How Kids Code and How We Know

Fenia Aivaloglou @feniaiv

Scratch - Imagine, Progra...

https://scratch.mit.edu

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Create stories, games, and animations
Share with others around the world

A creative learning community with **16,266,327** projects shared

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Featured Projects

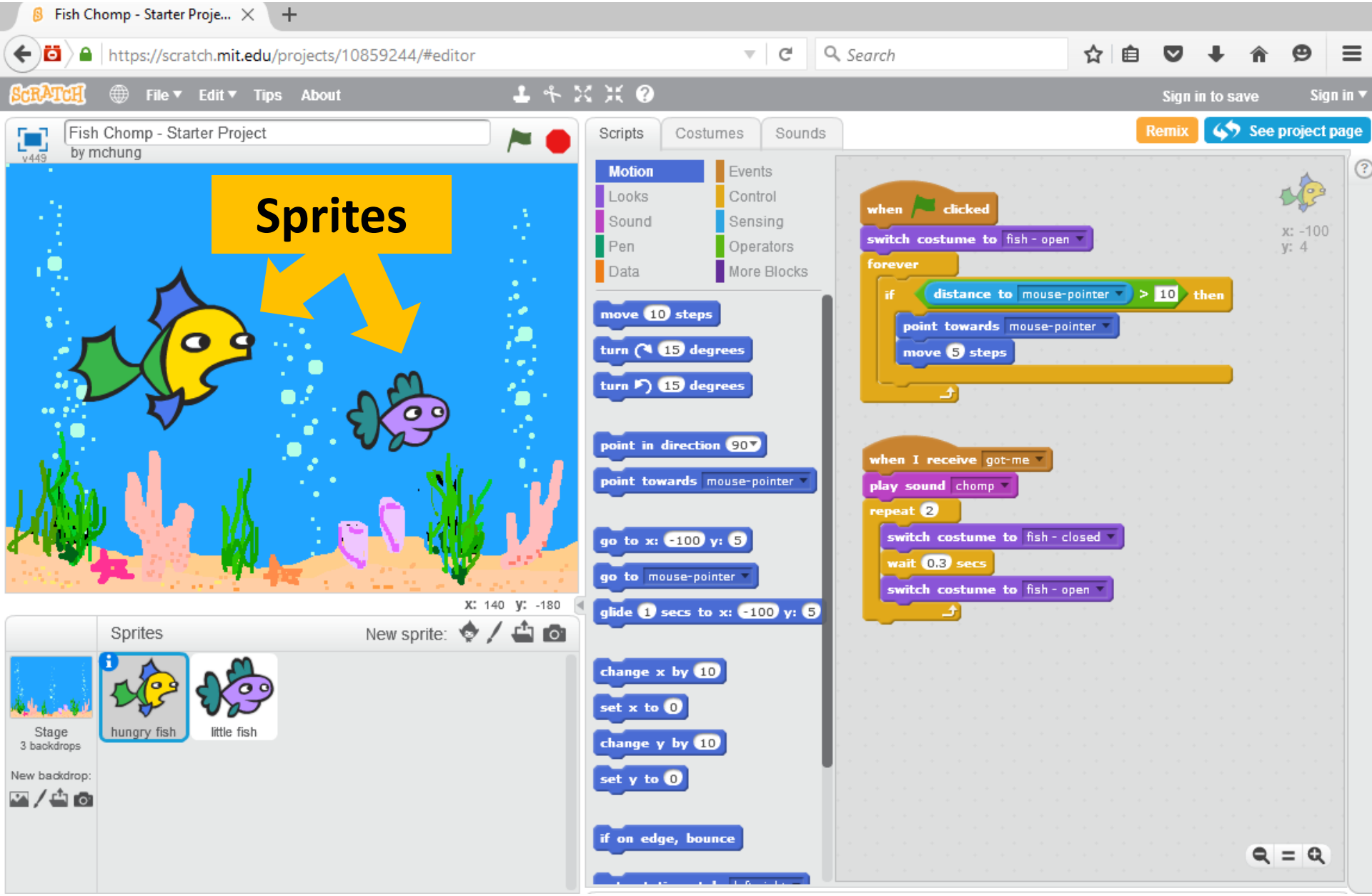
Pointillism: an Introduc
-TraditionalChibi-

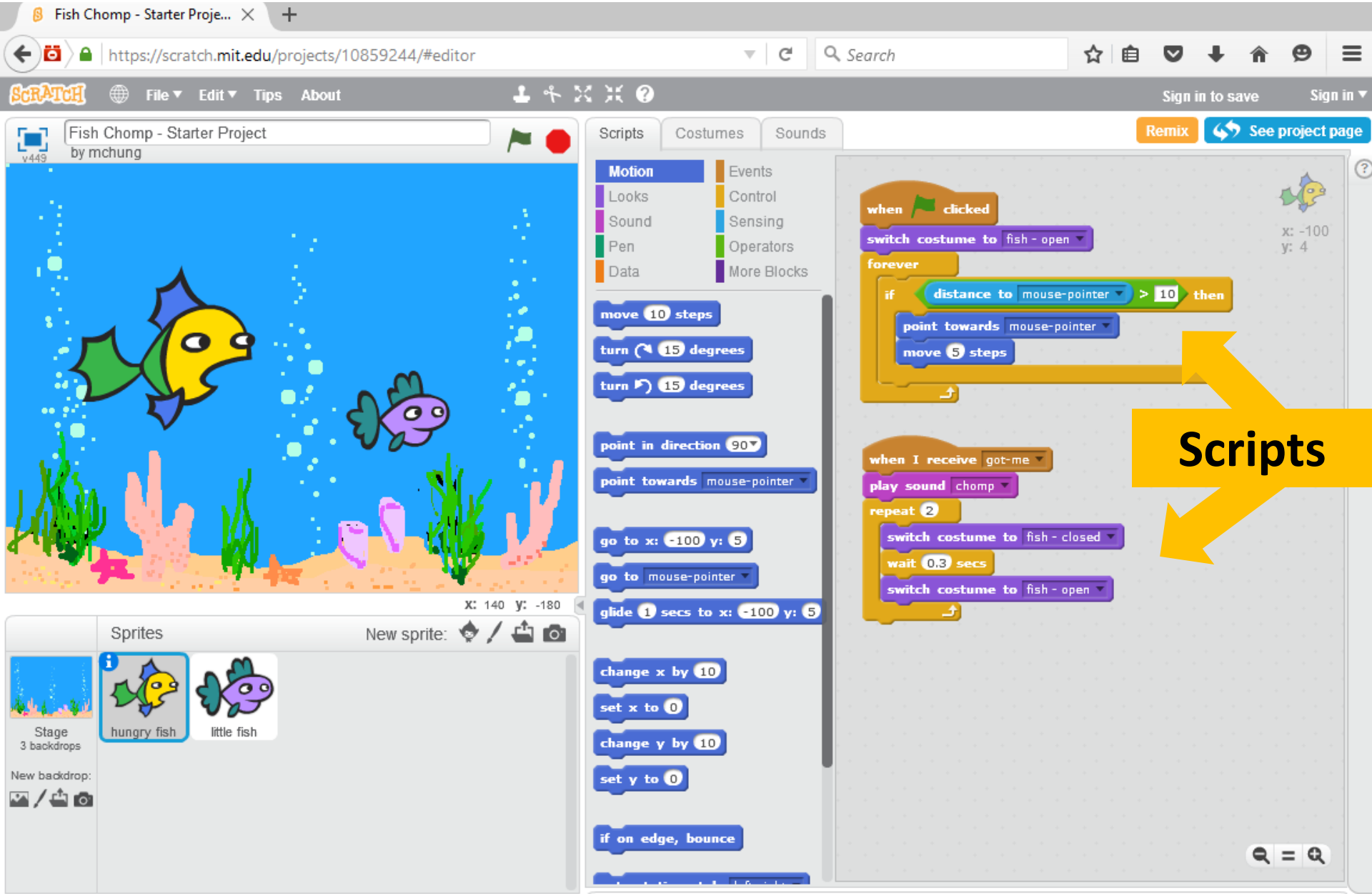
Pixel Level Maker!
TheCode7

illusyum (v1.0.3)
applepiesleth

Pinboard About Me
Dan0510

Lost Boy MAP
kendy4ever


Fish Chomp - Starter Proje...
https://scratch.mit.edu/projects/10859244/#editor
Search
File
Edit
Tips
About
Sign in to save
Sign in
Fish Chomp - Starter Project
by mchung
Sprites
Scripts
Costumes
Sounds
Remix
See project page
Motion
Looks
Sound
Pen
Data
Events
Control
Sensing
Operators
More Blocks
move 10 steps
turn 15 degrees
turn 15 degrees
point in direction 90
point towards mouse-pointer
go to x: -100 y: 5
go to mouse-pointer
glide 1 secs to x: -100 y: 5
change x by 10
set x to 0
change y by 10
set y to 0
if on edge, bounce
when clicked
switch costume to fish - open
forever
if distance to mouse-pointer > 10 then
point towards mouse-pointer
move 5 steps
when I receive got-me
play sound chomp
repeat 2
switch costume to fish - closed
wait 0.3 secs
switch costume to fish - open
x: -100
y: 4
x: 140 y: -180
Sprites
New sprite:
Stage
3 backdrops
New backdrop:
hungry fish
little fish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Sprites
New sprite:
Stage
3 backdrops
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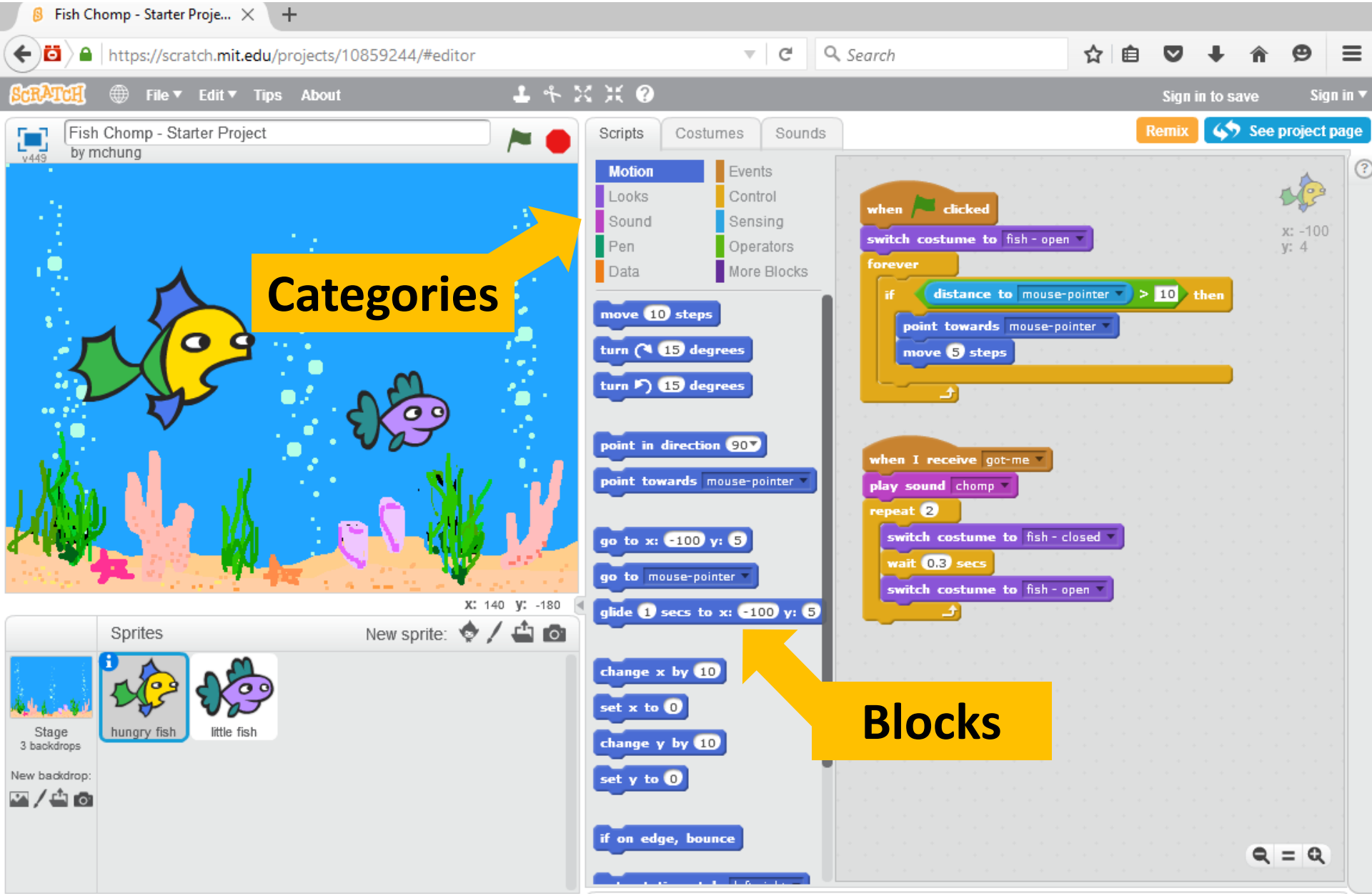
little fish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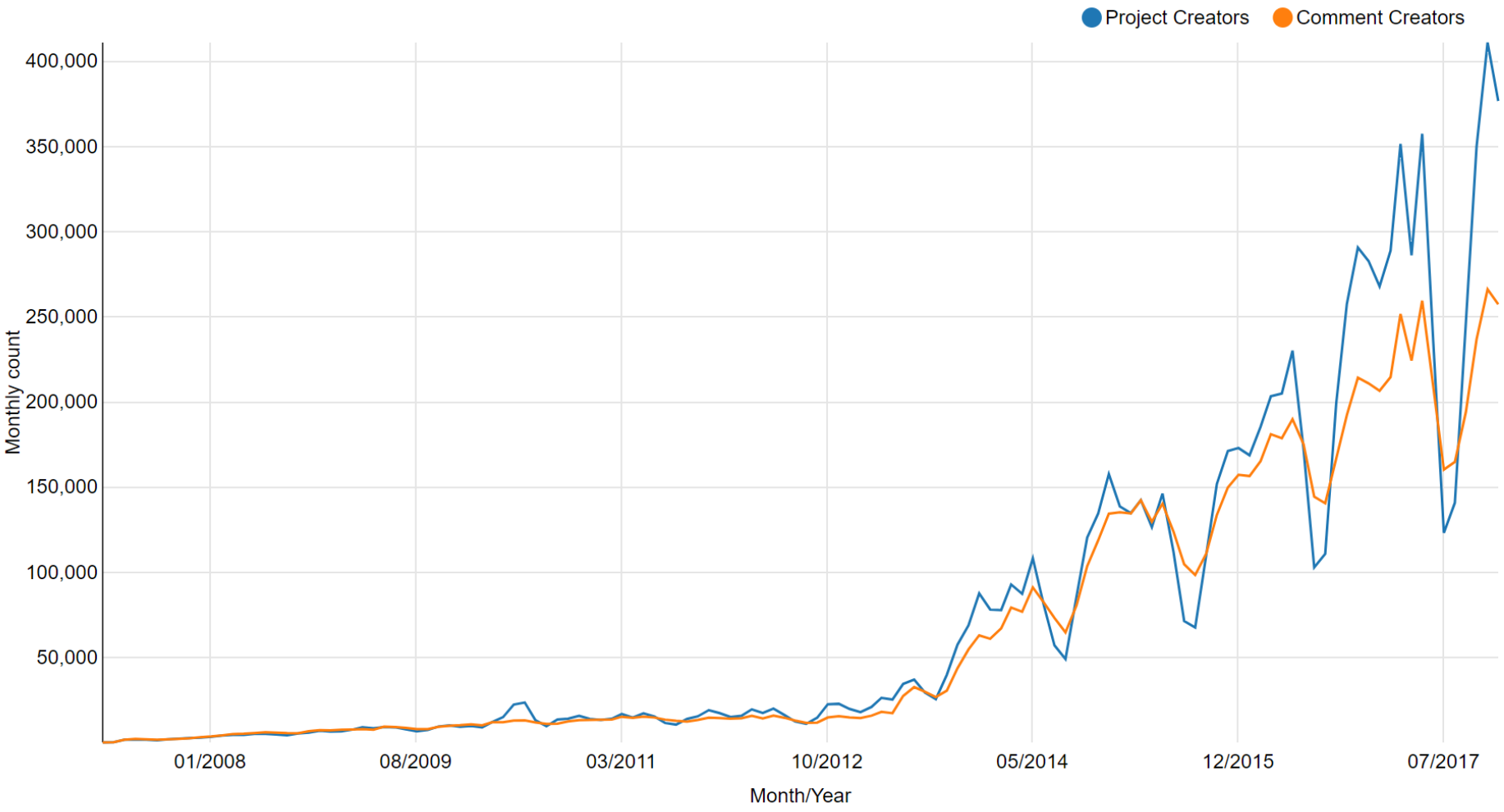
Data
Events
Control
Sensing
Operators
More Blocks
Categories
move 10 steps
turn 15 degrees
turn 15 degrees
point in direction 90
point towards mouse-pointer
go to x: -100 y: 5
go to mouse-pointer
glide 1 secs to x: -100 y: 5
change x by 10
set x to 0
change y by 10
set y to 0
if on edge, bounce
when clicked
switch costume to fish - open
forever
if distance to mouse-pointer > 10 then
point towards mouse-pointer
move 5 steps
when I receive got-me
play sound chomp
repeat 2
switch costume to fish - closed
wait 0.3 secs
switch costume to fish - open
x: -100
y: 4
Blocks
x: 140 y: -180
Sprites
New sprite:
Stage
3 backdrops
New backdrop:
hungry fish
little fish

Community statistics at a glance

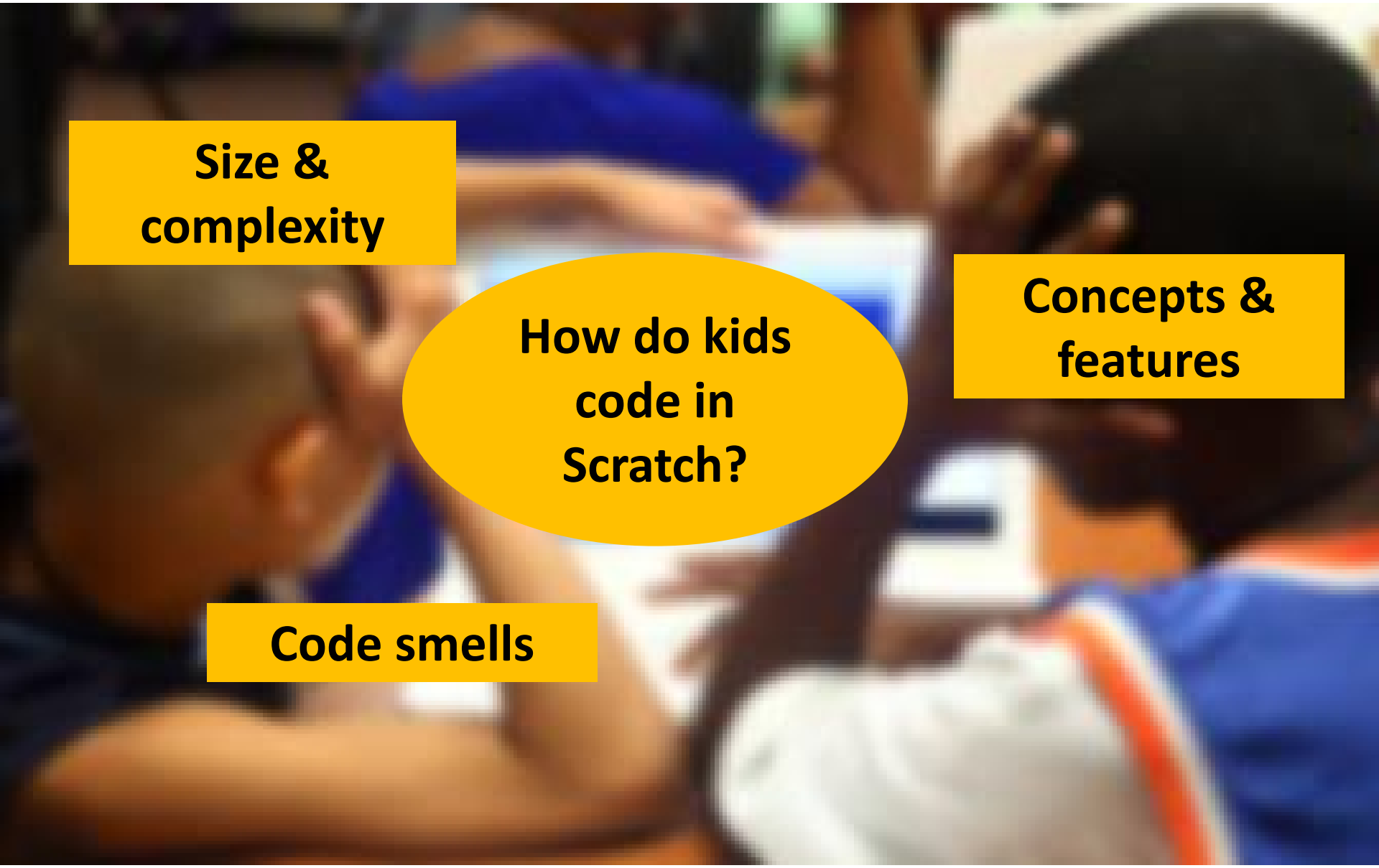
- 28,408,573 projects shared,
- 24,785,274 users registered,
- 142,624,859 comments posted,
- 4,117,795 studios created

…and growing!

Monthly Active Users

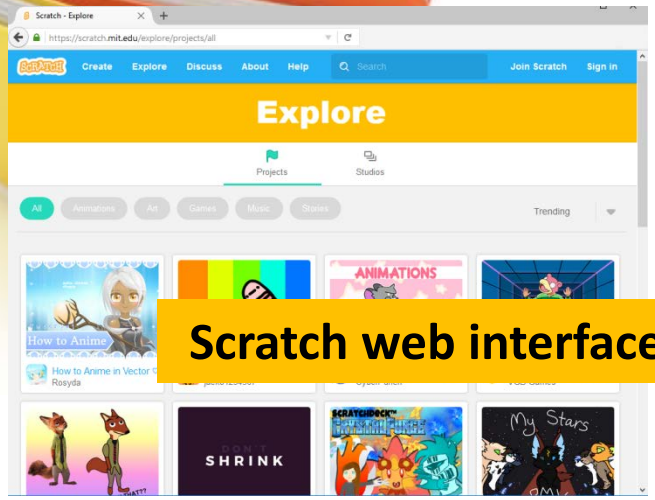



How do kids code in Scratch?


Size & complexity
How do kids code in Scratch?
Concepts & features
Code smells

How do we find out?

Getting the projects data



Scratch web interface

Scrape

```
"objName": "Sprite3",
"scripts": [[81,
                51,
                [["whenGreenFlag"], ["createCloneOf", "_myself_"], ["gotoX:y:", -179, 134], ["hide"]]],
        [119,
                212,
                [["whenIReceive", "fly"],
                        ["doRepeat",
                                20,
                                [["gotoX:y:", -179, 134],
                                        ["call", "random costume"],
                                        ["createCloneOf", "_myself_"],
                                        ["gotoX:y:", 140, 19],
                                        ["call", "random costume"],
                                        ["createCloneOf", "_myself_"],
                                        ["gotoX:y:", -47, -114],
                                        ["createCloneOf", "_myself_"],

        [376,
                2
                [                                                                :to:", 1, 4]]]],
        [227,
                483,
                ["whenCloned"],
                        ["show"],
                        ["doUntil", ["touching:", "_edge_"], [["changeXposBy:", -3]]],
                        ["hide"]]]],
```

JSON files of 250K projects

Parse

A	B	C	D	E	F	G	H
10519701	68-60	0	sprite	Sprite3	1	0	whenIReceive
10519701	68-60	0	sprite	Sprite3	1	1	say:duratio elap
10519701	68-60	0	sprite	Sprite3	1	2	broadcast:
10519701	108-1						ec
10519701	108-1						d:from:
10519701	108-1						psed:from:
10519701	108-143	1	sprite	Sprite4	1	3	nextCostume
10519701	129-121	2	sprite	Sprite1	1	0	whenGreenFlag
10519701	129-121	2	sprite	Sprite1	1	1	broadcast:
10541430	22-17	0	stage	stage	1	0	whenGreenFlag
10541430	22-17	0	stage	stage	1	1	setVar:to:
10541430	22-17	0	stage	stage	3	3	changeVar:by:
10541430	22-17	0	stage	stage	1	2	doForever
10541430	21-14	1	sprite	Tree_3	1	0	whenGreenFlag
10541430	21-14	1	sprite	Tree_3	1	1	show
10541430	21-14	1	sprite	Tree_3	1	2	goBackByLayers:

CSV files of 247K projects

Analyzing the projects data

A	B	C	D	E	F	G	H
10519701	68-60	0	sprite	Sprite3	1	0	whenIReceive
10519701	68-60	0	sprite	Sprite3	1	1	say:duration:elapsed:from:
10519701	68-60	0	sprite	Sprite3	1	2	broadcast:
10519701	108-143	1	sprite	Sprite4	1	0	whenIReceive
10519701	108-143	1	sprite	Sprite4	1	1	say:duration:elapsed:from:
10519701	108-143	1	sprite	Sprite4	1	2	wait:elapsed:from:
10519701	108-143	1	sprite	Sprite4	1	3	nextCostume
10519701	129-121	2	sprite	Sprite1	1	0	whenGreenFlag
10519701	129-121	2	sprite	Sprite1	1	1	broadcast:
10541430	22-17	0	stage	stage	1	0	whenGreenFlag
10541430	22-17						
10541430	22-17						
10541430	22-17						
10541430	21-14	1	sprite	Tree_3	1	0	whenGreenFlag
10541430	21-14	1	sprite	Tree_3	1	1	show
10541430	21-14	1	sprite	Tree_3	1	2	goBackByLayers:

CSV files of 247K projects

Import

Query

```
SELECT
    projectID,
    COUNT(DISTINCT spriteName) AS spritesWithCodeNo,
    MAX(codeBlockRank) + 1 AS codeBlocksNo,
    sum(totalLines) as totalLines
FROM dbo.scripts
GROUP BY projectid
```

100 %

Results | Messages

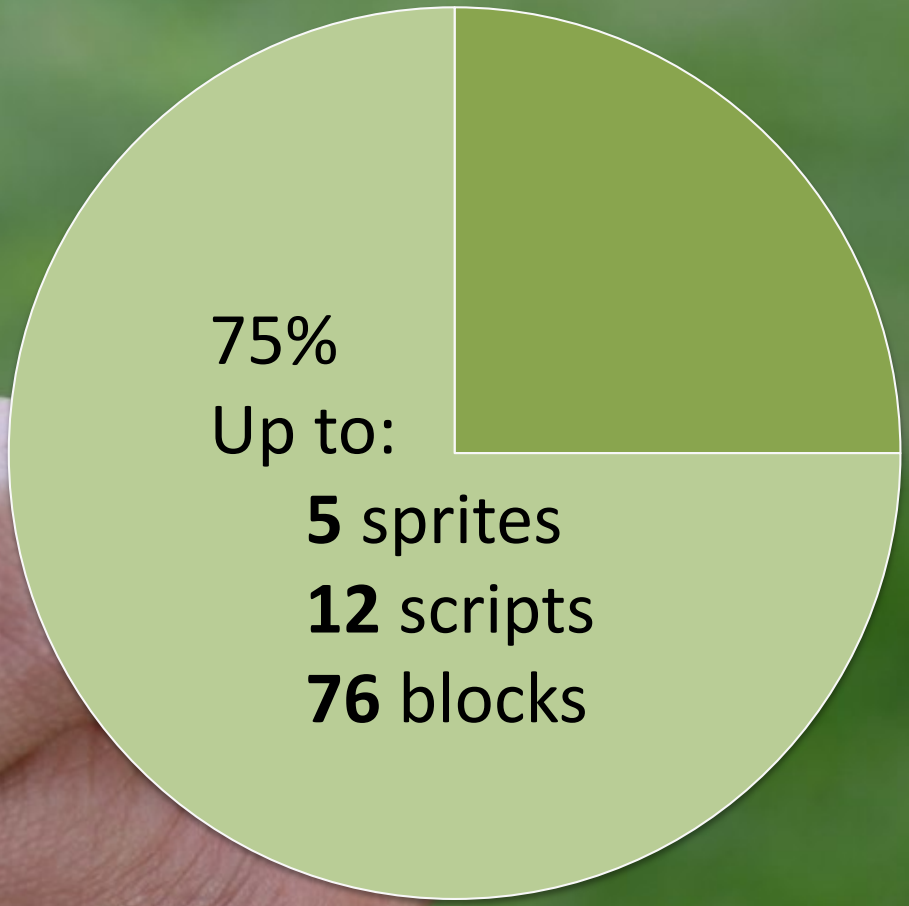
	projectID	spritesWithCodeNo	codeBlocksNo	totalLines
1	10519701	3	3	9
2	10541430	8	11	85
3	10942522	14	56	216
4	11823040	1	1	3
5	11828235	3	19	41
6	12030146	14	39	281
7	12237615	3	8	41
8	12256407	1	1	9

E. Aivaloglou, F. Hermans, J. Moreno-León, and G. Robles. 2017. A dataset of scratch programs: scraped, shaped and scored. In Proceedings of the 14th International Conference on Mining Software Repositories (MSR '17)

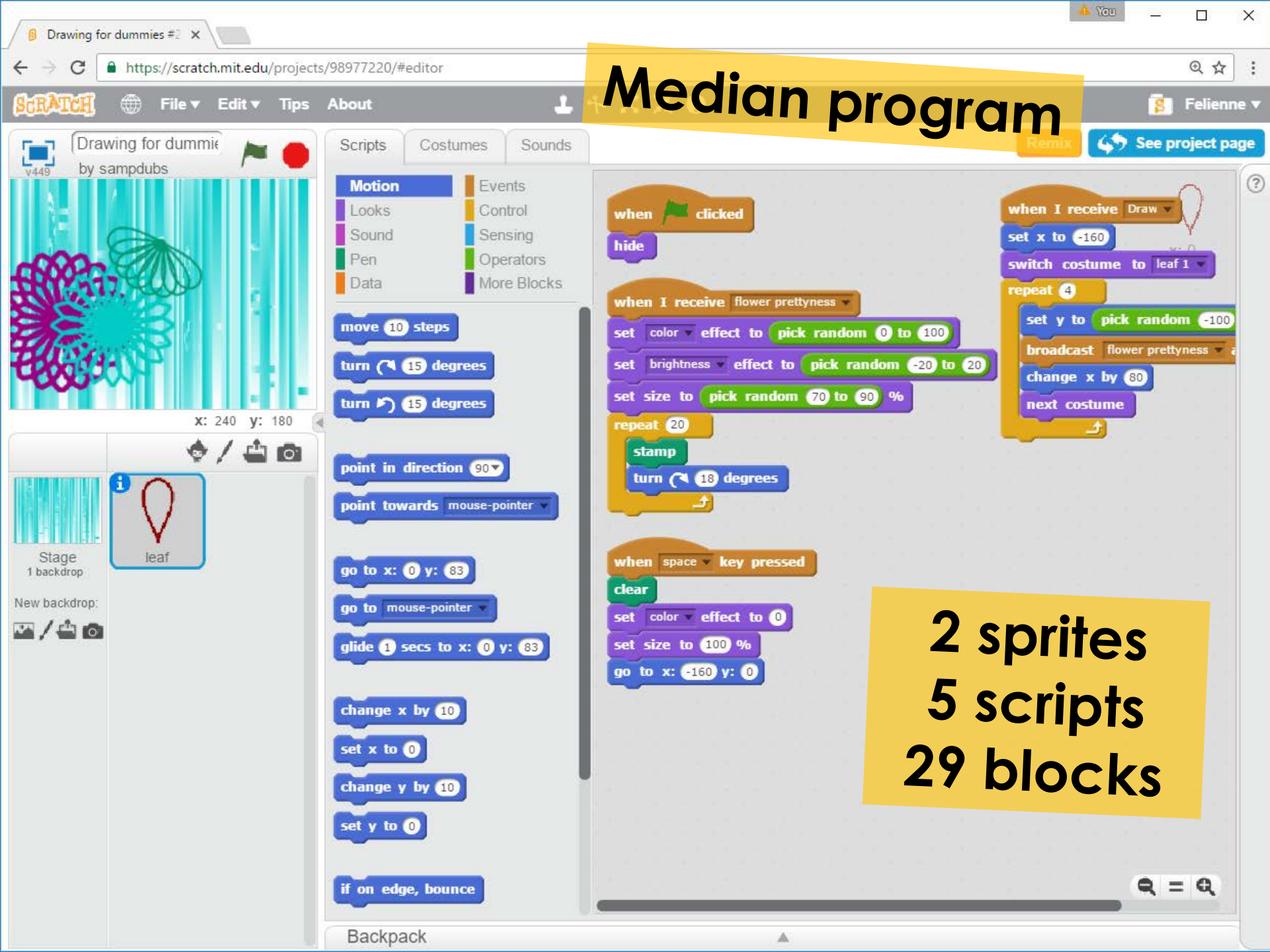

Size & complexity
What we found
Concepts & features
Code smells


Most programs
are small...

Most programs are small...



233K non-empty projects


Drawing for dummies #2
https://scratch.mit.edu/projects/98977220/#editor
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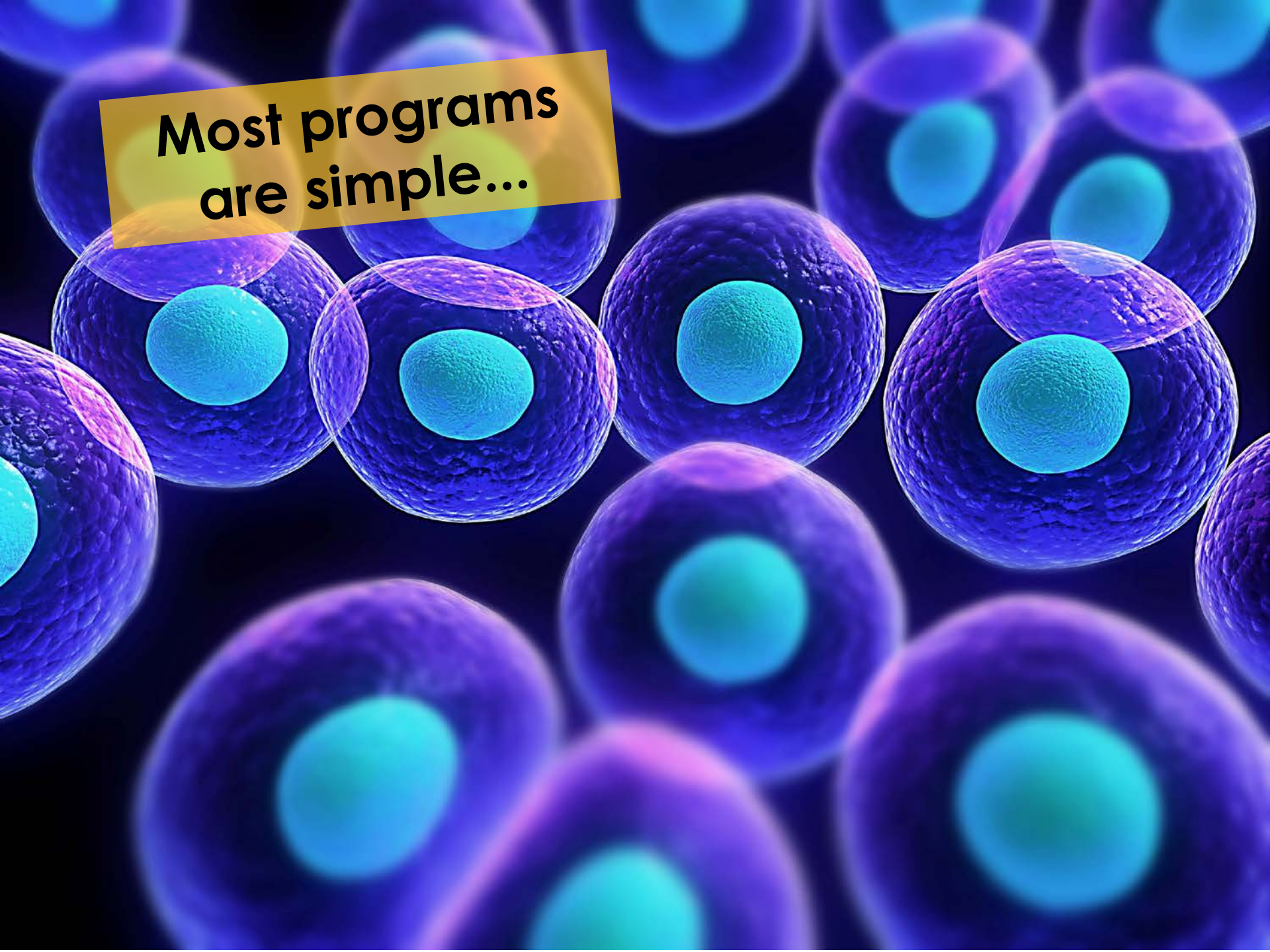
Edit
Tips
About
Felienne
Drawing for dummie
by sampdubs
v449
See project page
Scripts
Costumes
Sounds
Motion
Looks
Sound
Pen
Data
Events
Control
Sensing
Operators
More Blocks
move 10 steps
turn 15 degrees
turn 15 degrees
point in direction 90
point towards mouse-pointer
go to x: 0 y: 83
go to mouse-pointer
glide 1 secs to x: 0 y: 83
change x by 10
set x to 0
change y by 10
set y to 0
if on edge, bounce
when clicked
hide
when I receive flower prettyness
set color effect to pick random 0 to 100
set brightness effect to pick random -20 to 20
set size to pick random 70 to 90 %
repeat 20
stamp
turn 18 degrees
when space key pressed
clear
set color effect to 0
set size to 100 %
go to x: -160 y: 0
when I receive Draw
set x to -160
switch costume to leaf 1
repeat 4
set y to pick random -100
broadcast flower prettyness
change x by 80
next costume
x: 240 y: 180
Stage
1 backdrop
New backdrop:
leaf
Backpack
2 sprites
5 scripts
29 blocks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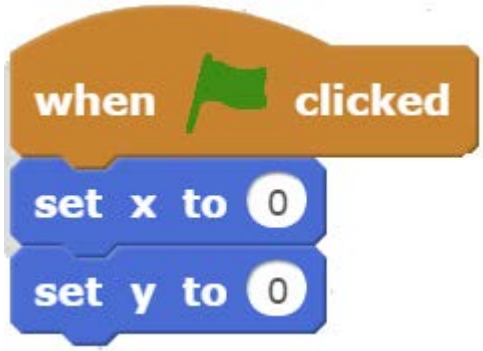
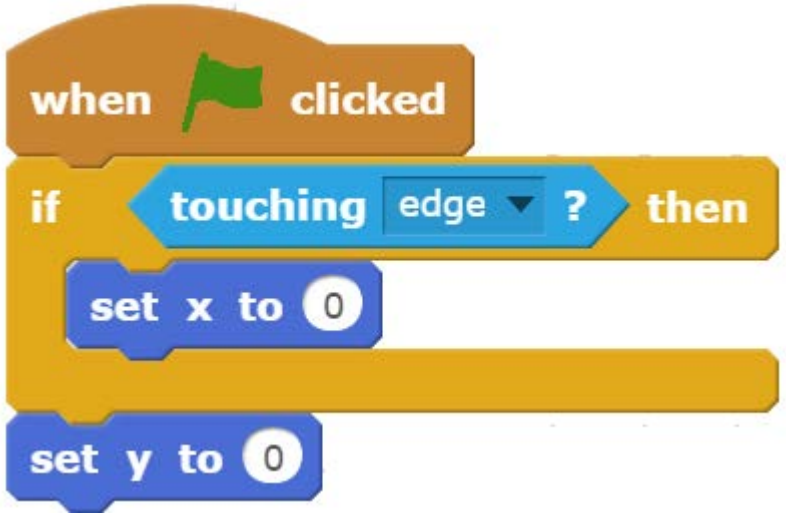


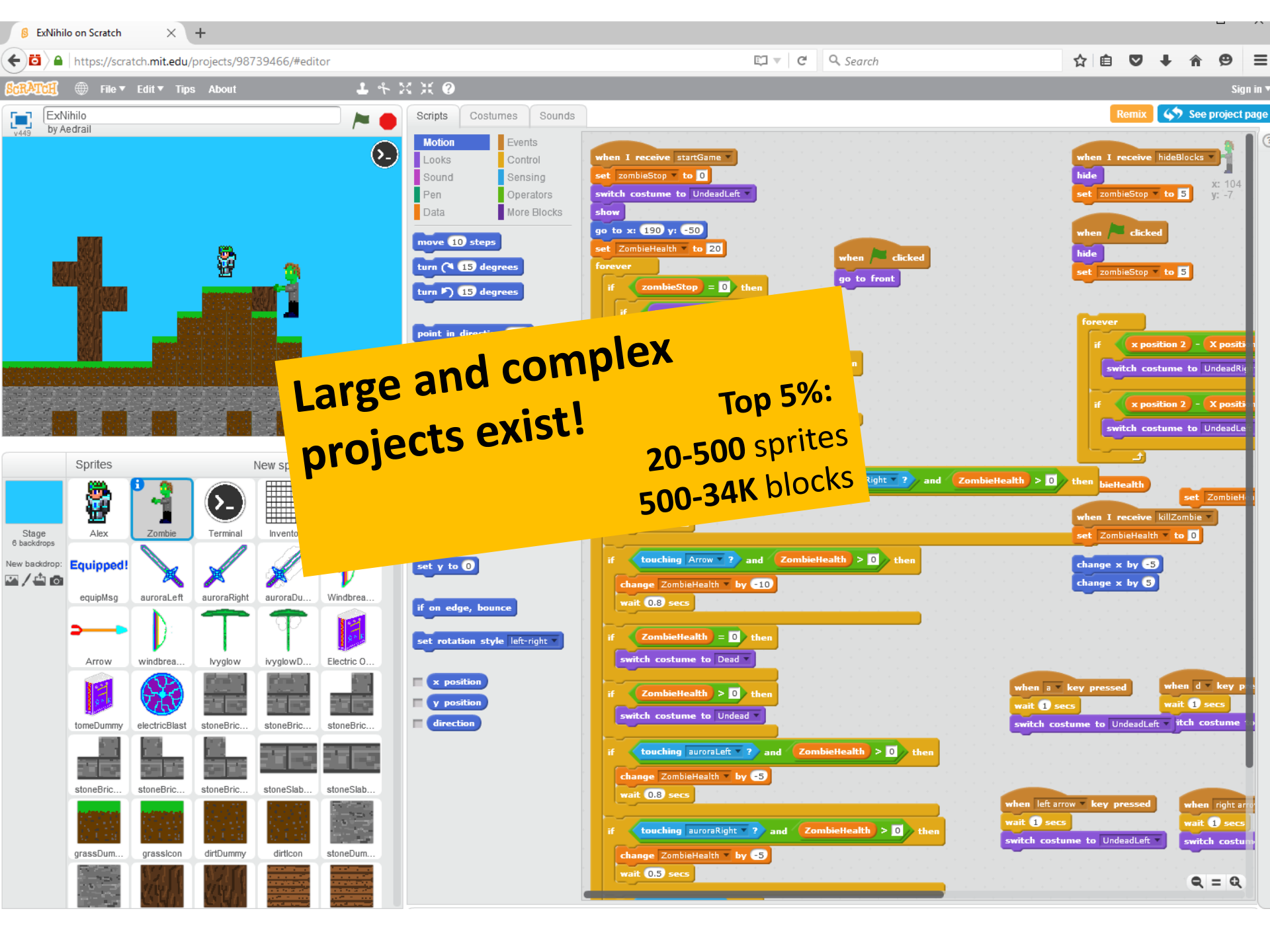
78%

Cyclomatic complexity: **1**



Cyclomatic complexity: **2**


But....


ExNihilo on Scratch
https://scratch.mit.edu/projects/98739466/#editor
Search
File
Edit
Tips
About
Sign in
ExNihilo
by Aedrail
Scripts
Costumes
Sounds
Remix
See project page
Motion
Looks
Sound
Pen
Data
Events
Control
Sensing
Operators
More Blocks
Sprites
Stage
6 backdrops
New backdrop:
Alex
Zombie
Terminal
Equipped!
equipMsg
auroraLeft
auroraRight
Arrow
windbrea...
Ivyglow
ivyglowD...
Electric O...
tomeDummy
electricBlast
stoneBric...
stoneSlab...
grassDum...
grassIcon
dirtDummy
dirtIcon
stoneDum...
when I receive startGame
set zombieStop to 0
switch costume to UndeadLeft
show
go to x: 190 y: -50
set ZombieHealth to 20
forever
if zombieStop = 0 then
when clicked
go to front
when I receive hideBlocks
hide
set zombieStop to 5
when clicked
hide
set zombieStop to 5
forever
if x position 2 - X positi
switch costume to UndeadRi
if x position 2 - X positi
switch costume to UndeadLe
x: 104
y: -7
move 10 steps
turn 15 degrees
turn 15 degrees
point in direct
set y to 0
if on edge, bounce
set rotation style left-right
x position
y position
direction
if touching Arrow ? and ZombieHealth > 0 then
change ZombieHealth by -10
wait 0.8 secs
if ZombieHealth = 0 then
switch costume to Dead
if ZombieHealth > 0 then
switch costume to Undead
if touching auroraLeft ? and ZombieHealth > 0 then
change ZombieHealth by -5
wait 0.8 secs
if touching auroraRight ? and ZombieHealth > 0 then
change ZombieHealth by -5
wait 0.5 secs
Right ? and ZombieHealth > 0 then
bieHealth
when I receive killZombie
set ZombieHealth to 0
change x by -5
change x by 5
when a key pressed
wait 1 secs
switch costume to UndeadLeft
when d key p
wait 1 secs
itch costume
when left arrow key pressed
wait 1 secs
switch costume to UndeadLeft
when right arr
wait 1 secs
switch costu
Large and complex projects exist!
Top 5%:
20-500 sprites
500-34K blocks


Size & complexity
What we found
Concepts & features
Code smells

Conditional statements

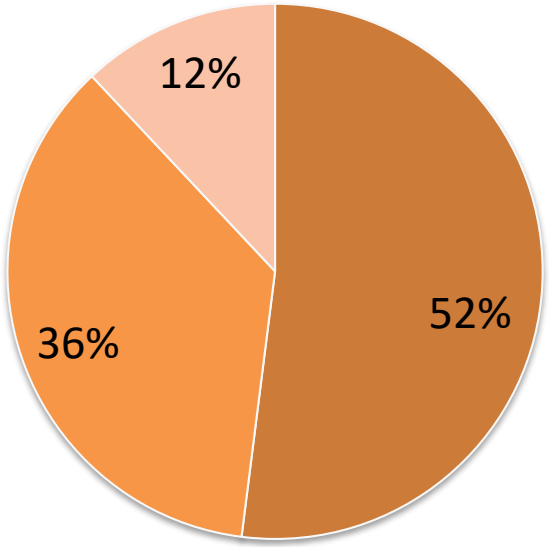
in 40% of the projects

Loops

in 77% of the projects

Loops

in 77% of the projects



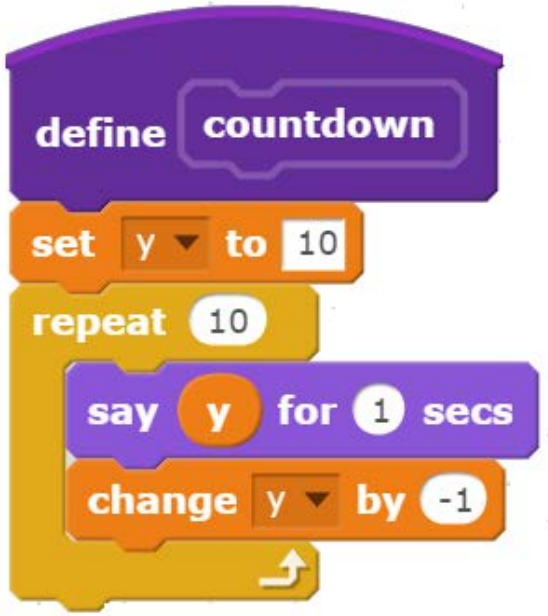
Variables

in 32% of the projects

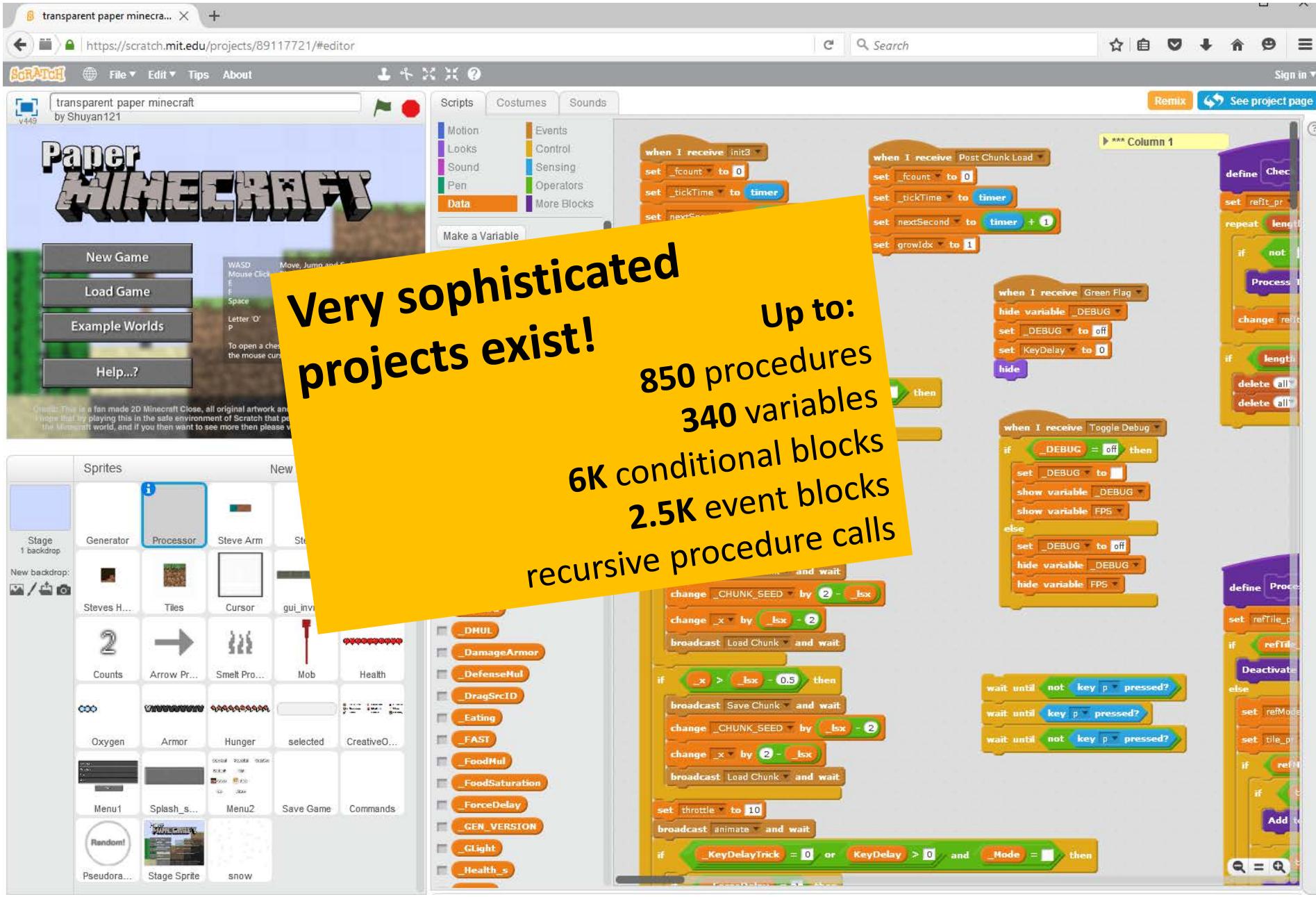
>4 in 7% of the projects

Procedures

in 8% of the projects

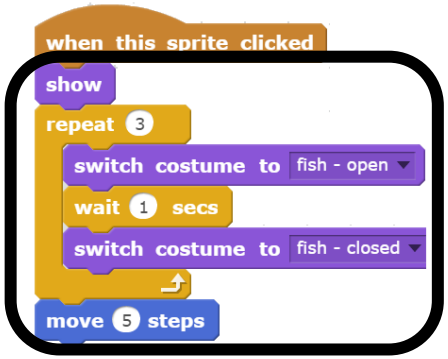


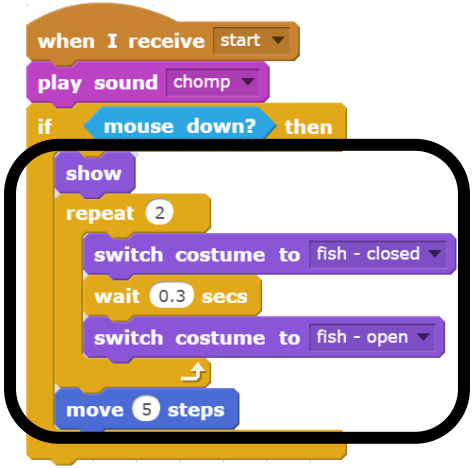

But....


transparent paper minecra...
https://scratch.mit.edu/projects/89117721/#editor
Search
File
Edit
Tips
About
Sign in
transparent paper minecraft
by Shuyan121
Scripts
Costumes
Sounds
Remix
See project page
Paper MINECRAFT
New Game
Load Game
Example Worlds
Help...?
Motion
Looks
Sound
Pen
Data
Events
Control
Sensing
Operators
More Blocks
Make a Variable
Sprites
New
Stage
1 backdrop
New backdrop:
Generator
Processor
Steve Arm
Steves H...
Tiles
Cursor
Counts
Arrow Pr...
Smelt Pro...
Mob
Health
Oxygen
Armor
Hunger
selected
CreativeO...
Menu1
Splash_s...
Menu2
Save Game
Commands
Pseudora...
Stage Sprite
snow
Very sophisticated projects exist!
Up to:
850 procedures
340 variables
6K conditional blocks
2.5K event blocks
recursive procedure calls


Size &
complexity
What we
found
Concepts &
features
Code smells

Duplicated code





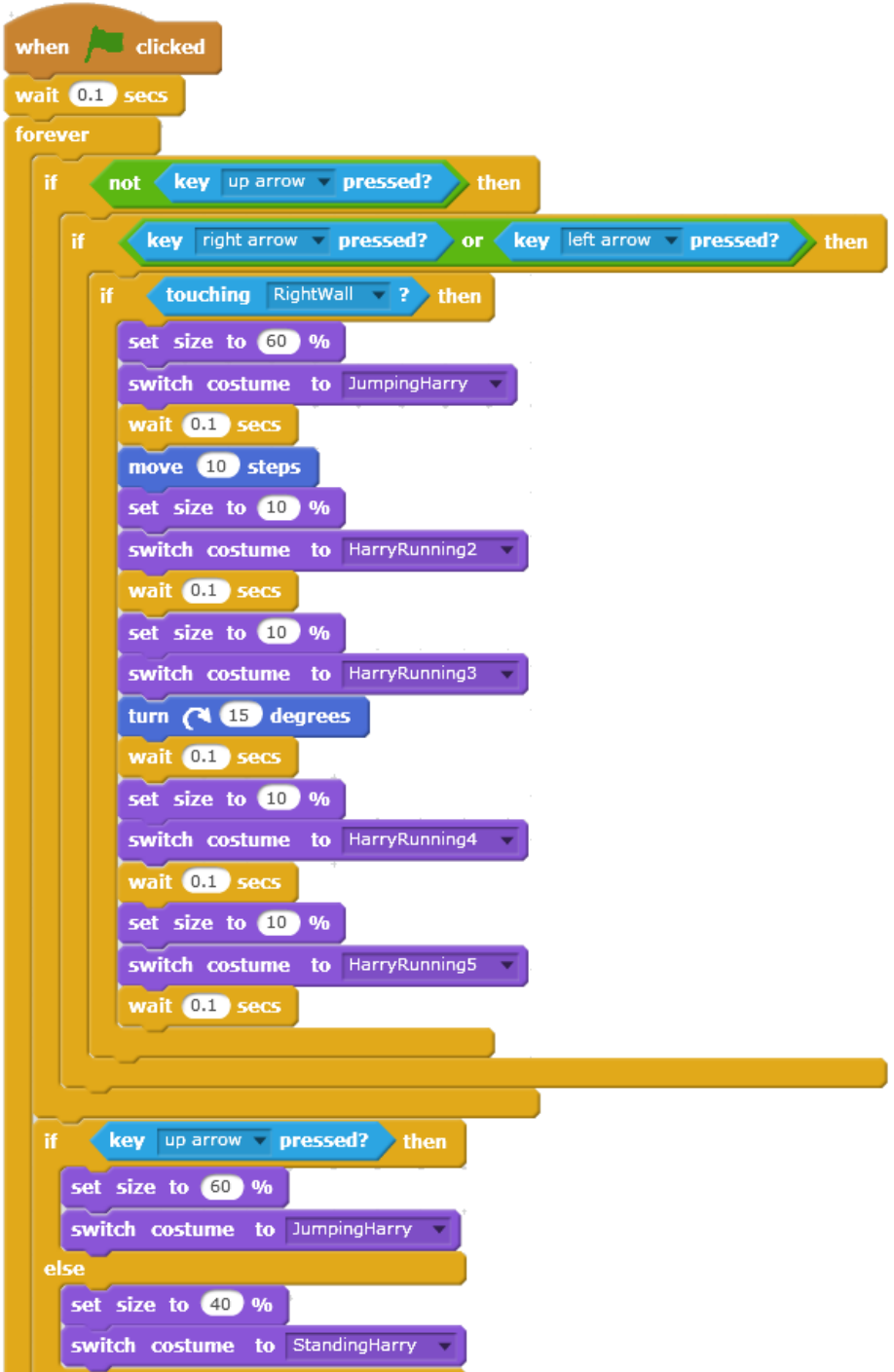
Across sprites: in 26% of the projects

Within sprites: in 10% of the projects

Large script

scripts with >18 blocks

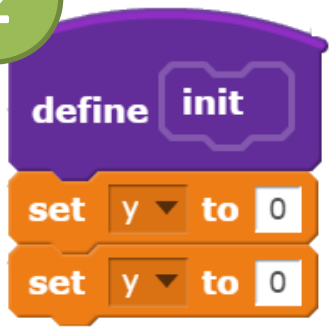
in 30% of the projects



Dead code

1

2

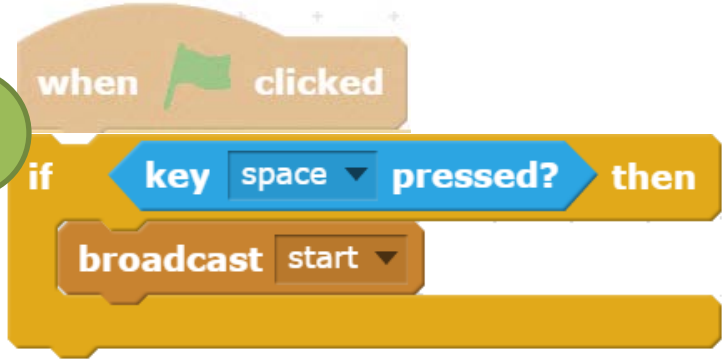


3

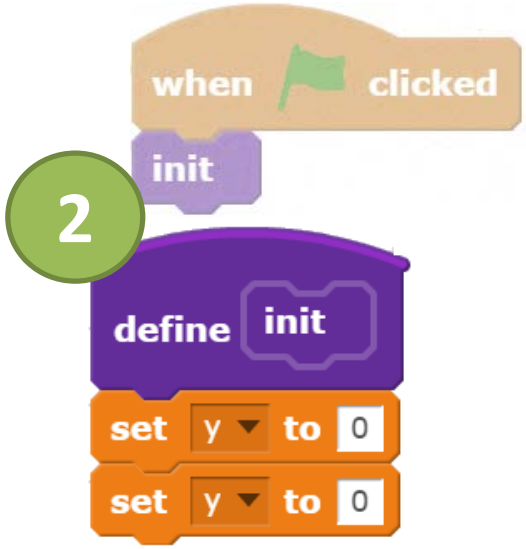
4

Dead code

1



2



3

4

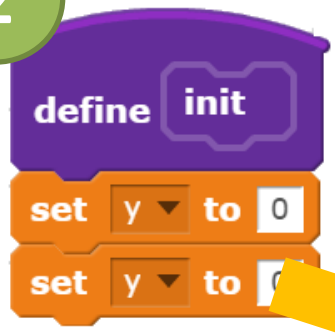
Dead code

in 28% of the projects

1

24%

2



1%

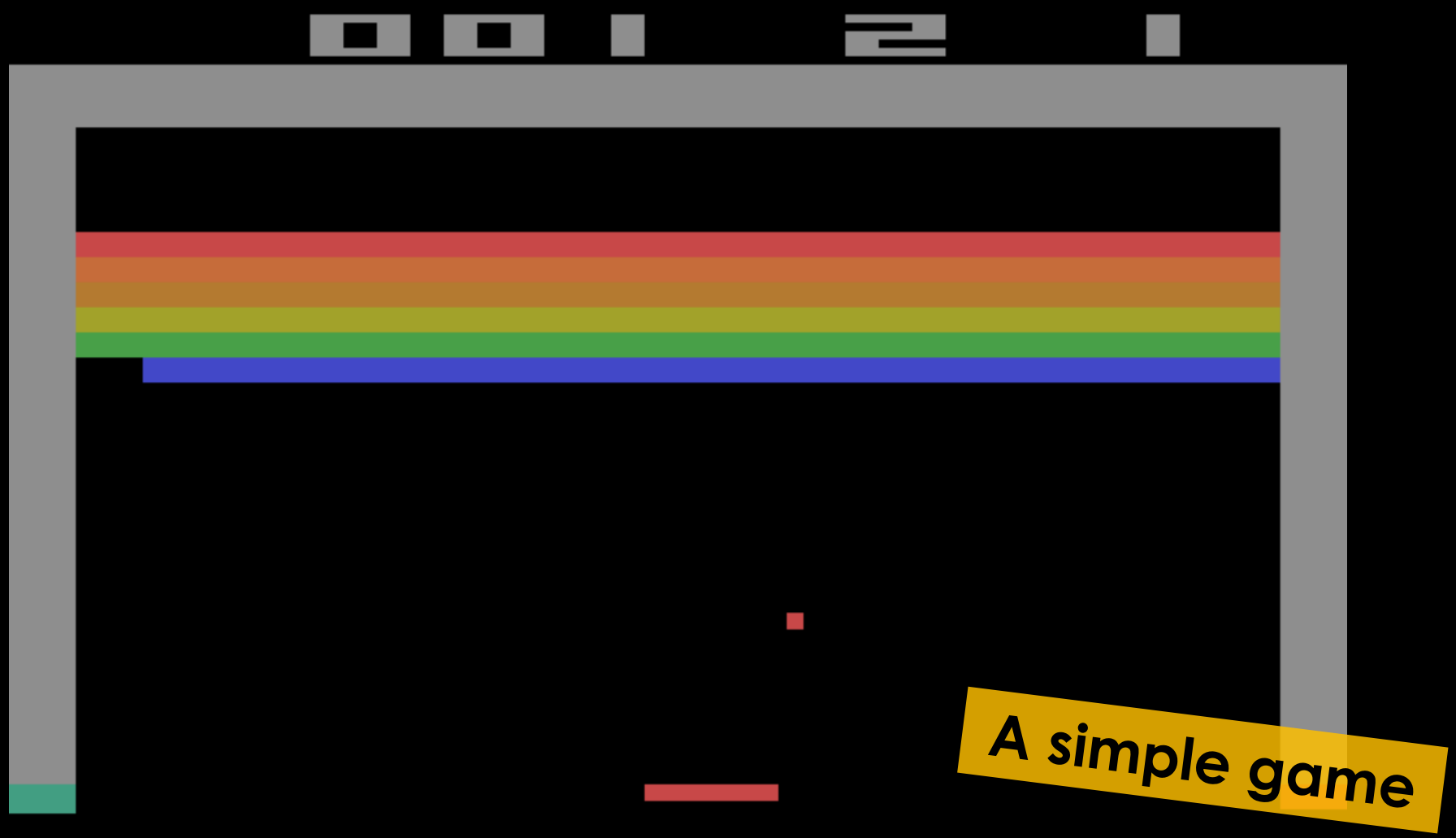
3

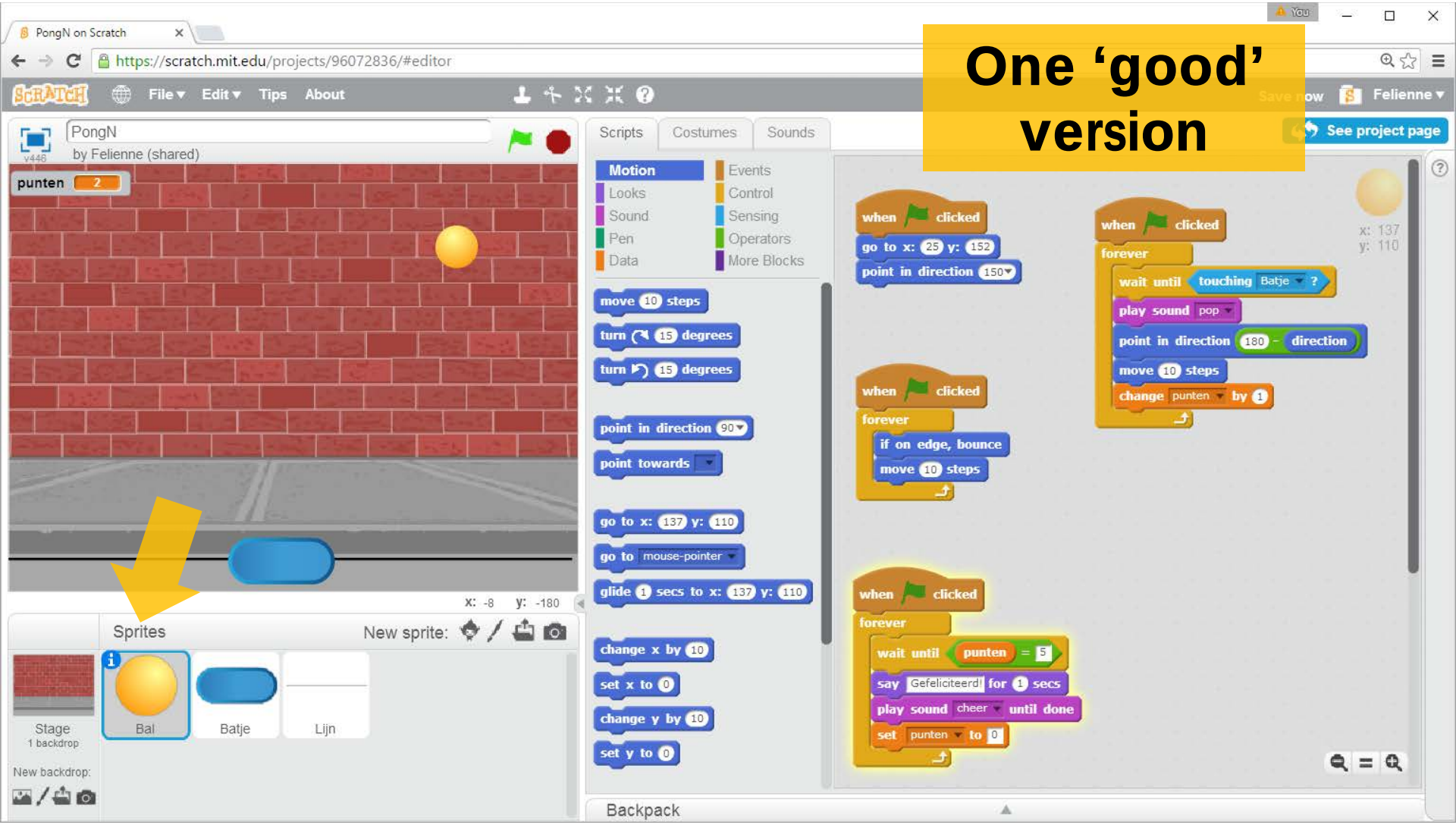
4

8%

E. Aivaloglou and F. Hermans. 2016. How Kids Code and How We Know: An Exploratory Study on the Scratch Repository. In Proceedings of the 2016 ACM Conference on International Computing Education Research (ICER '16)

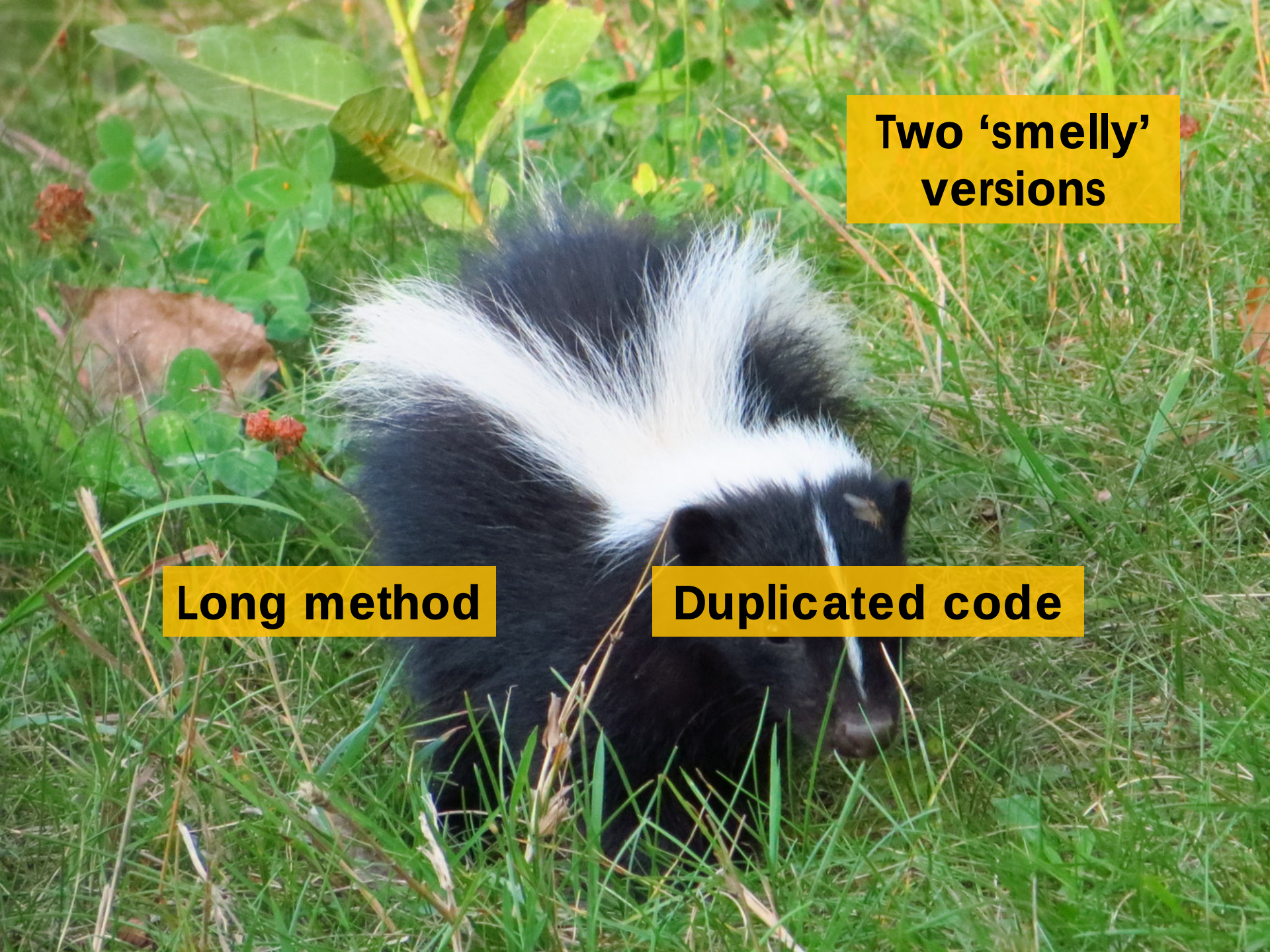

Do smells
matter to kids?


A simple game

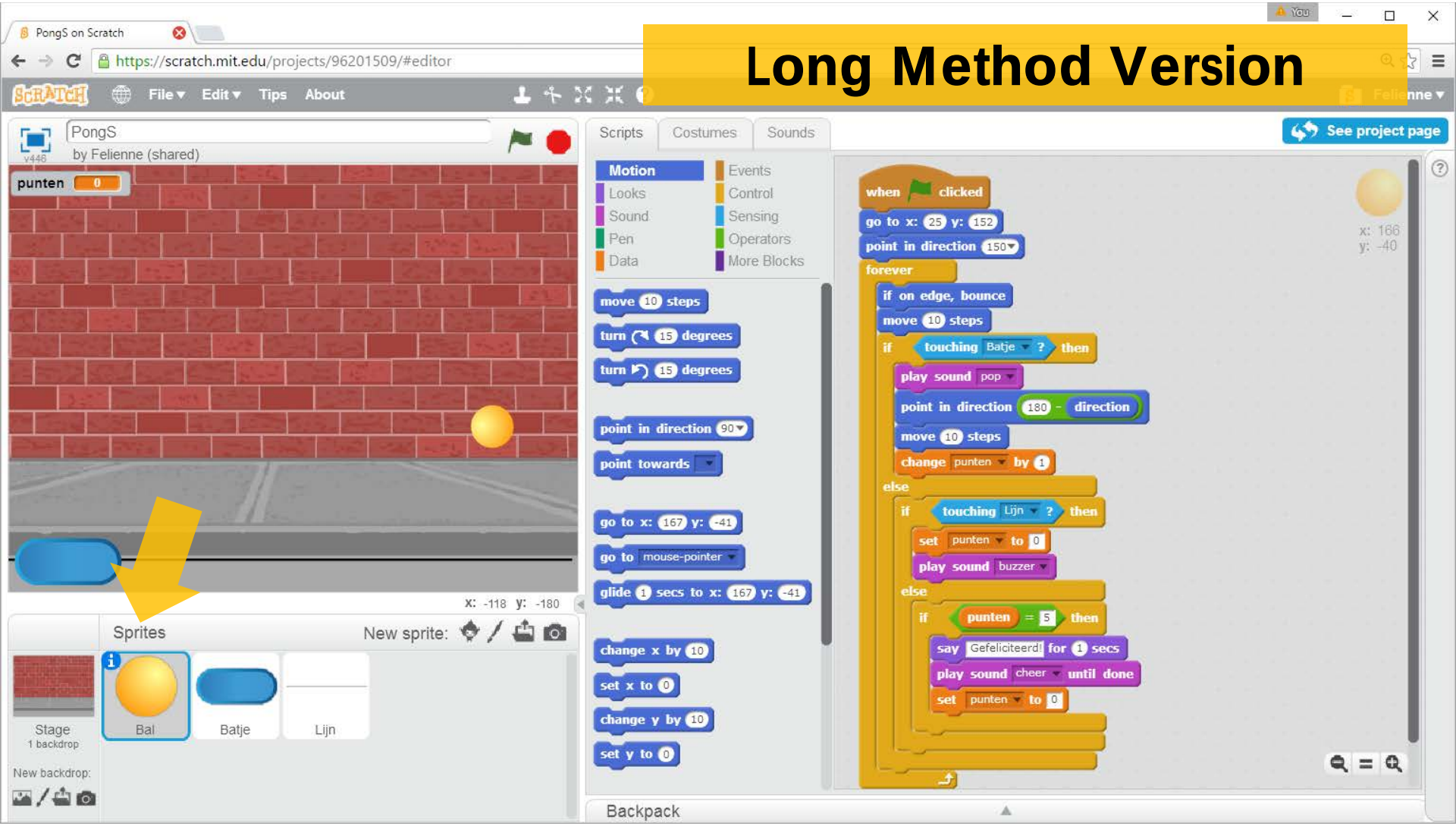


One ‘good’ version


Two ‘smelly’ versions


Two ‘smelly’ versions
Long method
Duplicated code

Long Method Version

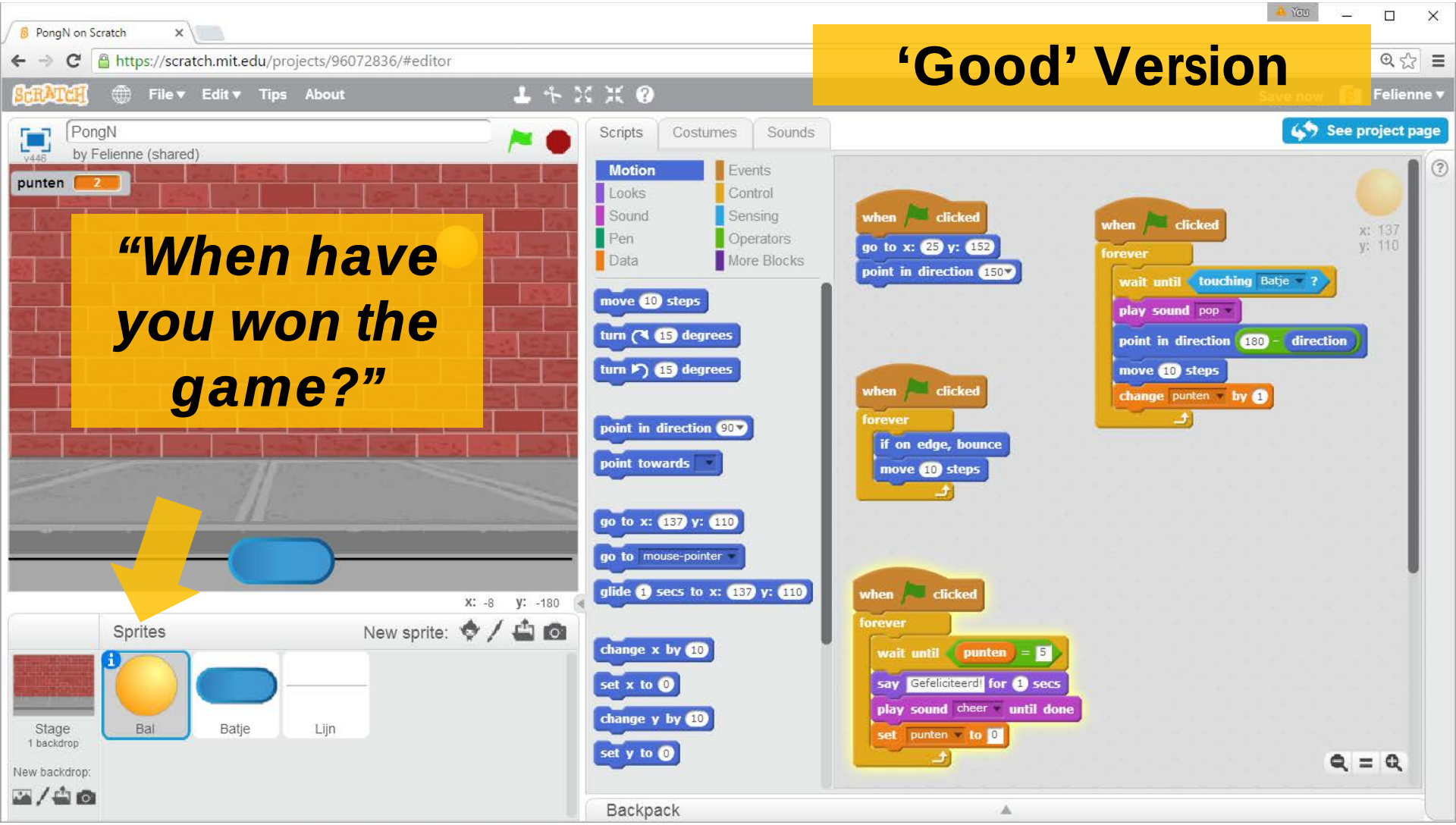


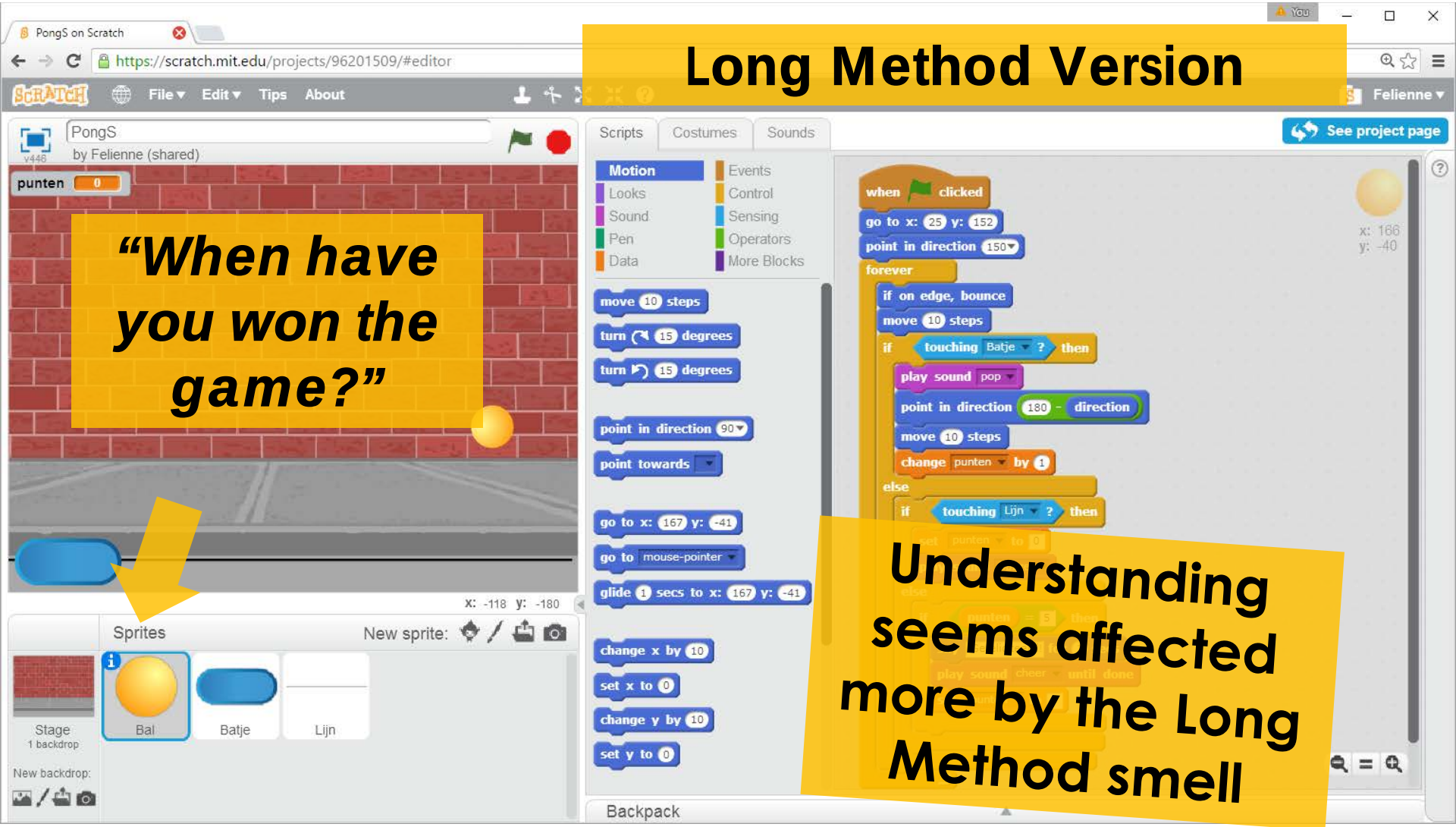

Do code smells
matter to kids?

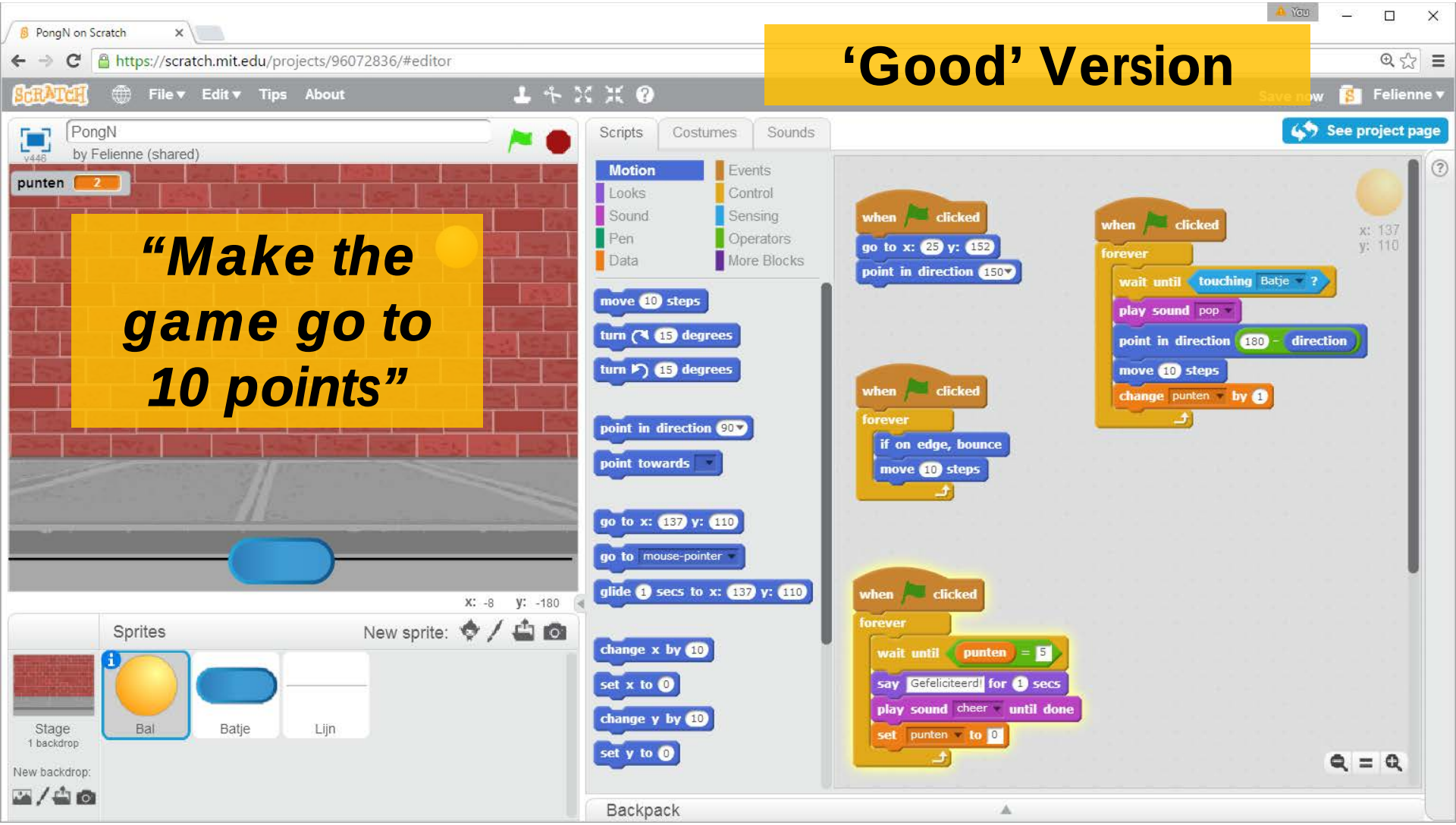

tl;dr
Yes
Kids performed significantly better on the non-smelly program

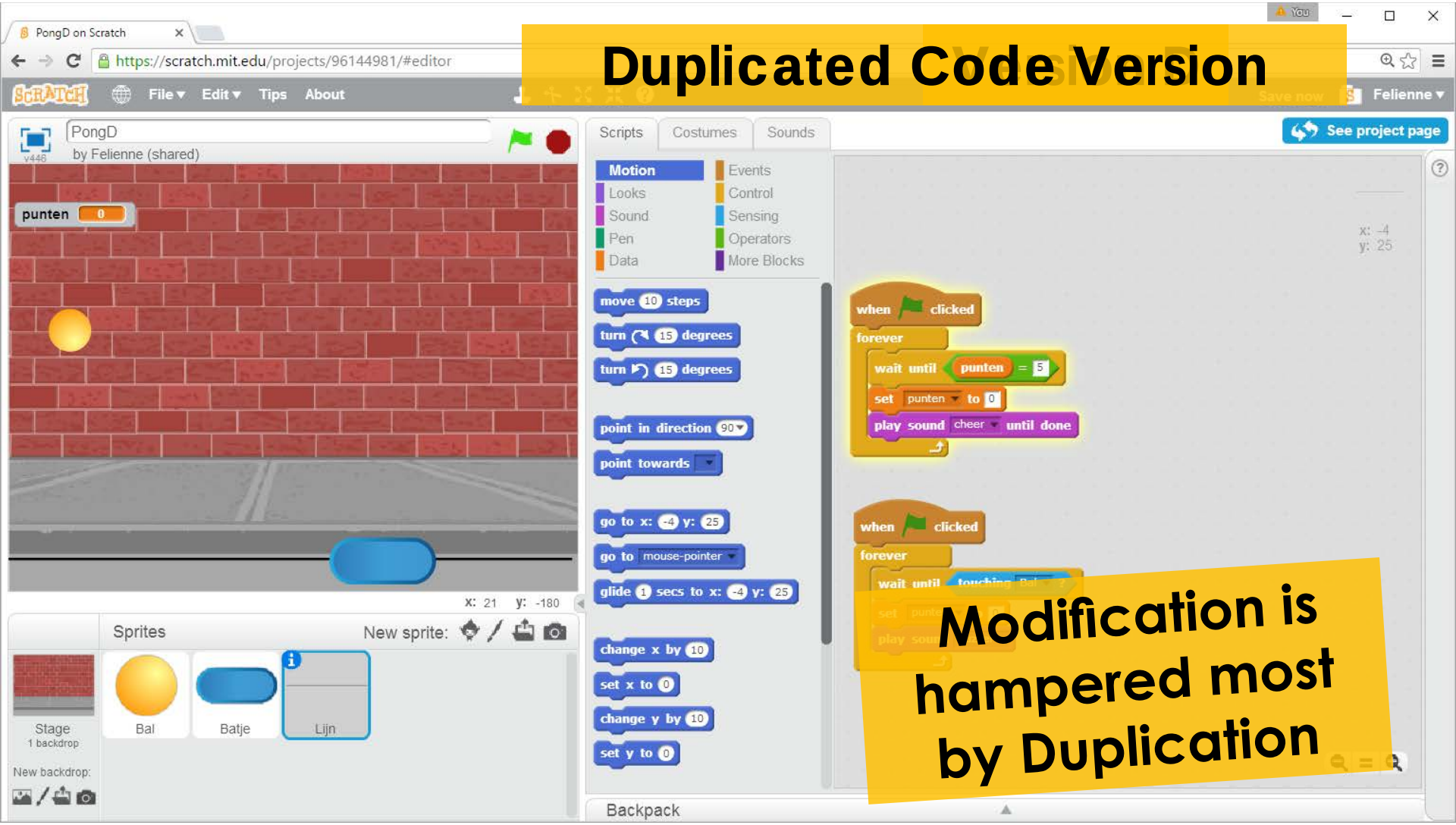

tl;dr
Yes
But, differences tasks are impacted differently

‘Good’ Version



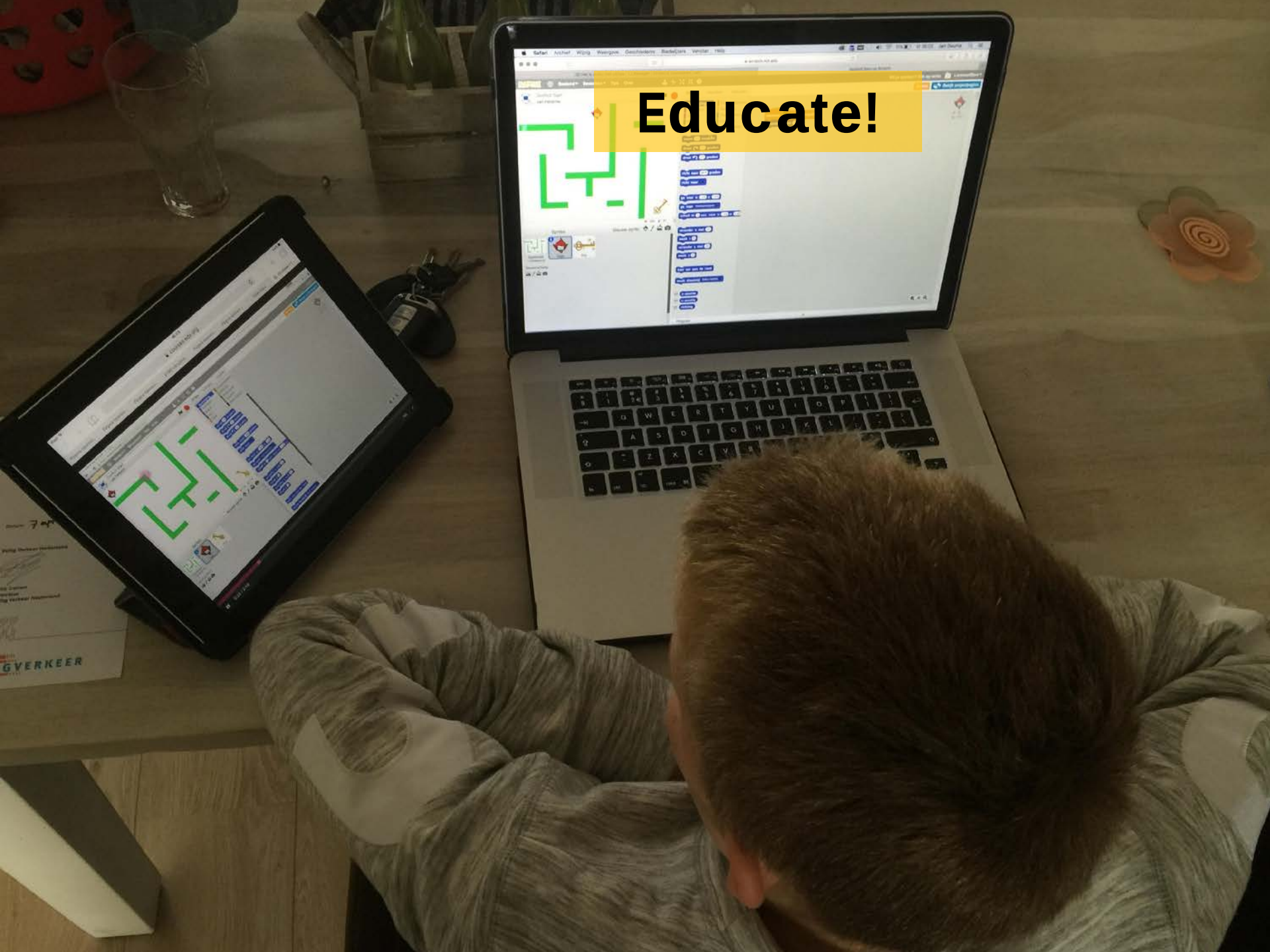

PongS on Scratch
https://scratch.mit.edu/projects/96201509/#editor
Long Method Version
File
Edit
Tips
About
Felienne
PongS
by Felienne (shared)
See project page
punten 0
"When have you won the game?"
Scripts
Costumes
Sounds
Motion
Looks
Sound
Pen
Data
Events
Control
Sensing
Operators
More Blocks
move 10 steps
turn 15 degrees
turn 15 degrees
point in direction 90
point towards
go to x: 167 y: -41
go to mouse-pointer
glide 1 secs to x: 167 y: -41
change x by 10
set x to 0
change y by 10
set y to 0
when clicked
go to x: 25 y: 152
point in direction 150
forever
if on edge, bounce
move 10 steps
if touching Batje ? then
play sound pop
point in direction 180 - direction
move 10 steps
change punten by 1
else
if touching Lijn ? then
x: 166
y: -40
x: -118 y: -180
Sprites
New sprite:
Stage
1 backdrop
Bal
Batje
Lijn
New backdrop:
Backpack
Understanding seems affected more by the Long Method smell


PongN on Scratch
https://scratch.mit.edu/projects/96072836/#editor
‘Good’ Version
File
Edit
Tips
About
Felienne
PongN
by Felienne (shared)
punten 2
“Make the game go to 10 points”
Scripts
Costumes
Sounds
See project page
Motion
Looks
Sound
Pen
Data
Events
Control
Sensing
Operators
More Blocks
move 10 steps
turn 15 degrees
turn 15 degrees
point in direction 90
point towards
go to x: 137 y: 110
go to mouse-pointer
glide 1 secs to x: 137 y: 110
change x by 10
set x to 0
change y by 10
set y to 0
when clicked
go to x: 25 y: 152
point in direction 150
when clicked
forever
if on edge, bounce
move 10 steps
when clicked
forever
wait until touching Batje ?
play sound pop
point in direction 180 - direction
move 10 steps
change punten by 1
when clicked
forever
wait until punten = 5
say Gefeliciteerd! for 1 secs
play sound cheer until done
set punten to 0
x: 137
y: 110
x: -8 y: -180
Sprites
New sprite:
Stage
1 backdrop
Bal
Batje
Lijn
New backdrop:
Backpack



F. Hermans and E. Aivaloglou, Do code smells hamper novice programming? A controlled experiment on Scratch programs, *2016 IEEE 24th International Conference on Program Comprehension (ICPC)*


Smells are bad!
(also for kids)
Smells are
common

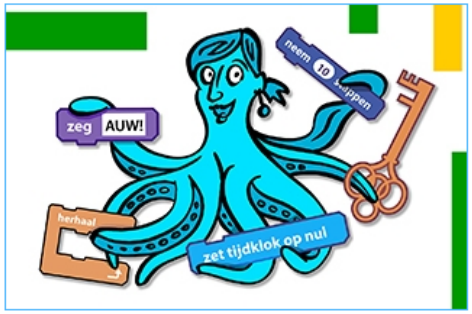

Educate!

Scratch: Programmer

https://www.edx.org/course/scratch-programmeren-voor-kinderen-8-delftx-scratchx-0

edX Courses Programs Schools & Partners About Search: Sign In Register

Home > All Subjects > Computer Science > Scratch: Programmeren voor kinderen (8+)



Scratch: Programmeren voor kinderen (8+)

In deze gratis cursus leer je spelenderwijs programmeren. Maak je eigen games met Scratch, terwijl je leert hoe je op een nette manier programmeert

TU Delft

Self-Paced

Enroll Now

I would like to receive email from Delft University of Technology (TU Delft) and learn about other offerings related to Scratch: Programmeren voor kinderen (8+).

About this course

1 Reviews 4.5/5

Programmeren is steeds belangrijker in onze wereld. En jong geleerd is oud gedaan. Deze MOOC bevat filmpjes en opdrachten waarmee kinderen zelf kunnen leren programmeren.

Iedere week maken we samen een game: een doolhof, een aquarium, een Flappy Bird spel en een soort Super Mario

See more

Over 3000 kids enrolled

What you'll learn

- Programmeren in Scratch
- Algemene programmeerconcepten (lussen, variabelen, datastructuren)

Meet the instructor

Length:	6 weken
Effort:	2-6 uur per week
Institution:	DelftX
Subject:	Computer Science
Level:	Introductory
Languages:	Nederlands
Video Transcripts:	Nederlands

Share this course with a friend

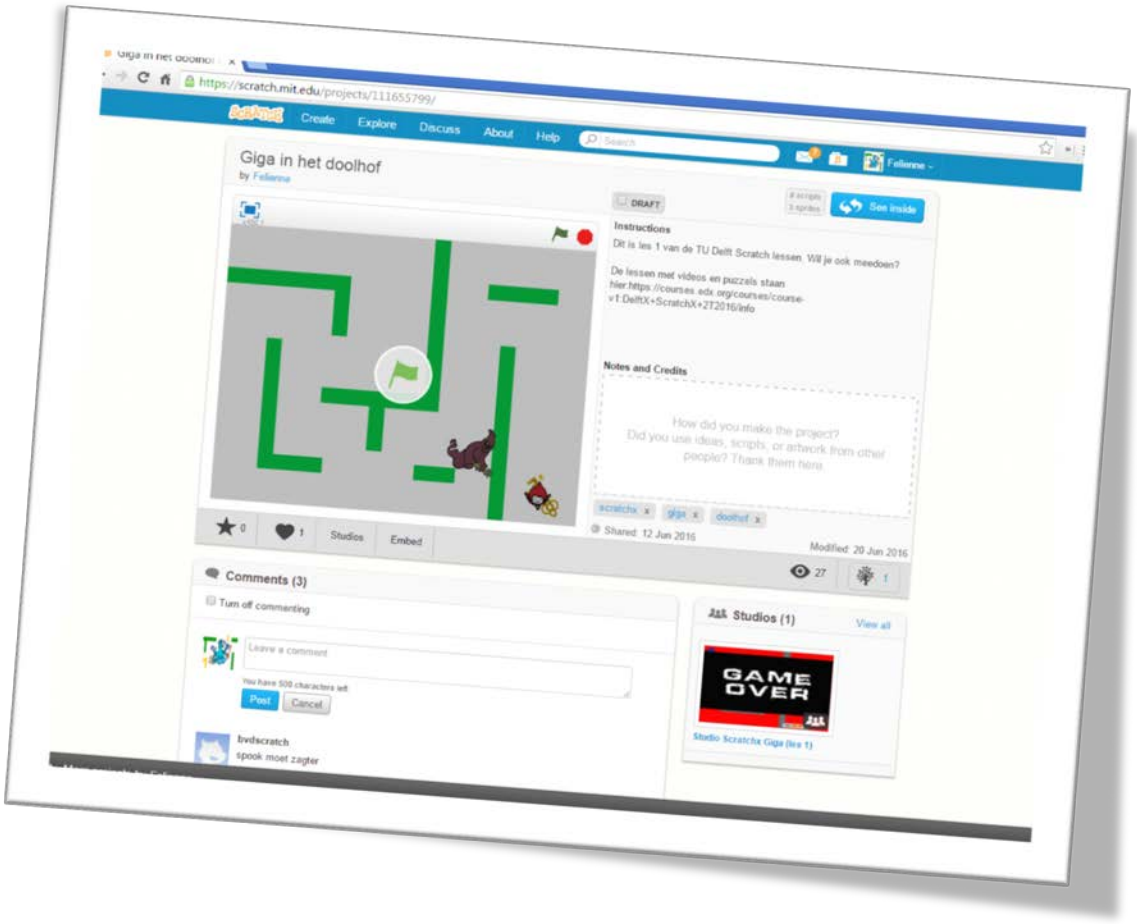
student profile

8 years old

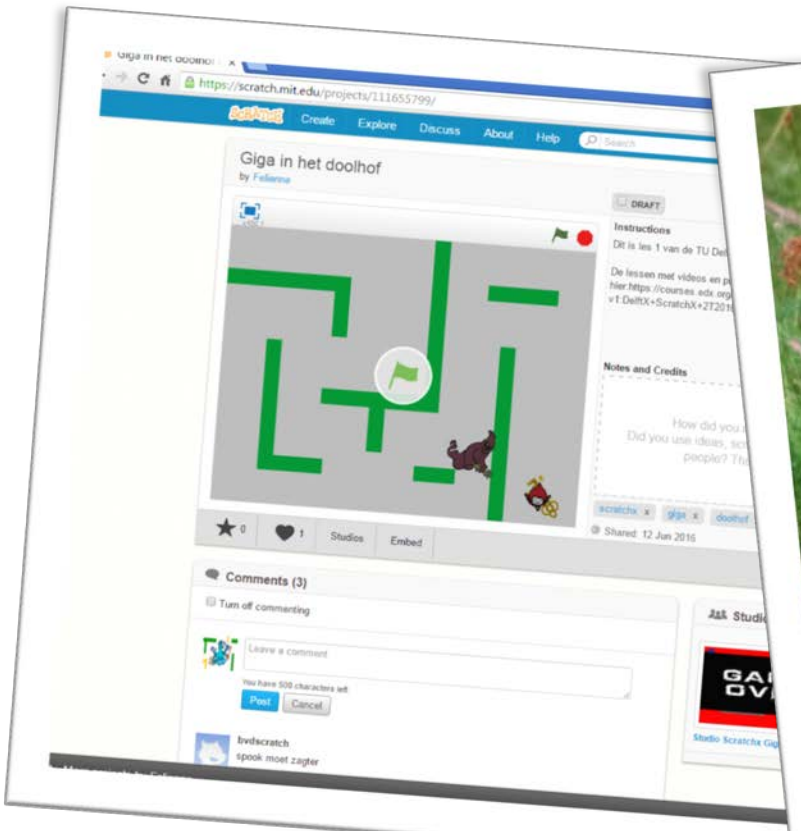
Male (65%)

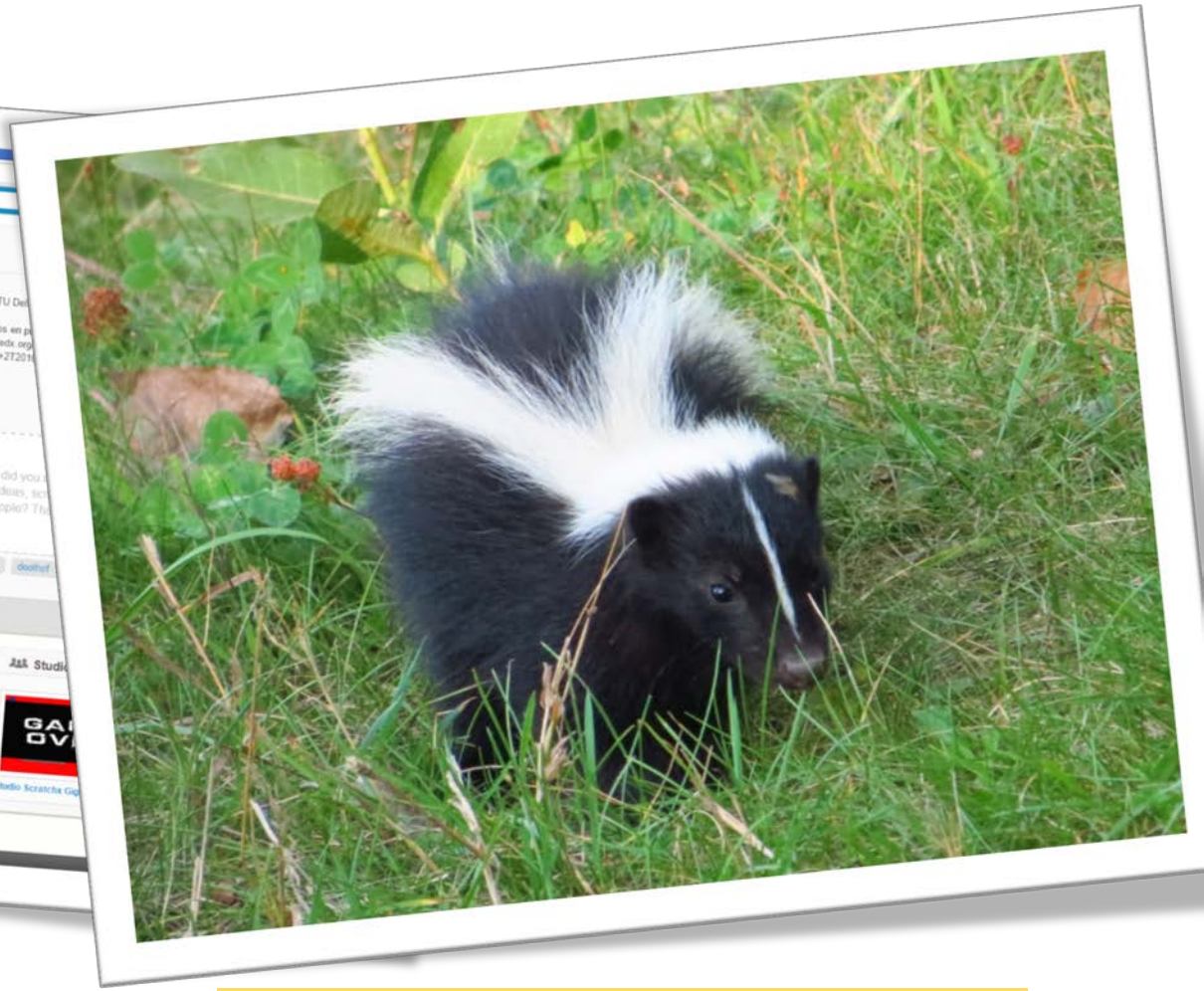
No programming experience (60%)

With parent



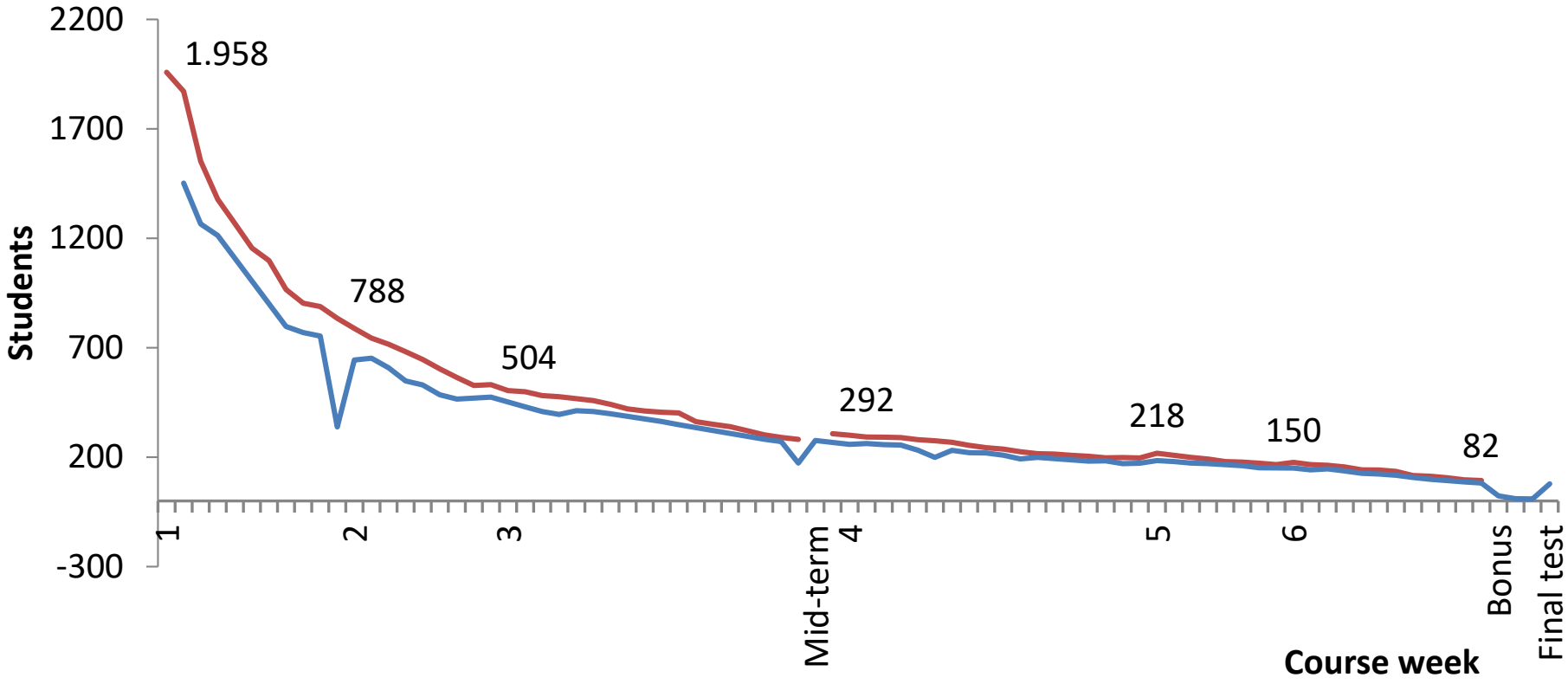
What kids thought they learned





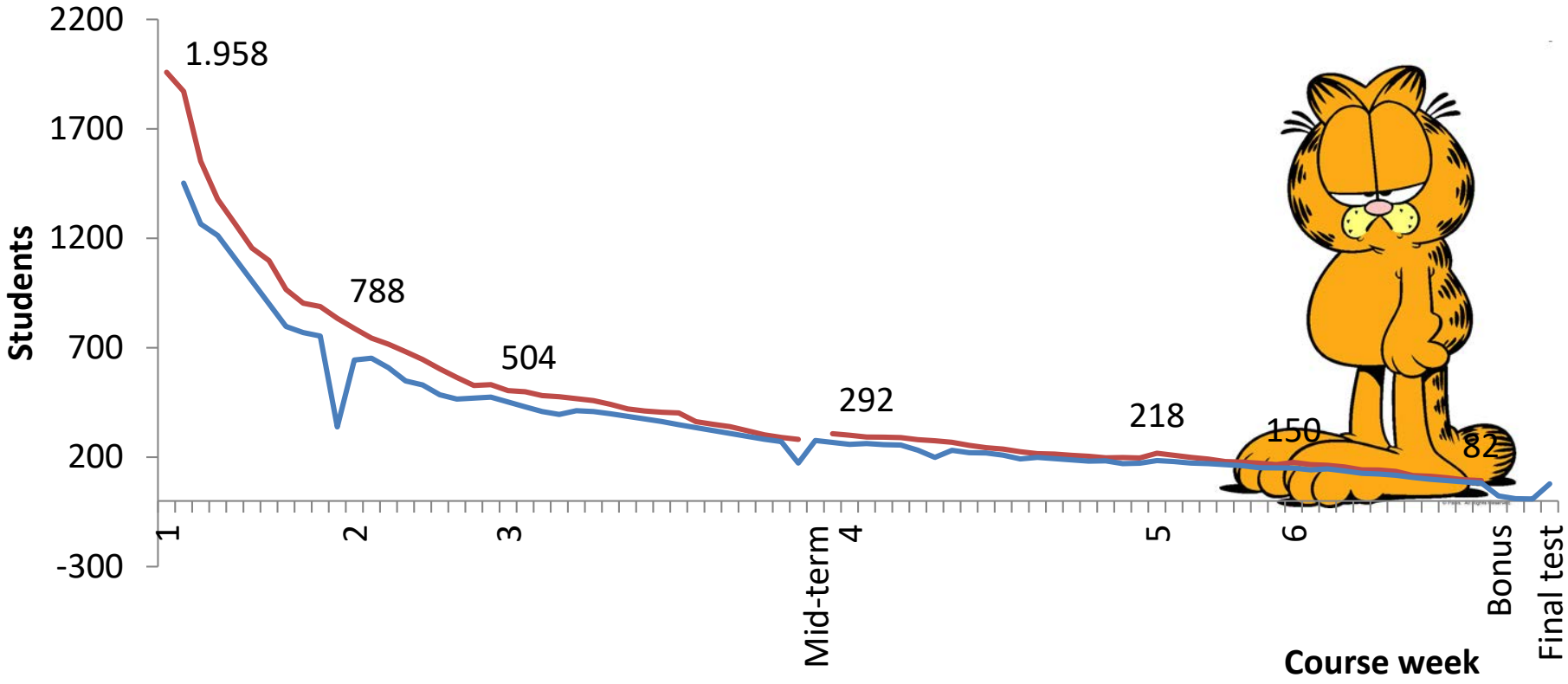
What they really learned

students per week

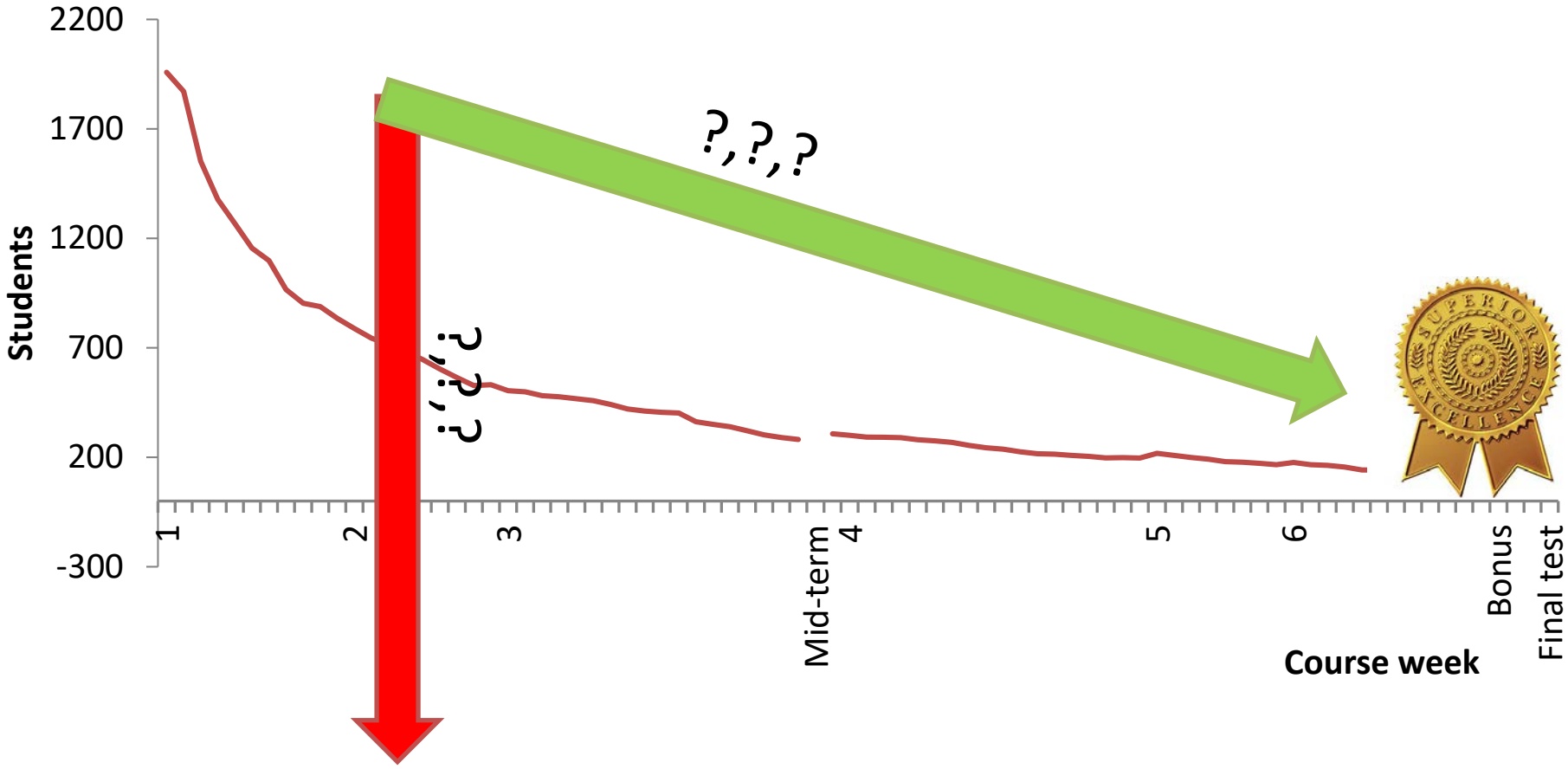


(as expected)

http://www.katyjordan.com/MOOCproject.html



WHY, though?


2200
1700
1200
700
200
-300
Students
1
2
3
Mid-term
4
5
6
Bonus
Final test
Course week
?,?,?
¿¿¿
SUPERIOR EXCELLENCE

Feature	Description	Quant	Mean	Median	Quant_95	Histogram
gender	The gender declared in the student profile questionnaire			-	-	
age	The age declared in the student profile questionnaire or the edX profile age			0.00	50.00	
alone	Is the student profile questionnaire	-			-	
experience	Does the student profile questionnaire)	-	-			
joined_calendar_week	Which week was the course in when the student first became active	1.00	2.88	2.00	7.00	
forum_searches	Number of searches in the discussion forum in the 1st course week	0.00	0.01	0.00	0.00	
forum_times_accessed	Times the	0.00	0.17	0.00	1.00	
forum_max_duration	Duration week (seconds)	0.00	19.95	0.00	59.00	
distinct_videos_watched	Different 1st week videos watched	0.00	3.14	0.00	15.00	
prc_videos_warched	Percentage of 1st week videos watched	0.00	0.20	0.00	1.00	
skipped_video	Did the student skip any of the 1st week videos?	-	-	-	-	
total_watches	Total number of video watches in the 1st week	0.00	7.75	0.00	43.00	
days_engaged_videos	Distinct calendar days engaged in 1st week video watching	0.00	0.60	0.00	3.00	
total_pauses	Number of video pauses in the 1st week	0.00	53.19	0.00	365.00	
total_forward_seek	Number o	0.00	1.21	0.00	7.00	
total_backward_seek	Number o	0.00	0.85	0.00	6.00	
mean_pauses	Mean pauses per video in the 1st week	0.00	1.78	0.00	11.00	
mean_forward_seek	Mean forwards per video in the 1st week	0.00	0.05	0.00	0.30	
mean_backward_seek	Mean backwards per video in the 1st week	0.00	0.03	0.00	0.21	
total_duration	Total time spent watching 1st week videos	0.00	407.48	0.00	2145.05	
mean_duration	Mean time per video in the 1st week	0.00	19.25	0.00	91.47	
questionnaires_skipped	Number of 1st week questionnaires skipped	0.00	9.14	8.00	17.00	
questonnaires_tried	Number of 1st week questionnaires with at least one submitted answer	0.00	1.70	0.00	8.00	
questions_skipped	Number o	0.00	20.01	16.00	47.00	
questions_tried	Number o	0.00	3.83	0.00	18.00	
mean_tries_question	Mean submissions per 1st week question	0.00	0.38	0.00	1.77	
mean_grade	Mean grade from the 1st week questions	0.00	0.25	0.00	1.00	
has_failed_answer	Did the student fail in any of the 1st week questions?	-	-	-	-	

Student profile

Discussion forum

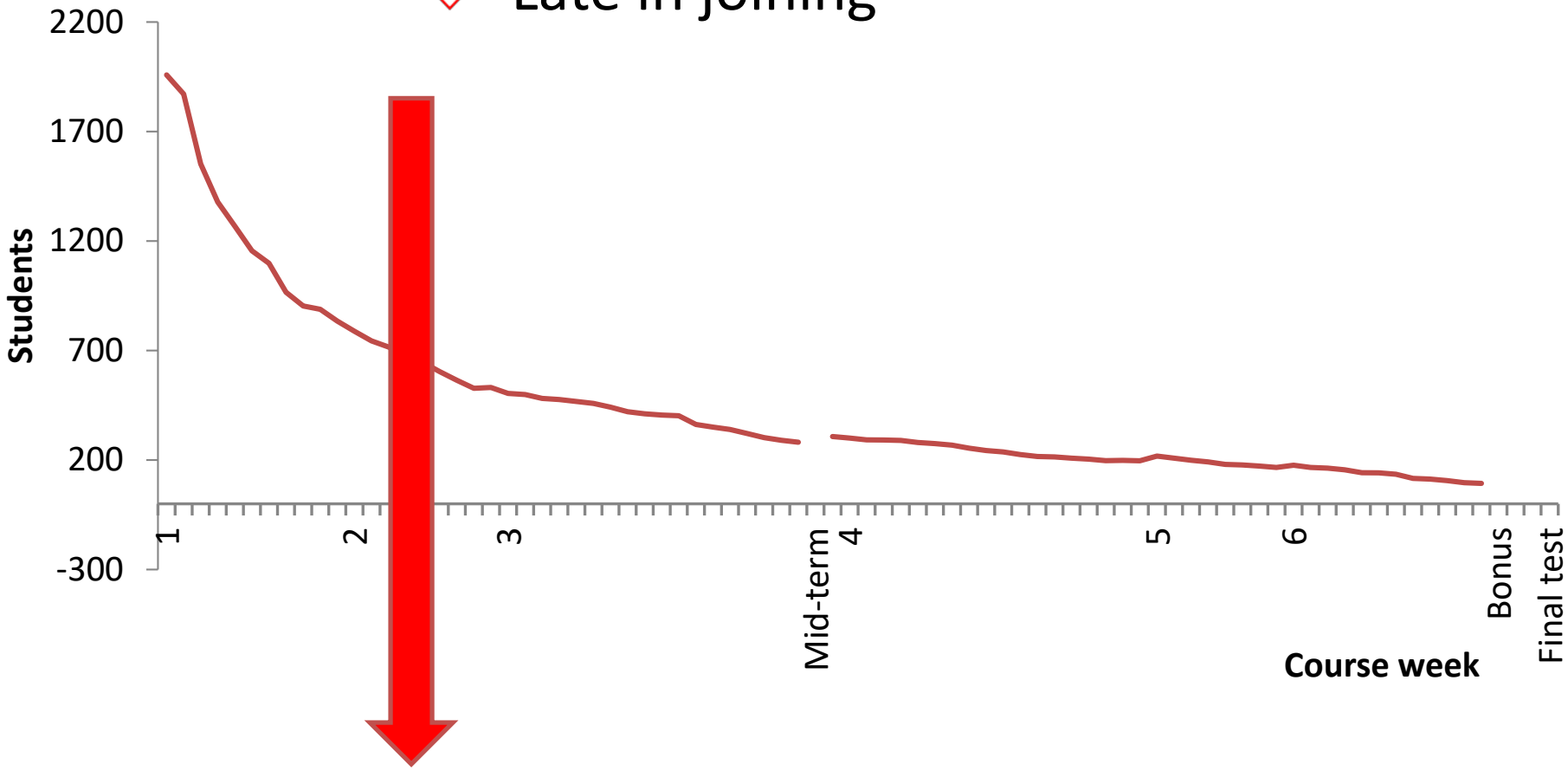
Course videos

Questionnaires

factors

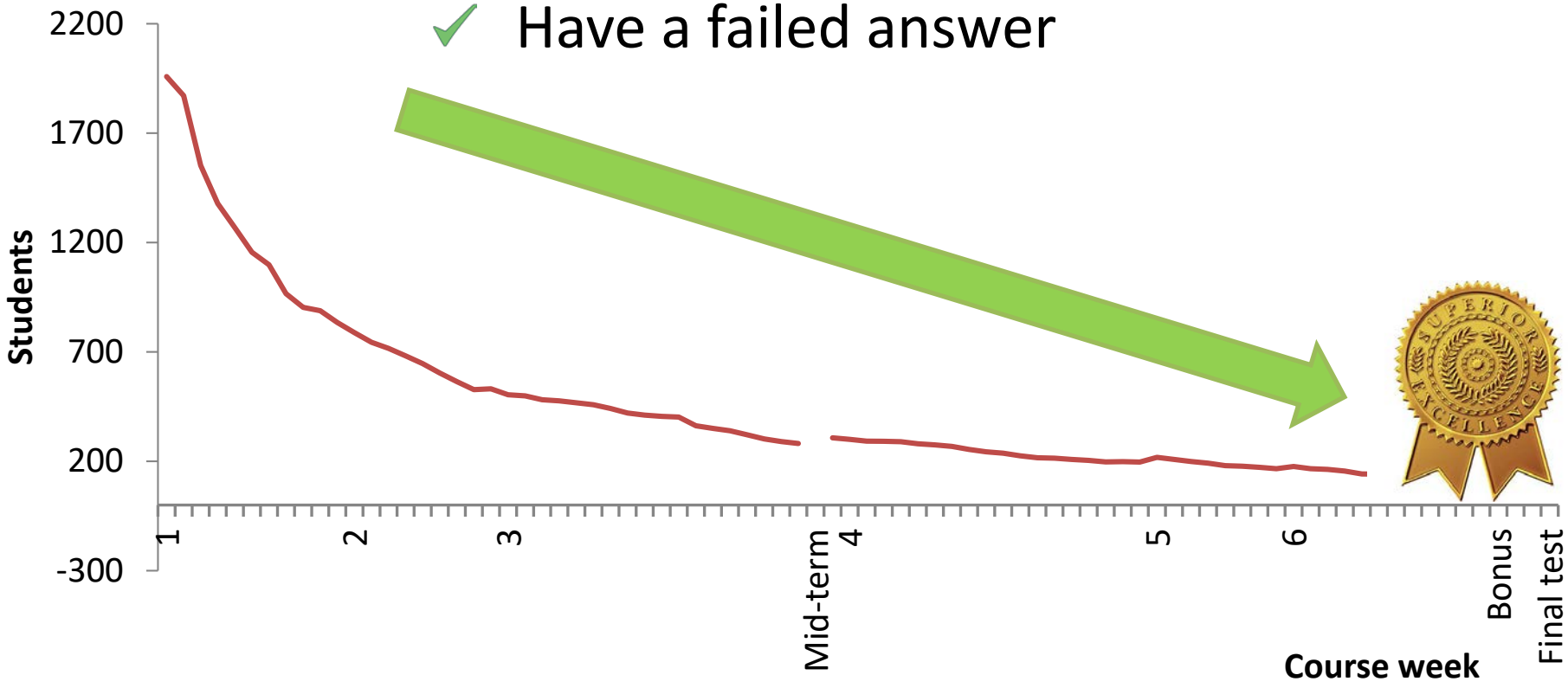
What not to do

- Follow the course with a parent
- Late in joining



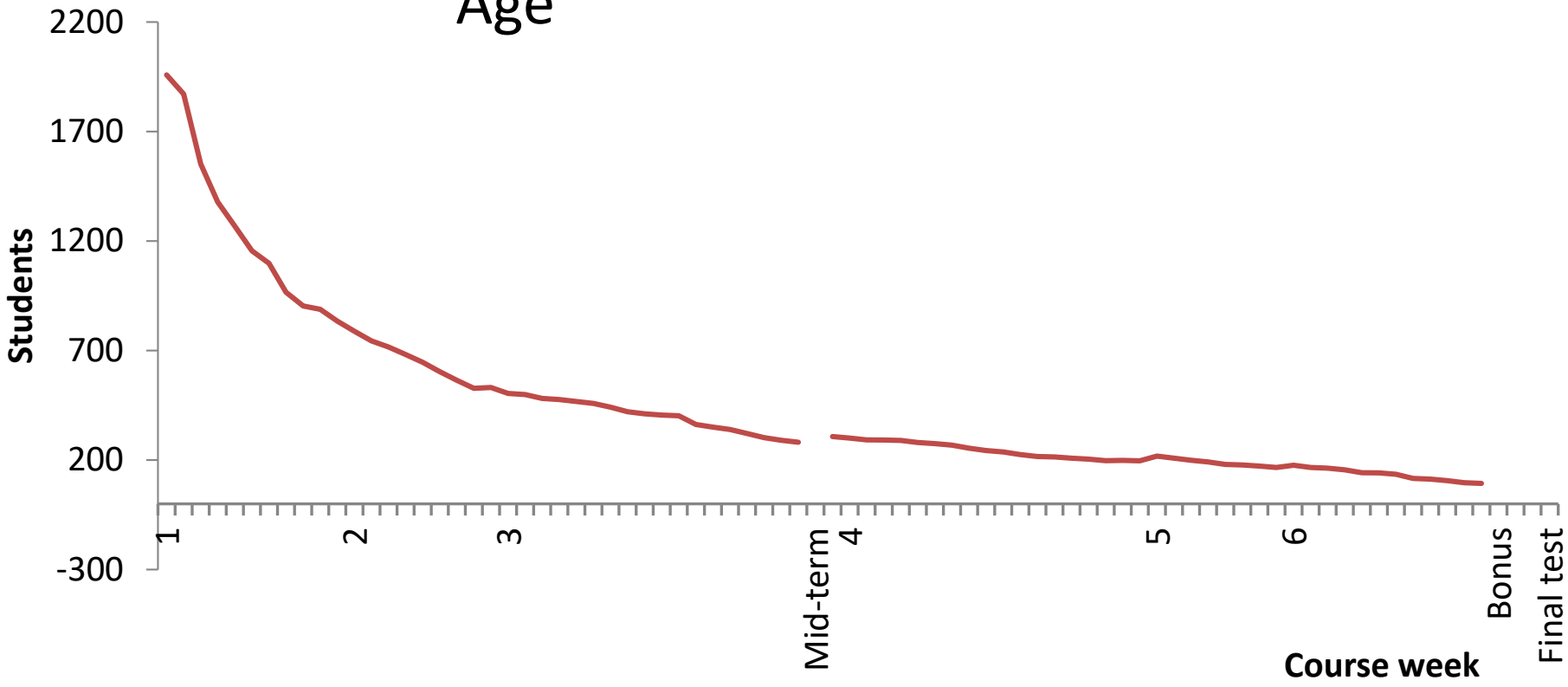
To do (1st week!)

- ✓ Try all questionnaires
- ✓ Get a good grade
- ✓ Have a failed answer



Nothing to do with

Gender
Age



Do they get it?

64 quizzes
2 tests

smells +
programming
concepts

Previous | Next

Deel 4

VIEW UNIT IN STUDIO

Bookmark this page

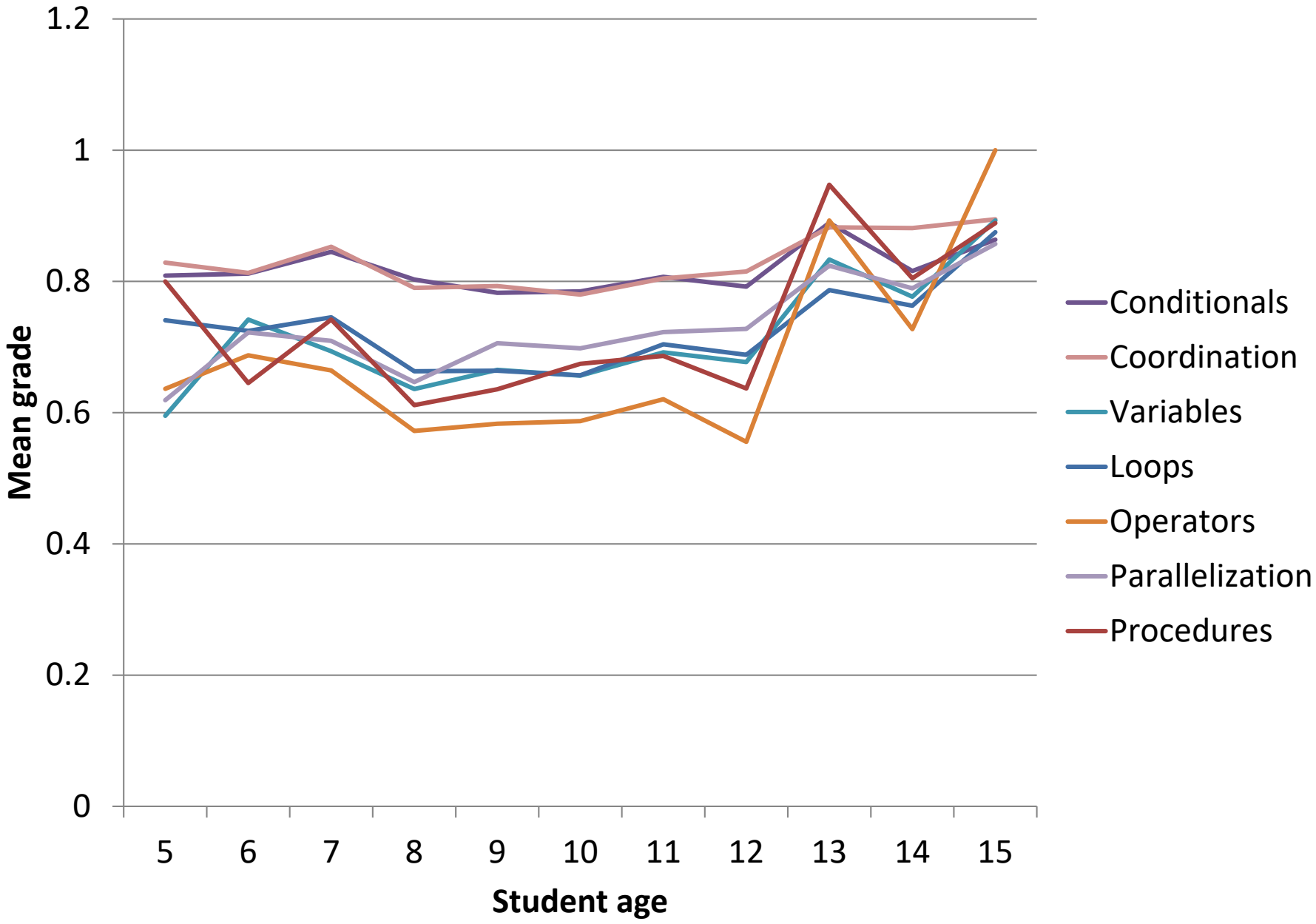
Vraag 20

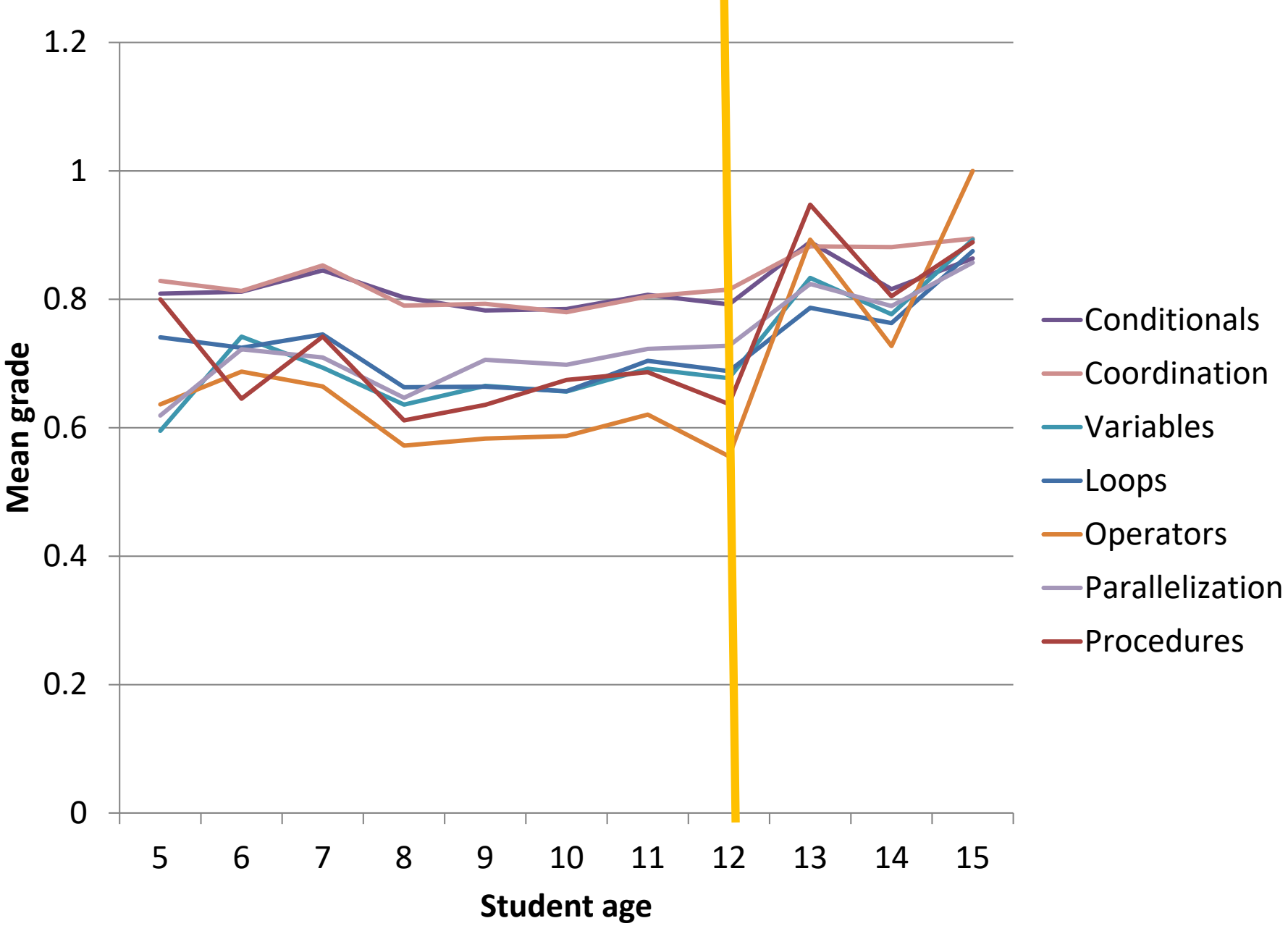
1/1 point (graded)

Kijk naar dit programma:

Je duwt op de groene vlag. Wat is de x op het einde van het programma?

- 10
- 100
- 110 ✔


1.2
1
0.8
0.6
0.4
0.2
0
Mean grade
5
6
7
8
9
10
11
12
13
14
15
Student age
Conditionals
Coordination
Variables
Loops
Operators
Parallelization
Procedures


1.2
1
0.8
0.6
0.4
0.2
0
Mean grade
5
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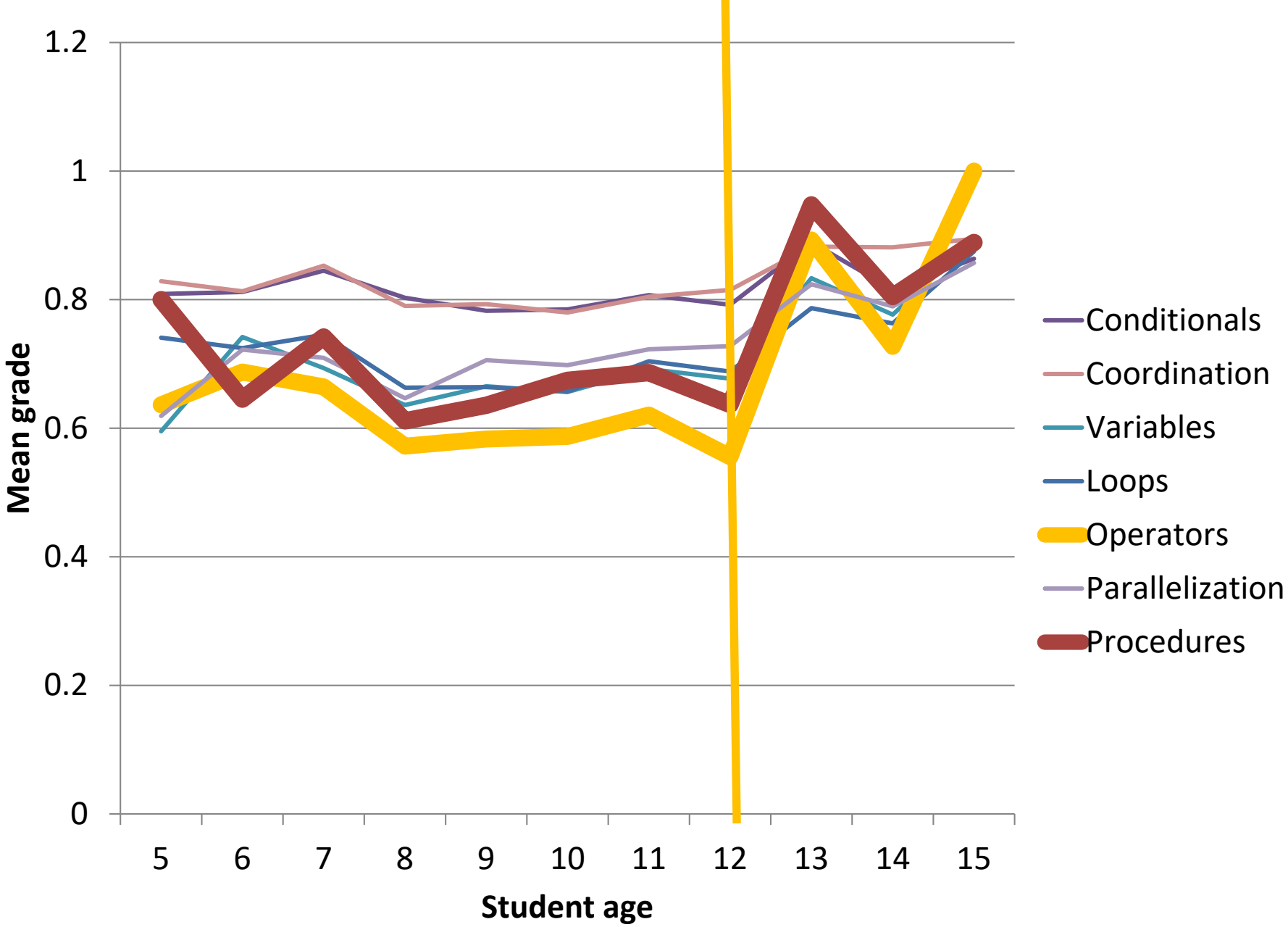
14
15
Student age
Conditionals
Coordination
Variables
Loops
Operators
Parallelization
Procedures



F. Hermans and E. Aivaloglou. 2017. Teaching software engineering principles to K-12 students: a MOOC on scratch. In *Proceedings of the 39th International Conference on Software Engineering: Software Engineering and Education Track (ICSE-SEET '17)*


Paper
VS
Computer

Points

Wouldn't it be nice if we could keep track of the score of the game?

For this we will use a "variable".
Remember you saw them before?

We used this:

points
0

When you write

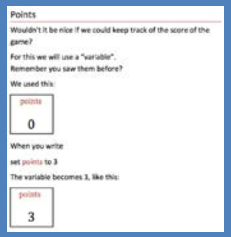
set points to 3

The variable becomes 3, like this:

points
3

http://csunplugged.org/

8 weeks



No difference in understanding of programming concepts

Better self-efficacy beliefs

Used wider selection of Scratch blocks

F. Hermans and E. Aivaloglou. 2017. To Scratch or not to Scratch?: A controlled experiment comparing plugged first and unplugged first programming lessons. In Proceedings of the 12th Workshop on Primary and Secondary Computing Education (WiPSCE '17)

Future work

- How do Scratch programs evolve? Complexity, sophistication and smells
- Comparison between different environments (Minecraft, Mindstorms)
- How to teach the “hard” concepts
- Early introduction to programming, self-efficacy and career orientation