On Modeling

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What is Modeling?

Why Modeling?

How to teach Modeling?

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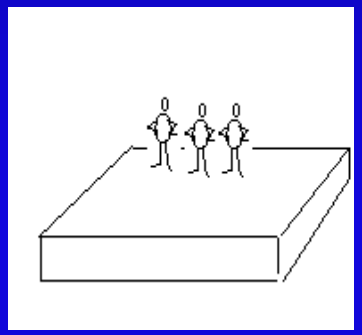
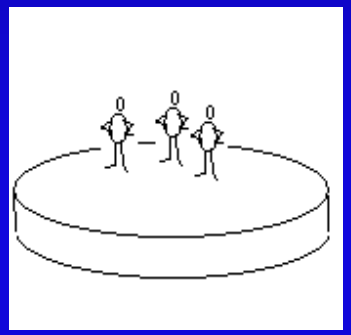
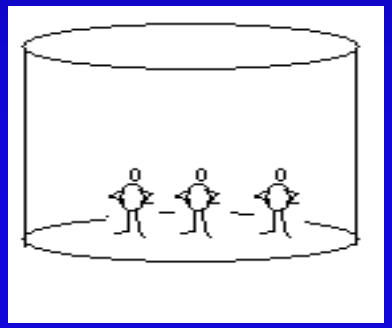
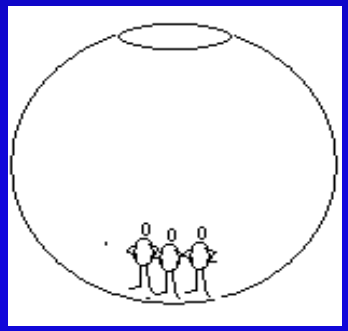
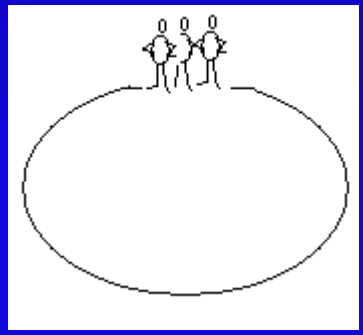
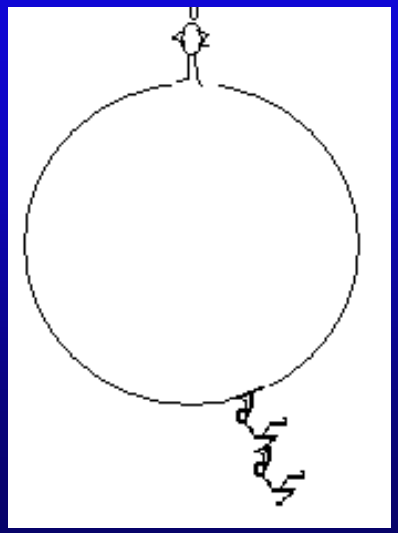
Why Modeling?

How to teach Modeling?

What is Modeling?

Predictions

Explanations

Implicit versus Explicit Models

Particulate model of matter

Wave model of matter

Poblational model of life

Informational model of life

Hydraulic model of mind

Computational model of mind

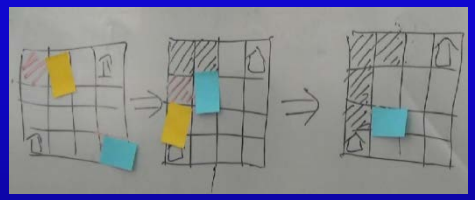
Network model of mind

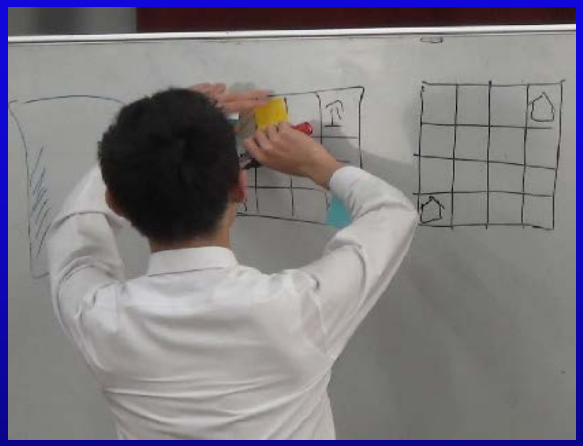
Concrete

Pictoric

Symbolic

Transit from concrete models to symbolic models





What is Mathematical Modeling?

Explicit

Symbolic

Expressed in mathematical language

What is Modeling?

Why Modeling?

How to teach Modeling?

Why Explicit Models?

- Compare
- Improve
- Predictions
- Explanations

Why Mathematical Modeling?

More powerful

Predictions in new situations

Explanations in new situations

Hidden mechanisms

Why Mathematical Modeling?

Critical skill for XXI century

Citizens have to deal with

- more info from devices and the cloud
- more complex information
- more multidisciplinary information
- more complex decisions

Credit risk

Insurance

Retail

Customer support

Machine maintenance

Process monitoring

Medical diagnosis

Autonomous navigation systems

Personal assistants

FUEGO – U.C. Berkeley

Common Core v/s NGSS

Mathematical Practices	Scientific and Engineering Practices
1. Make sense of problems and persevere in solving them	1. Ask questions and define problems
2. Reason abstractly and quantitatively	2. Develop and use models
3. Construct viable arguments and critique the reasoning of others	3. Plan and carry out investigations
4. Model with mathematics	4. Analyze and interpret data
5. Use appropriate tools strategically	5. Use mathematics and computational thinking
6. Attend to precision	6. Construct explanations and design solutions
7. Look for and make use of structure	7. Engage in argument from evidence
8. Looking for and expressing regularity in repeated reasoning	8. Obtain, evaluate, and communicate information

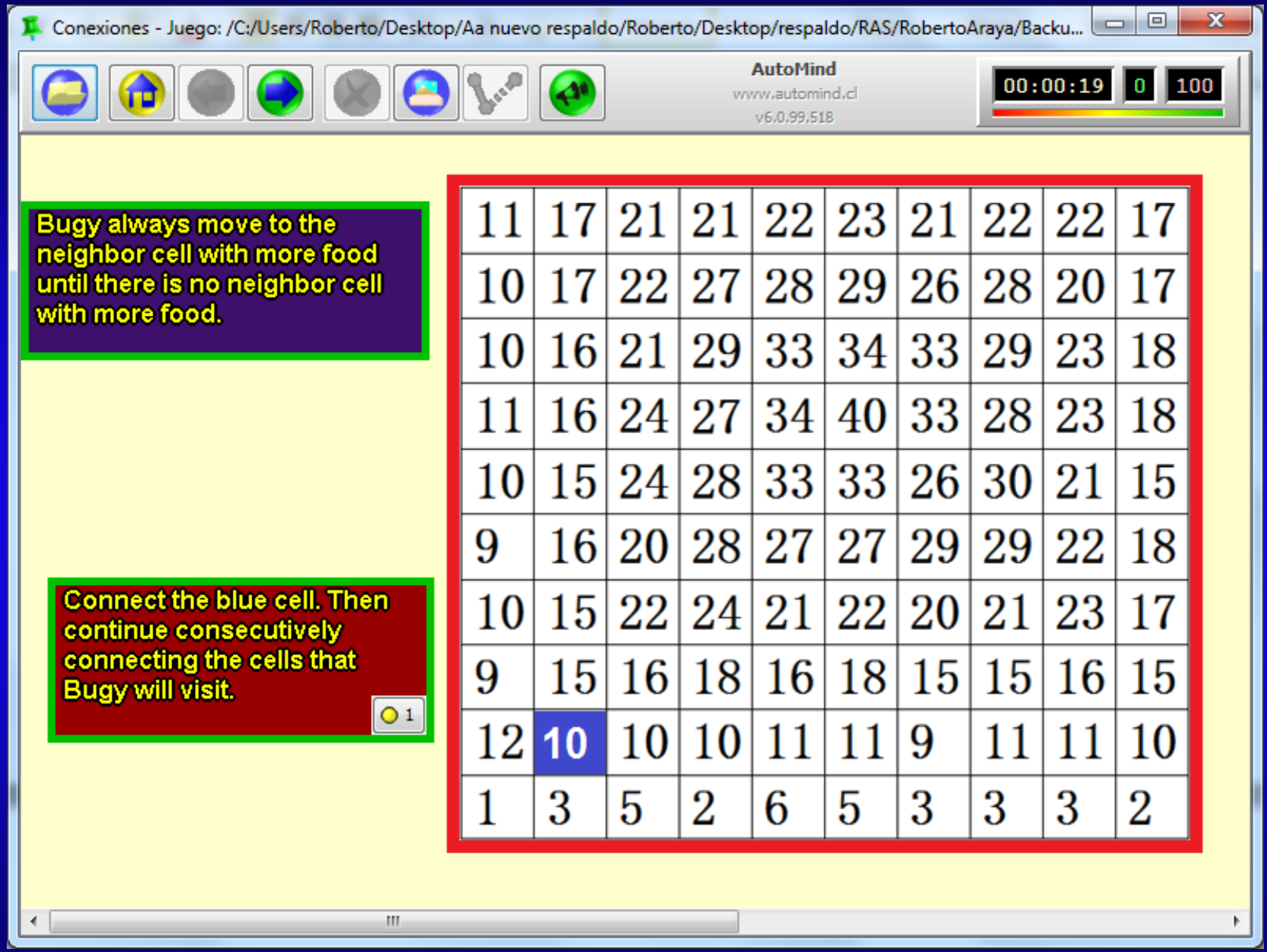
What is Modeling?

Why Modeling?

How to teach Modeling?

How to teach Modeling?

1) Use-Select-Adjust-Build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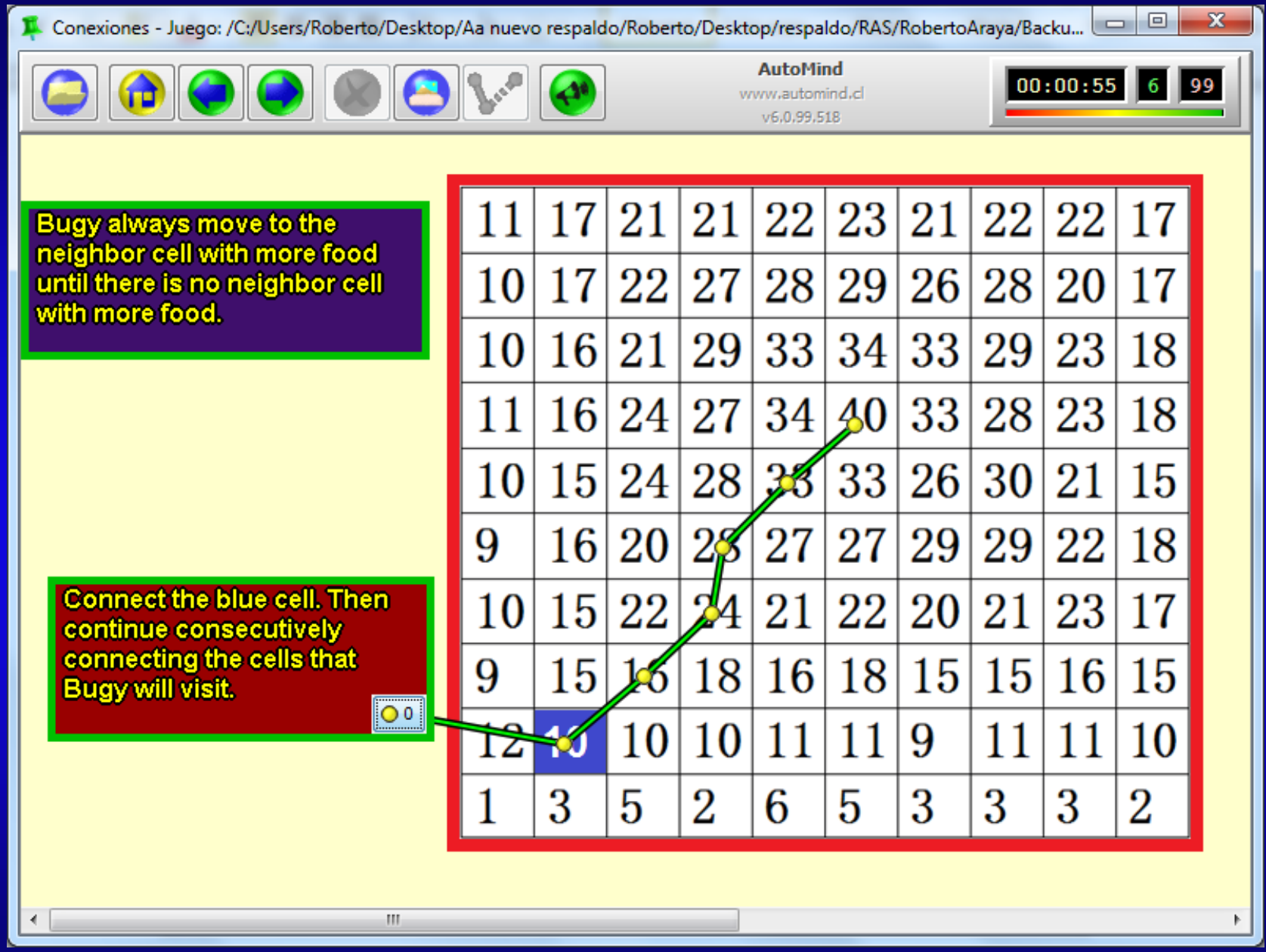
Bugy always move to the neighbor cell with more food until there is no neighbor cell with more food.
Connect the blue cell. Then continue consecutively connecting the cells that Bugy will visit.
1
11 17 21 21 22 23 21 22 22 17
10 17 22 27 28 29 26 28 20 17
10 16 21 29 33 34 33 29 23 18
11 16 24 27 34 40 33 28 23 18
10 15 24 28 33 33 26 30 21 15
9 16 20 28 27 27 29 29 22 18
10 15 22 24 21 22 20 21 23 17
9 15 16 18 16 18 15 15 16 15
12 10 10 10 11 11 9 11 11 10
1 3 5 2 6 5 3 3 3 2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Bugy always move to the neighbor cell with more food until there is no neighbor cell with more food.
Connect the blue cell. Then continue consecutively connecting the cells that Bugy will visit.
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9 16 20 25 27 27 29 29 22 18
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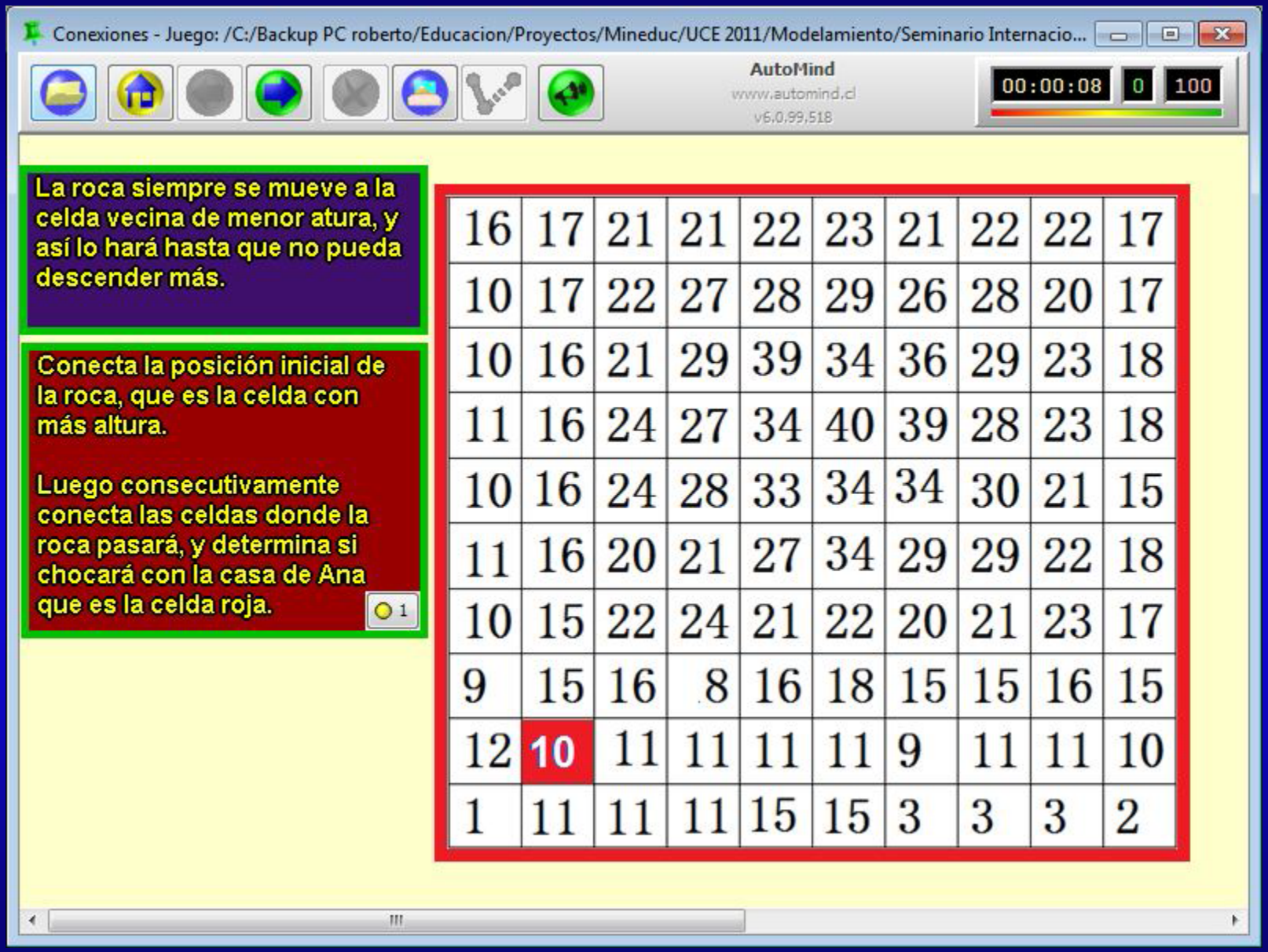
Landslides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La roca siempre se mueve a la celda vecina de menor atura, y así lo hará hasta que no pueda descender más.
Conecta la posición inicial de la roca, que es la celda con más altura.
Luego consecutivamente conecta las celdas donde la roca pasará, y determina si chocará con la casa de Ana que es la celda roja.
1
16 17 21 21 22 23 21 22 22 17
10 17 22 27 28 29 26 28 20 17
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10 16 24 28 33 34 34 30 21 15
11 16 20 21 27 34 29 29 22 18
10 15 22 24 21 22 20 21 23 17
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12 10 11 11 11 11 9 11 11 10
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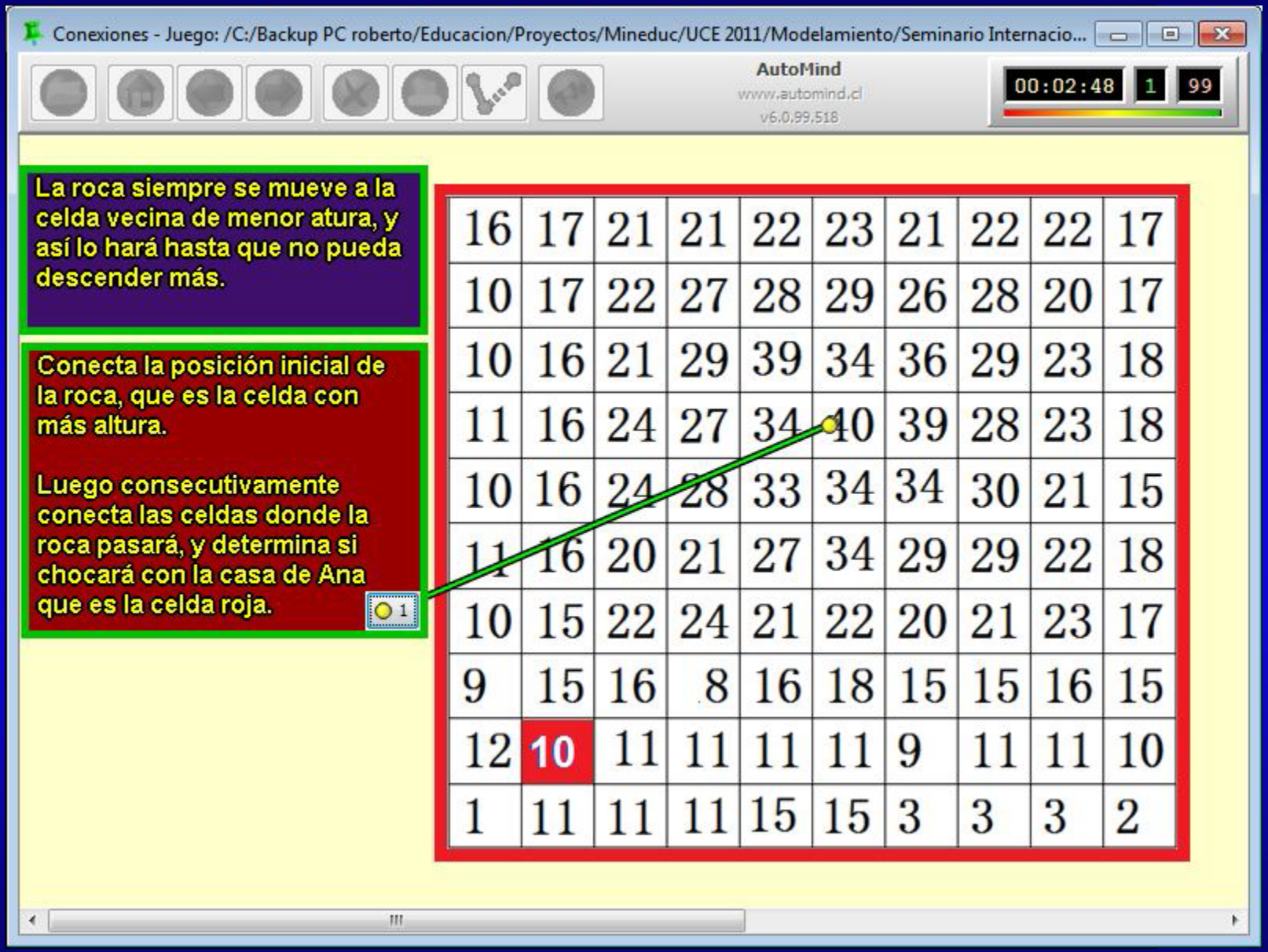
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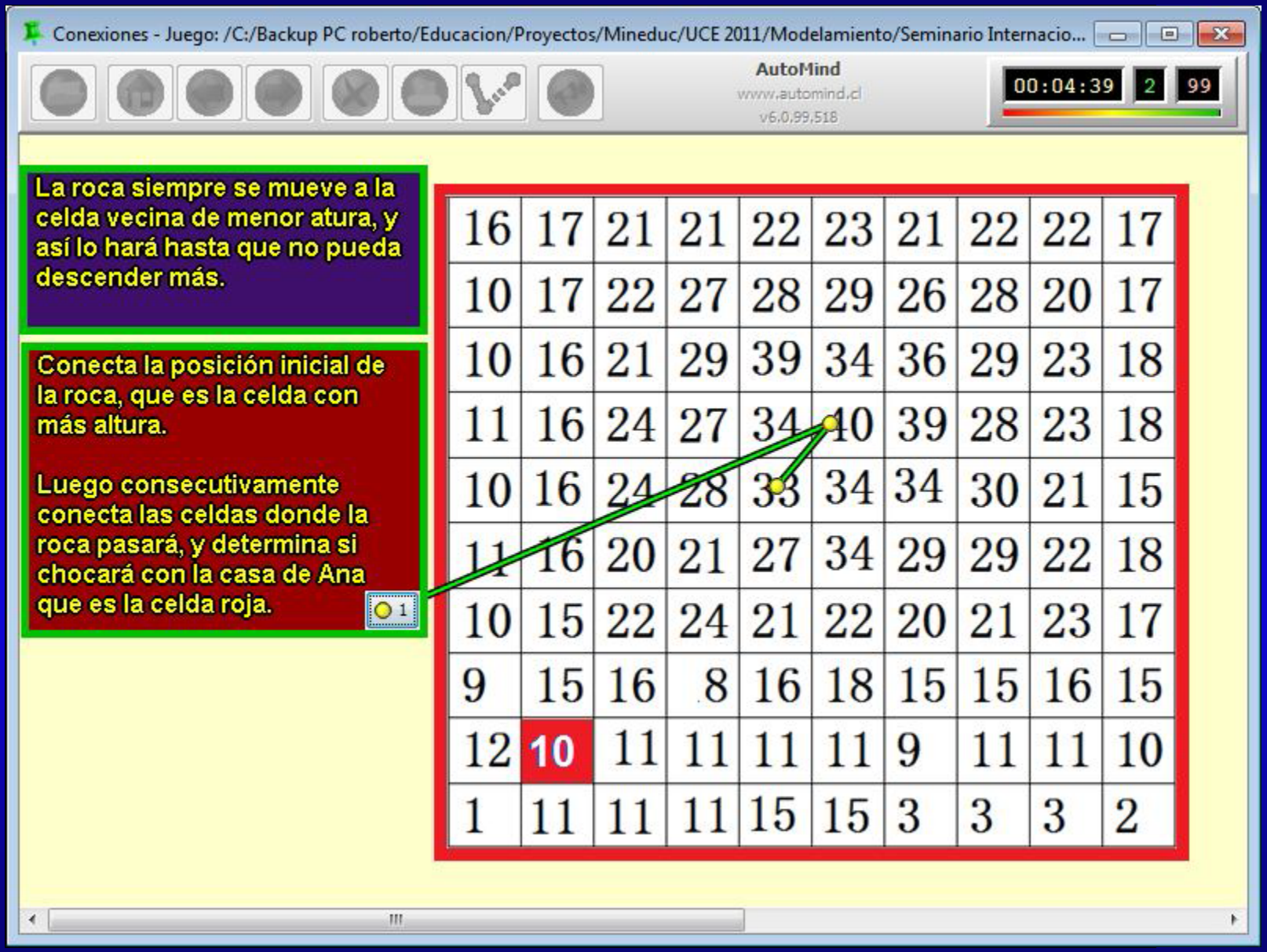
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11 16 24 27 34 40 39 28 23 18
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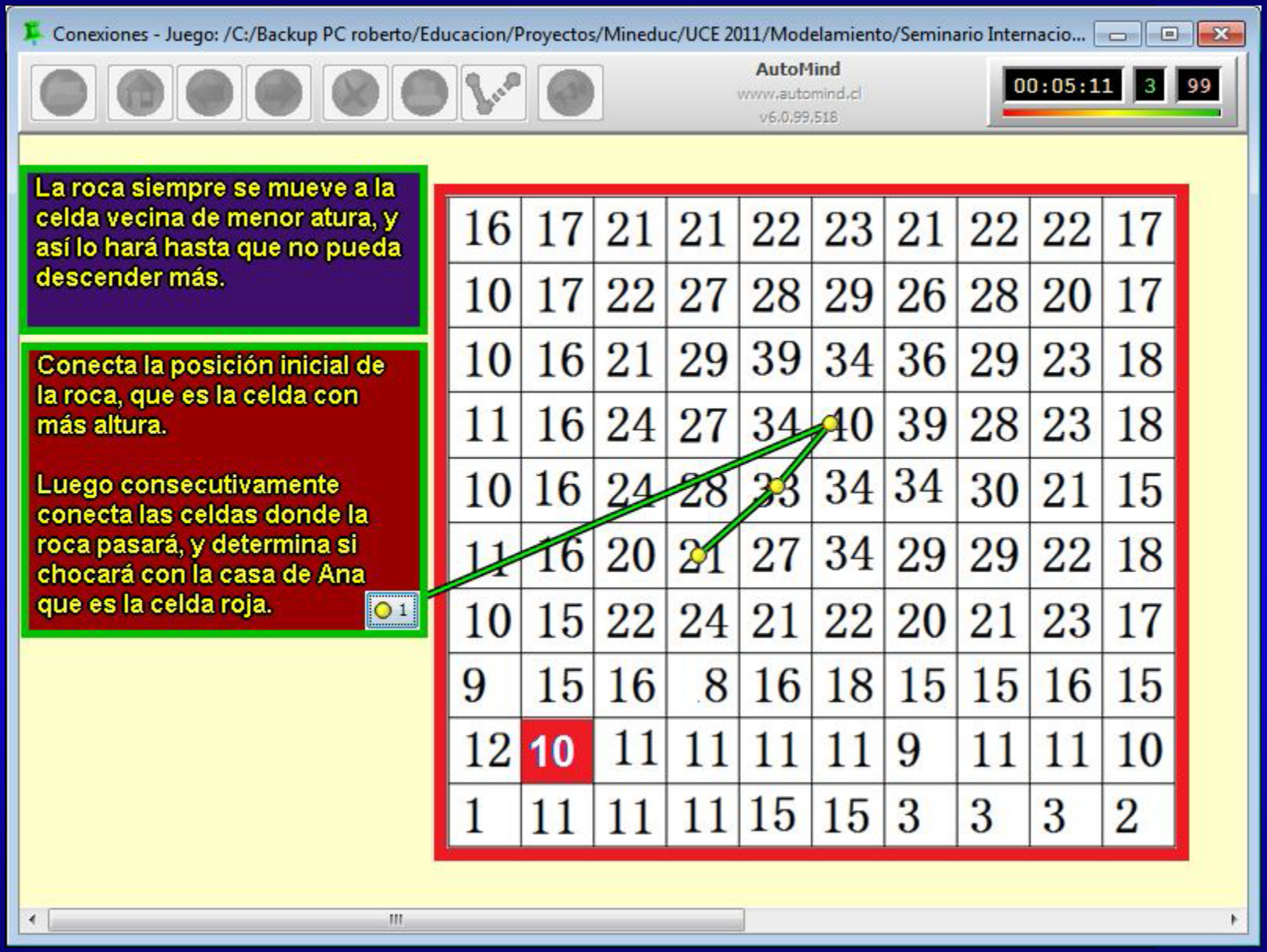
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La roca siempre se mueve a la celda vecina de menor atura, y así lo hará hasta que no pueda descender más.
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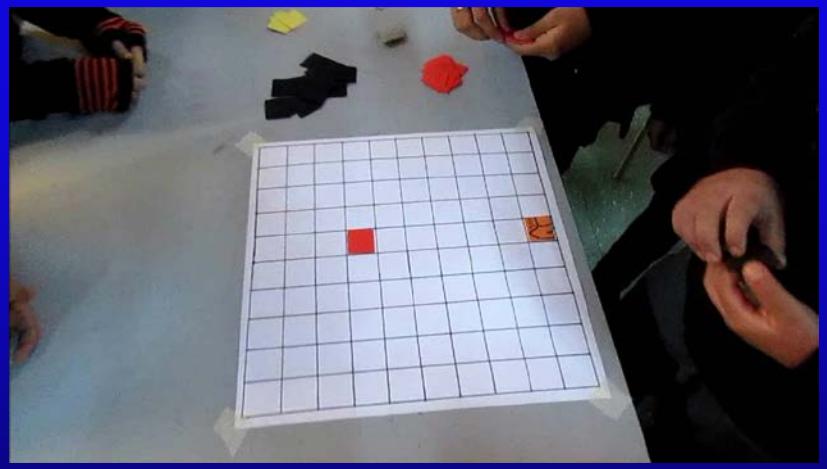
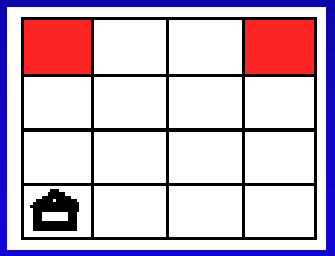
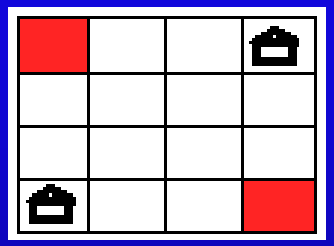
How to teach Modeling?

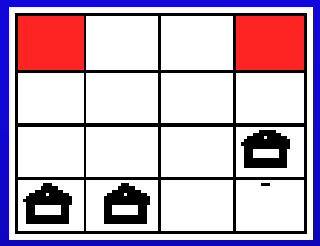
2) Concrete Model → Pictorial Model → Math Model

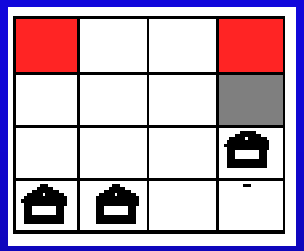


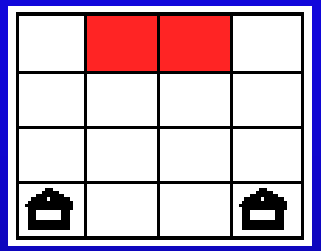
Program an autonomous drone











Fuego – U.C. Berkeley

How to teach Modeling?

3) Predict & explain

Teacher presents a challenge

Teacher track answers in real time

Students:

- Make predictions
- Explain predictions with models
- Make experiment
- Explain agreement with models
- Peer review

Respuestas de los alumnos

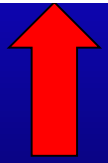
Número de estudiantes que respondieron: 11 de 3 estudiantes conectados.

Hora (HH:MM:SS)	Nombre	RUT	Respuesta	
09:32:29	Rain A, Elmer	20789738-8	si porque el baso con el agua hela se pone mas oscura por la poca energia que tiene,con el agua caliente tiene mas energia que hace que la tinta se disuelva mas rapido	Premiar con 4 banderas
09:33:26	Pradenas B, Cristopher	20446681-5	concuerdan con un poco de lo que dije me falto decir que tambien cambia un poco de color y estaba bien que se disuelve mas rapido en el agua caliente	Premiar con 4 banderas
09:34:19	Cid M, Jairo	20813352-7	si por que la tinta en el resipiente con agua caliente se disolvio mas rapido que el que tenia agua fria	Premiar con 4 banderas
09:35:27		20450148-3	en el transcurso de los dos minutos el recipiente de agua helada se demoro mas en disolverse y de agua caliente se	Premiar con 4 banderas

Peers Review

Visualize thinking of students´ peers

13:03:09	 Bascur G, Cris	21797658-8	Saez V, Catalina dijo: porque ella dice que tiene 30 panes y despues dice que les corresponde a cada uno 180 y esta mal y 30 es menor que (180) tenia que dividir 180 dividido en 30	NOPOOOOOO SI ERA KE RRESPONDER 30DIVIDIDO EN 6	4 b
13:03:09	 Fernández C, Johan	22037069-0	Carrasco F, Thiare dijo: esta mal por que dijo que tenia que aver 180 panes dijo ella	mal	Premiar con 4 banderas
13:03:56		21818369-7	Sánchez M, Carla dijo: estamal porque dibidio y es multiplicar	esta mal	Premiar con 4 banderas

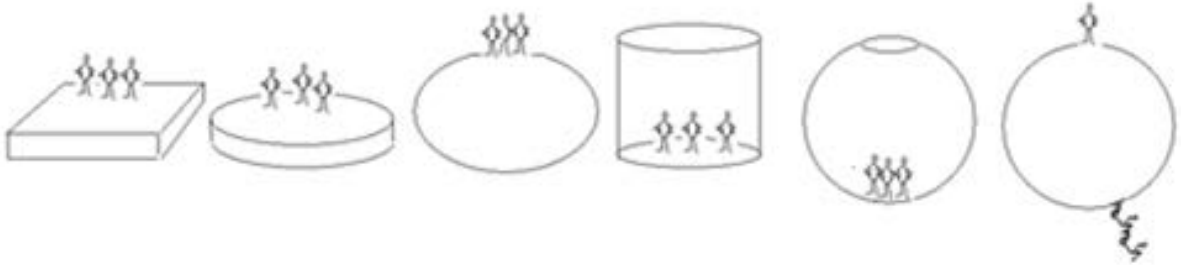


Peers commentary

Record on the cloud each prediction and each explanation of every student

→ Powerful data mining

→ Critical information to improve practices



PLANET-STEM

Paradigm-shifting Learning And Networking for Education using Technology for Science Technology Engineering Mathematics (STEM)

Carl Pennypacker, Ph.D
Educator and Research Physicist
University of California, Berkeley

Roberto Araya, Ph.D.
Educator and STEM Researcher
CIAE, University of Chile

www.planet-stem.org

How to teach Modeling?

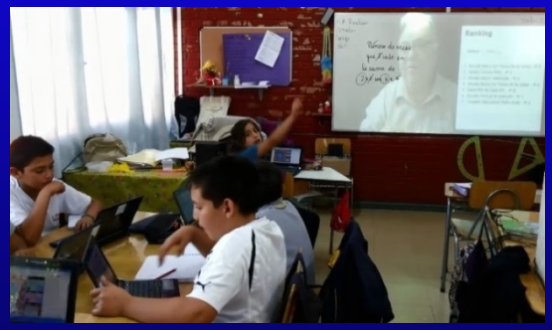
4) Inter classroom competition

and

Intra class collaboration

Inter school on-line synchronous tournaments

Classroom n



Classroom k


Conectado a sala 6
Roberto
Hola, en este juego puedes hacer clic en cualquier celda para llegar a tu destino. Haz clic en el tablero para eliminar estos mensajes.
Jugada N°1
Roberto
Finalizar turno
Haz girar la tómbola...
Turno N°1
105 s
Oro:0
Err:0
10
Esperando turno...
Turno N°0
-
Oro:0
Err:0
¿...?
Contar de nuevo...

Synchronized classrooms

Internet servers (amazon)

School 1

Salas de Clase 1

Sala de Clases 2

Sala de Clases 3

Sala de Clases 4

Sala de Clases 5

School 2

Salas de Clase 1

Sala de Clases 2

Sala de Clases 3

Sala de Clases 4

Sala de Clases 5

School n

Salas de Clase 1

Sala de Clases 2

Sala de Clases 3

Sala de Clases 4

Sala de Clases 5

How to teach Modeling?

1) Use-Select-Adjust-Build

2) Concrete Model → Pictorial Model → Math Model

3) Predict & explain (visualize with models)

4) Inter classroom competition & Intra class collaboration

Homework

Energy?

Energy efficiency?

Energy efficiency in Mining and in Industry?

Can we explain why it works?

Isn´t there beauty here?

It sparked the whole insustrial revolution

How to scale this process to the whole school system?

Lesson study and public classes

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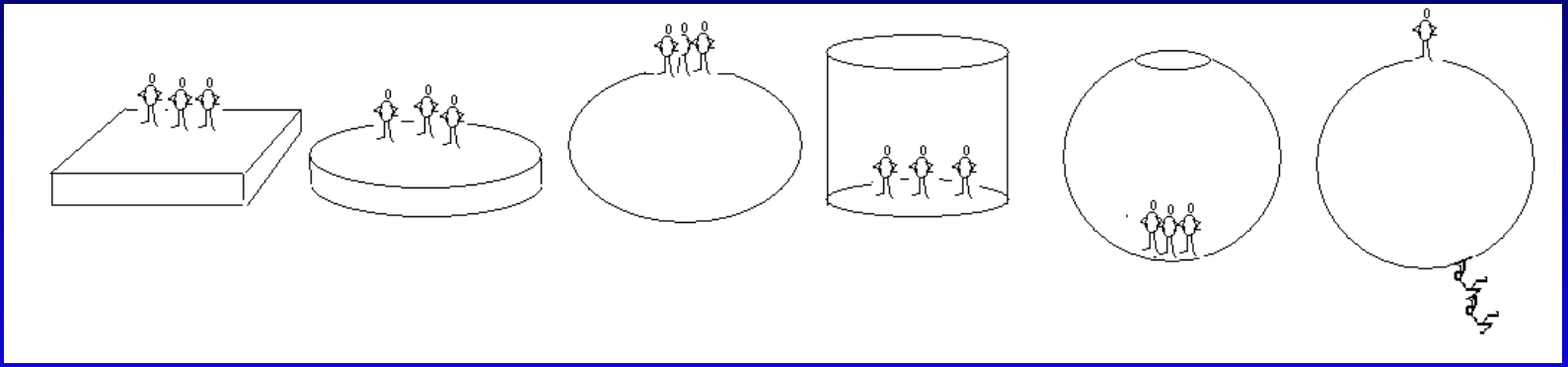
How to teach Modeling?



www.planet-stem.org

Thank you