1=if-then-else, 2=if with multiple conditions

Then you get a nice certificate and best-practices suggestions

Examples

Shoot the balloons



Procedural Recursive tree
Recursive tree with parallel clones

Scratch “language” ability to show C.T. topics

| | | | |
|---|---------|--|--------------------|
| Algorithm | YES | (stacked blocks) | |
| Structured control | YES | (bracket blocks, loops, if-then-else) | |
| Code reuse | YES | (My Blocks, but only procedures) | |
| Procedures | YES | Functions | NO |
| Scope | LIMITED | (global or agent scope, no local) | |
| Memory usage | LIMITED | | |
| global variables YES, agent variables YES, local variables NO | | | |
| Data Types | LIMITED | (numbers, booleans, strings, flat lists) | |
| Static types | LIMITED | (booleans vs. other values) | |
| Agents attributes | YES | with methods | (MESSAGES) |
| Events | YES | Messages | YES (named, empty) |
| Concurrency | YES | Clones | YES |

Scratch + extensions vs. other subjects

| | |
|------------------------------------|--|
| Agent-based simulation | (Physics, Math, ...) |
| Agent-based animation | (Literature, History, Art, ...) |
| Music extension | (Music, Rhythm, Harmony) |
| Text-based interaction | (Interactive Fiction, Text generation) |
| Lego Robot extension | (Robotics, Physics) |
| Voice recognition / Text to Speech | (non-textual interaction) |