The Couch or the Bottle

Levels of Abstraction and the Anxious Mind

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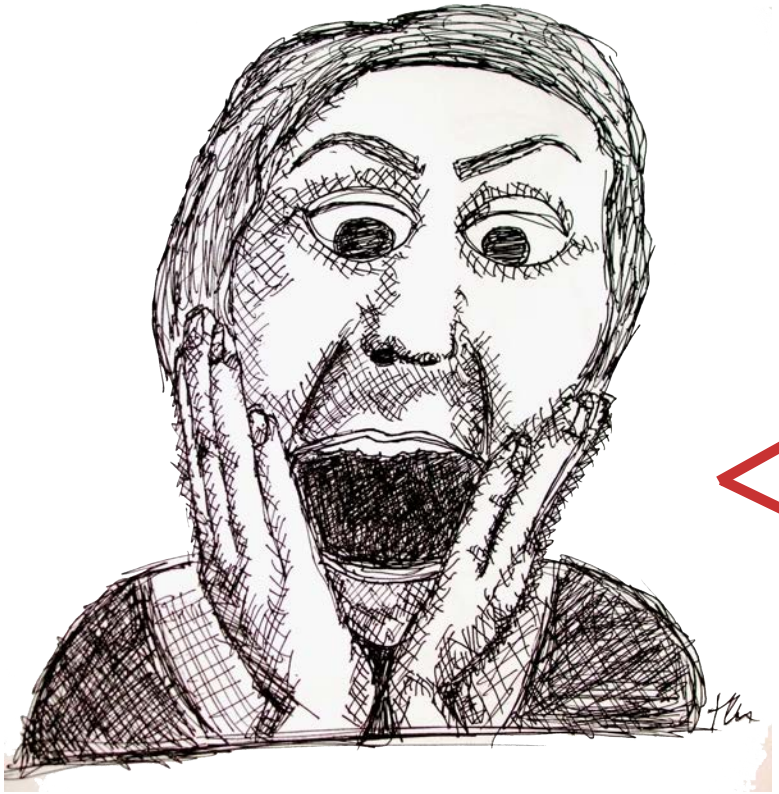
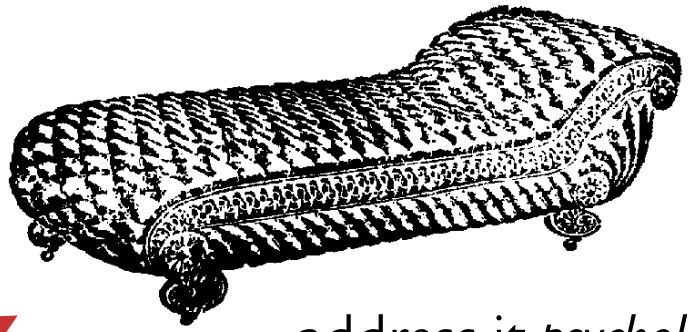
University of Toronto





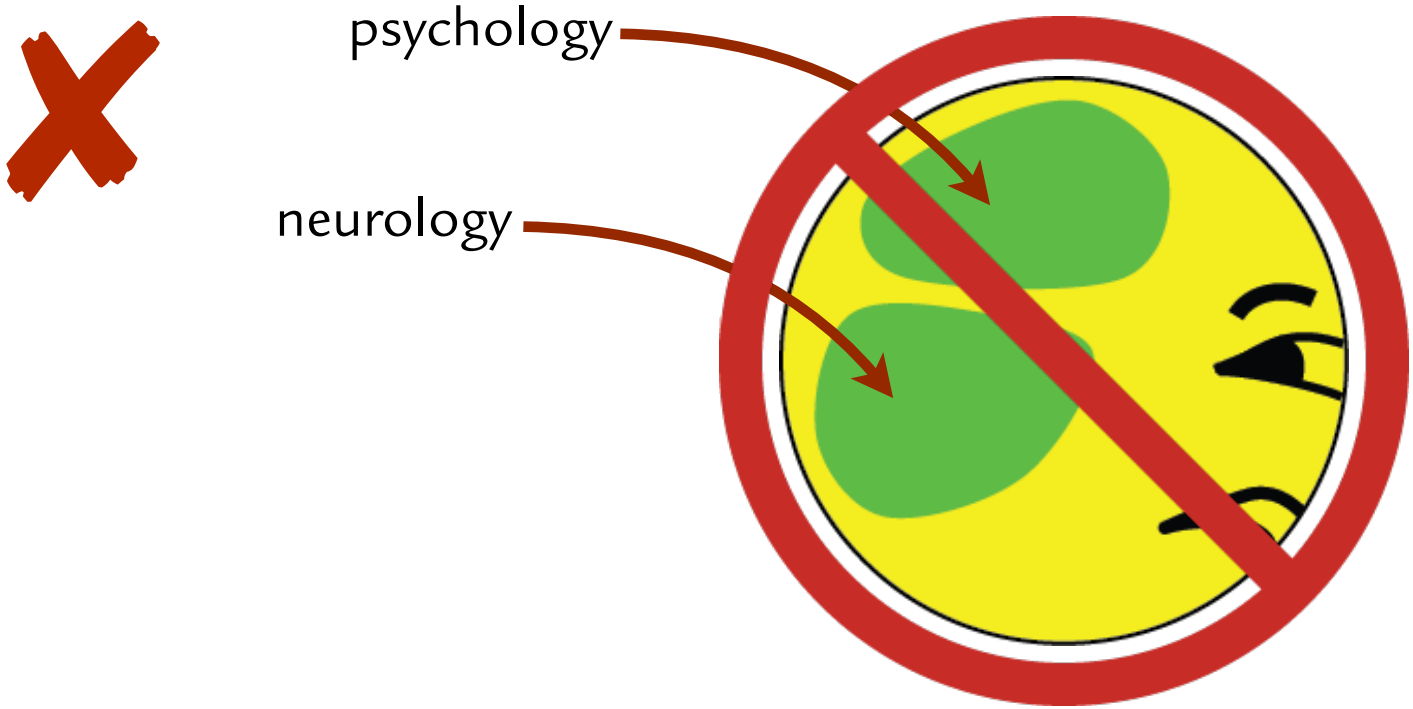
address it *psychologically*

?

address it *neurochemically*

(*We'll talk about other kinds of bottles later …* )

~~An~~ obviously Untenable Idea — different modules



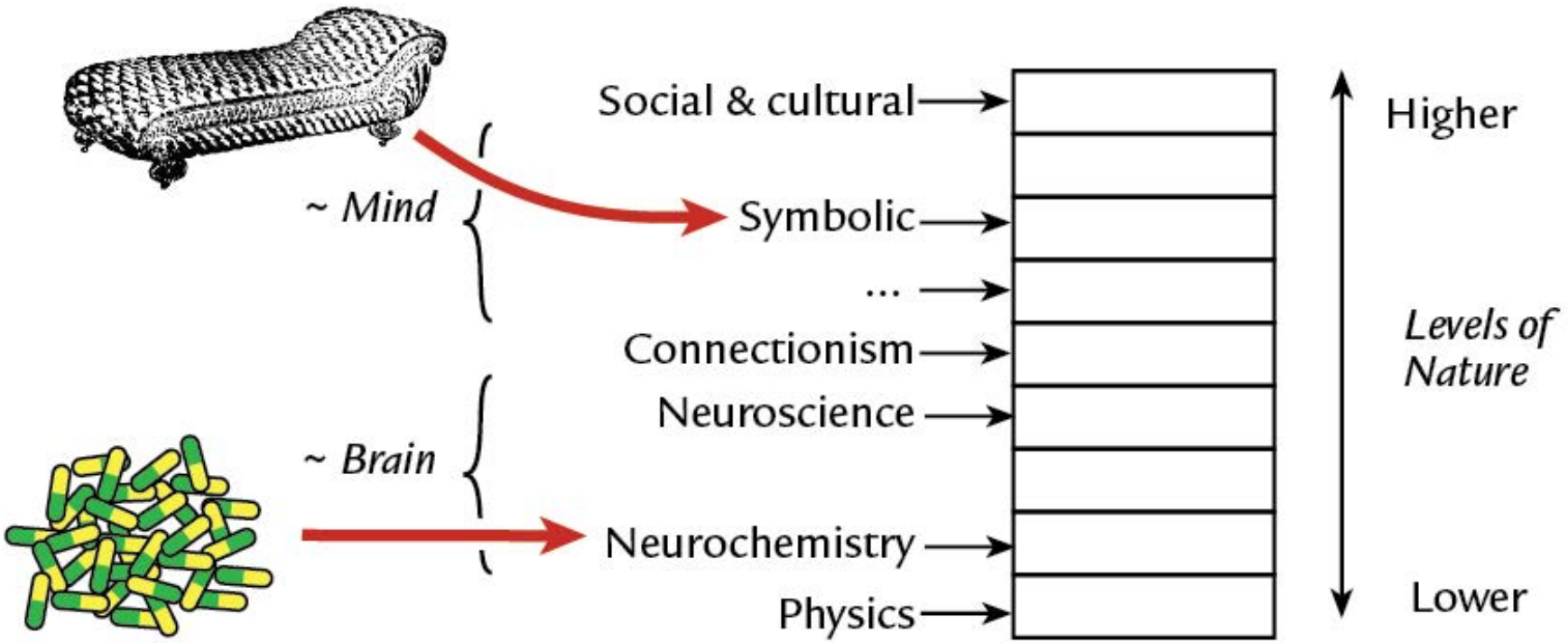
A Better Idea — one phenomenon, *two levels of description*

A **psychological** level of description

A **neurochemical** level of description

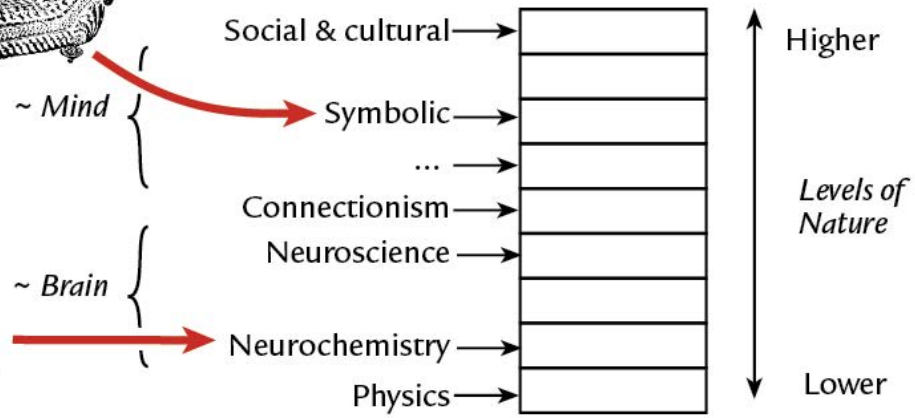
1. *Two perspectives* on *one* (integral) *phenomenon*
2. In simple cases
   a) *Intelligible* at one level
   b) *Messy* or *unintelligible* at other levels
   c) With luck: *analyzable* at a single level
3. In complicated cases
   a) *Requires simultaneous multi-level analysis*
   b) intrinsic *multidisciplinarity*!

Psychological Levels of Description



1. We assume talk therapy has *influence downwards*

2. And that pills have *influence upwards*



3. How does **inter-level influence** work? And how do we **understand** it?

4. That is, how do we understand the relation between
   a) A system understood at *one level of abstraction*, and
   b) *That same system*, understood at a *different level of abstraction*?

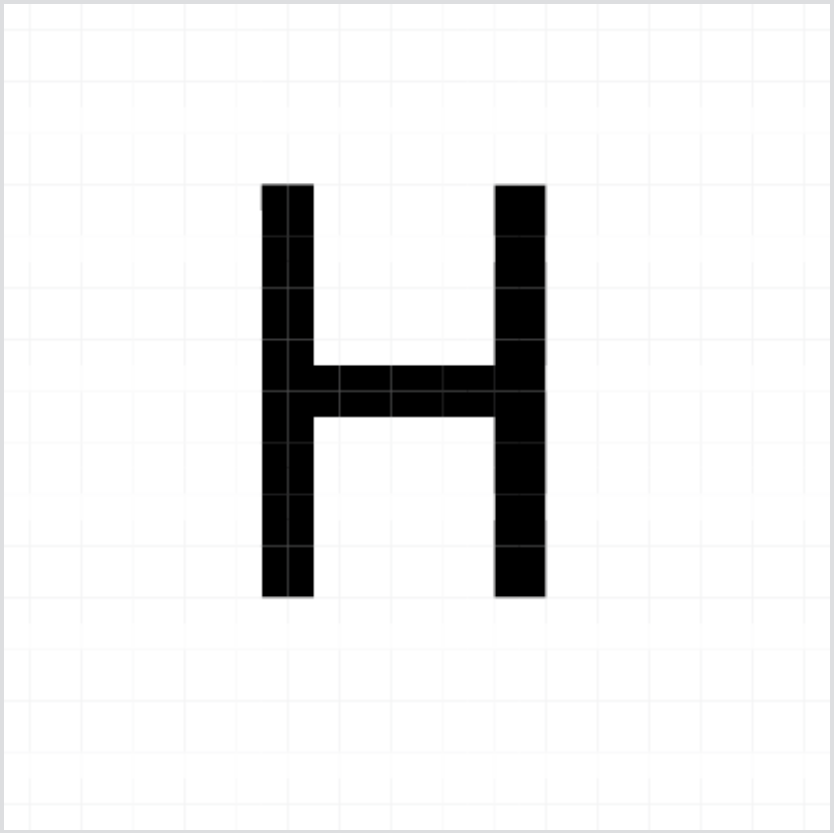
5. This relation has different names in different fields:
   a) **Philosophy**: ⇐ **reduction** (**supervenience**, **realisation**)
   b) **Computing**: ⇐ **implementation**

Philosophical Digression on Reduction and Supervenience (At the end if there is time)

Some Examples of Inter-level Relations & Analysis

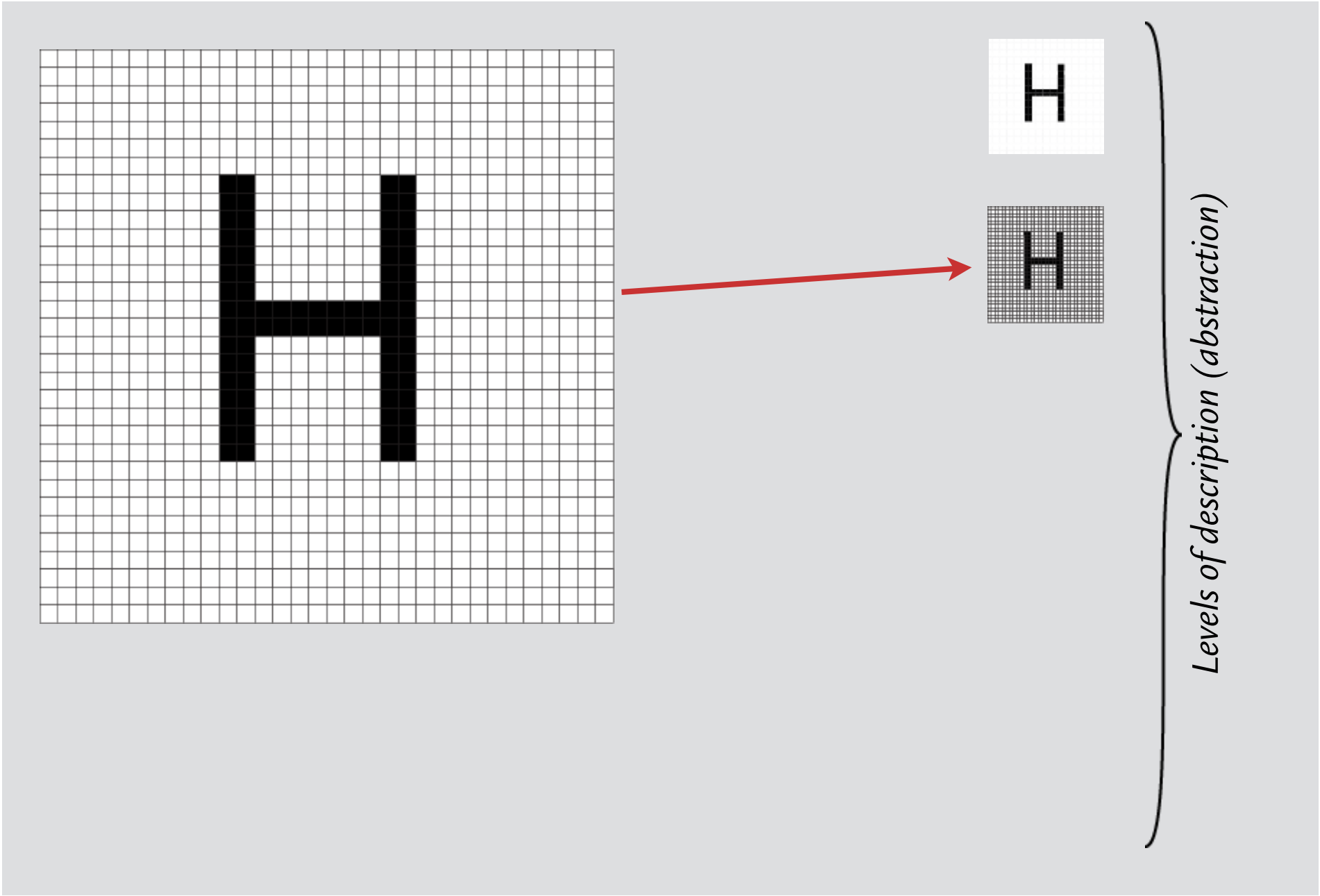
Example #1

What we see

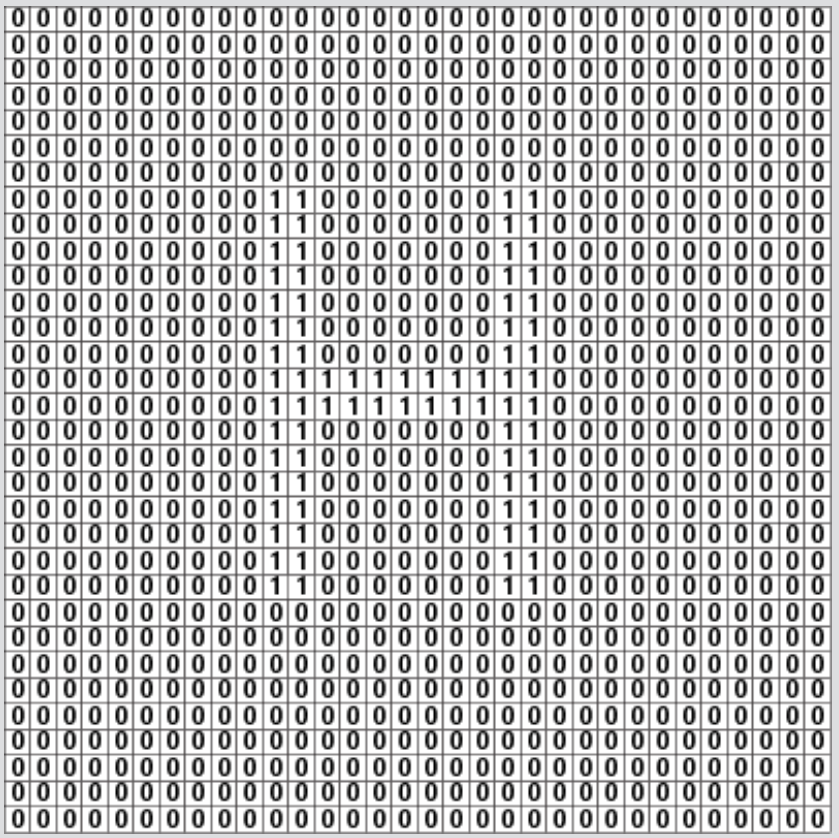


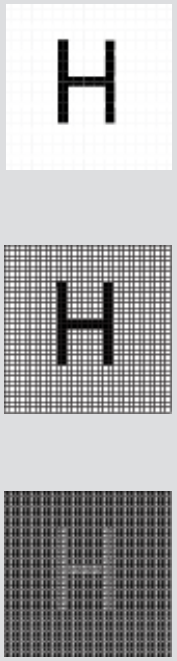
Levels of description (abstraction)

In more detail



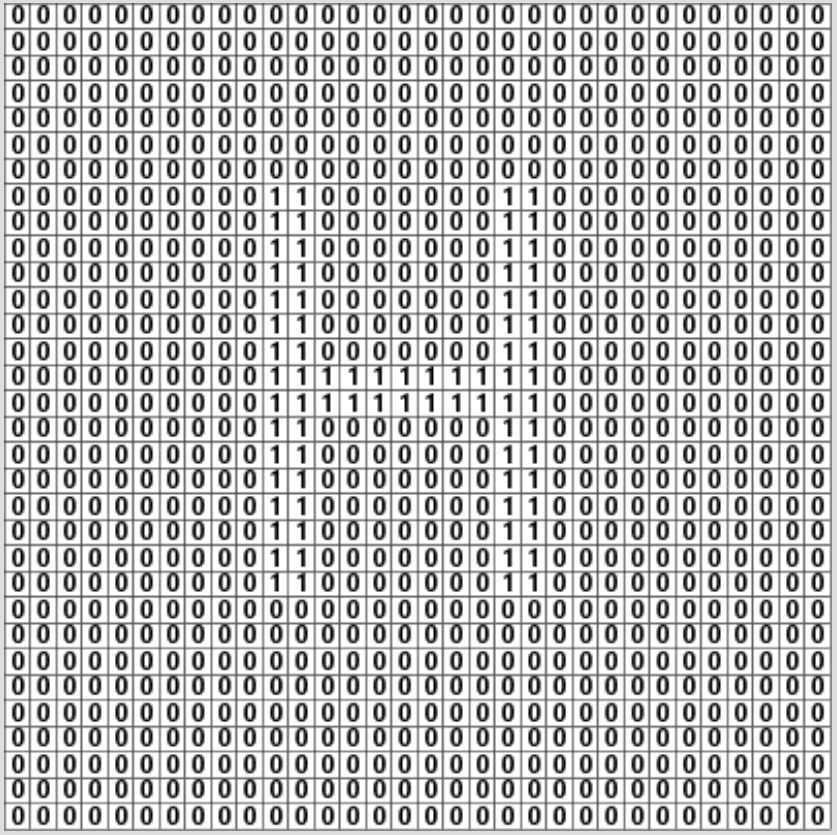
A bitmap implementation





Levels of description (abstraction)

A bitmap implementation



"Run-length" encoding

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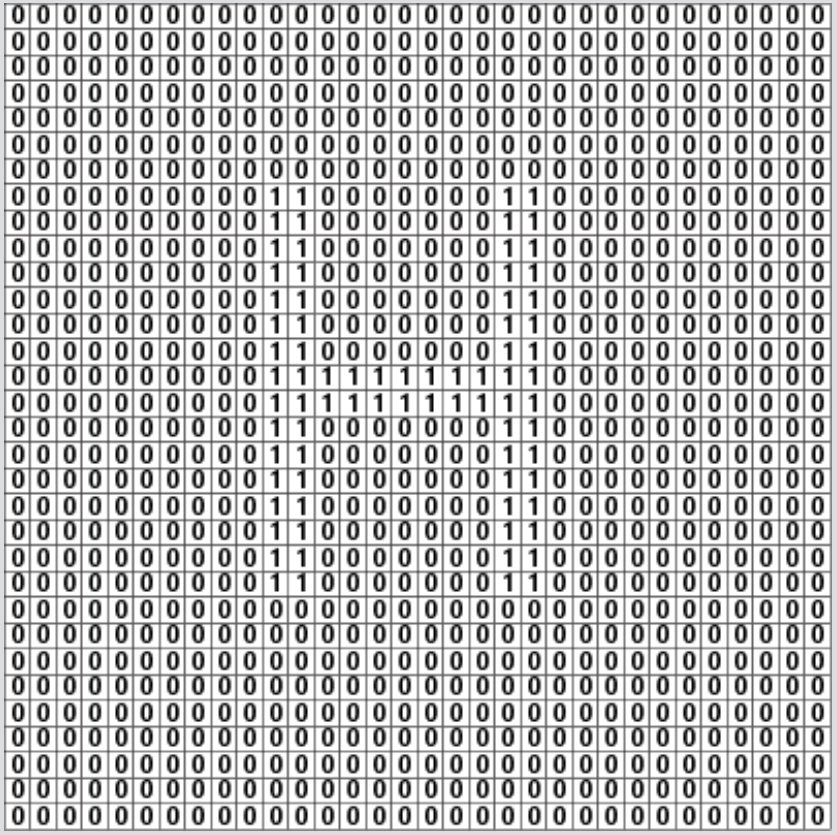
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	11	(on)	2	(on)
7	(off)	21	(off)	7	(off)
2	(on)	11	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)

A bitmap implementation



"Run-length" encoding

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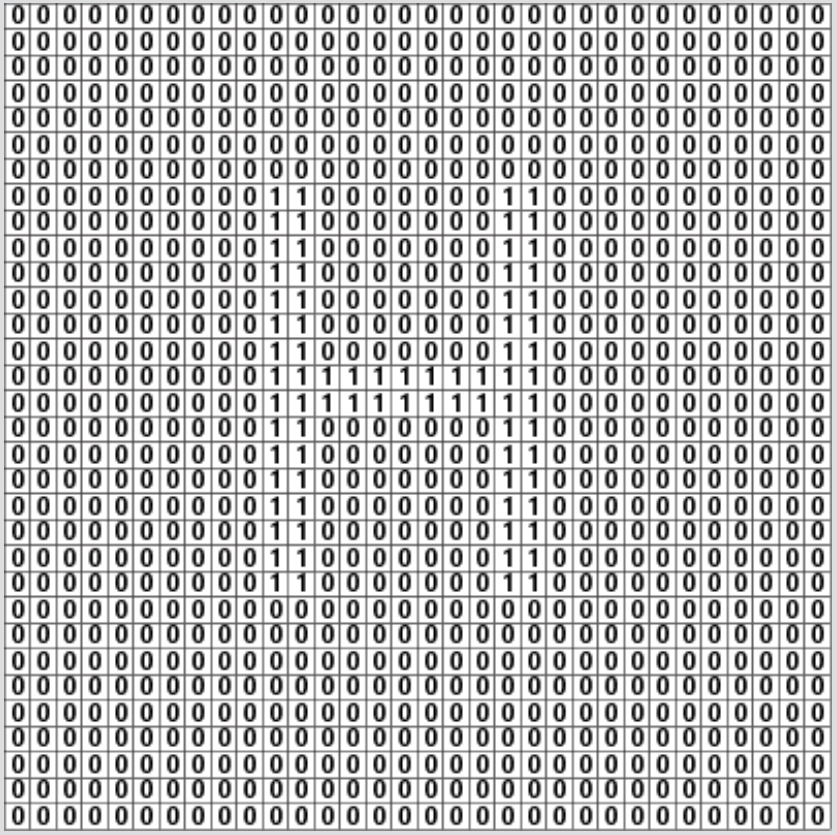
7	7	7
2	2	2
21	21	21
2	2	2
7	7	7
2	2	2
21	21	21
2	11	2
7	21	7
2	11	2
21	21	21
2	2	2
7	7	7
2	2	2
21	21	21
2	2	2
7	7	7
2	2	2

A bitmap implementation



"Run-length" encoding

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00000111	00000111	00000111
00000010	00000010	00000010
00101001	00101001	00101001
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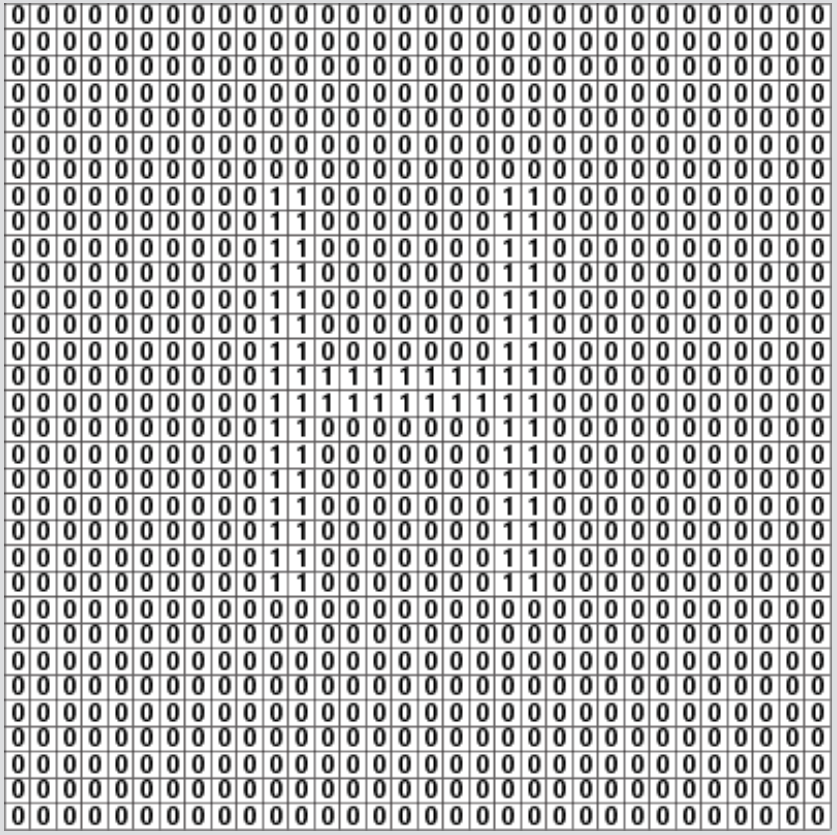
00000111	00000111	00000111
00000010	00000010	00000010
00101001	00101001	00101001
00000010	00001011	00000010
00000111	00101001	00000111
00000010	00001011	00000010
00101001	00101001	00101001
00000010	00000010	00000010
00000111	00000111	00000111
00000010	00000010	00000010
00101001	00101001	00101001
00000010	00000010	00000010
00000111	00000111	00000111
00000010	00000010	00000010

A bitmap implementation



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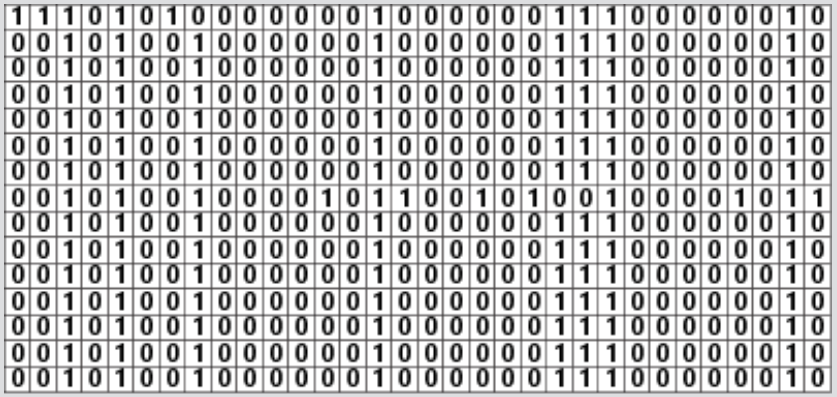
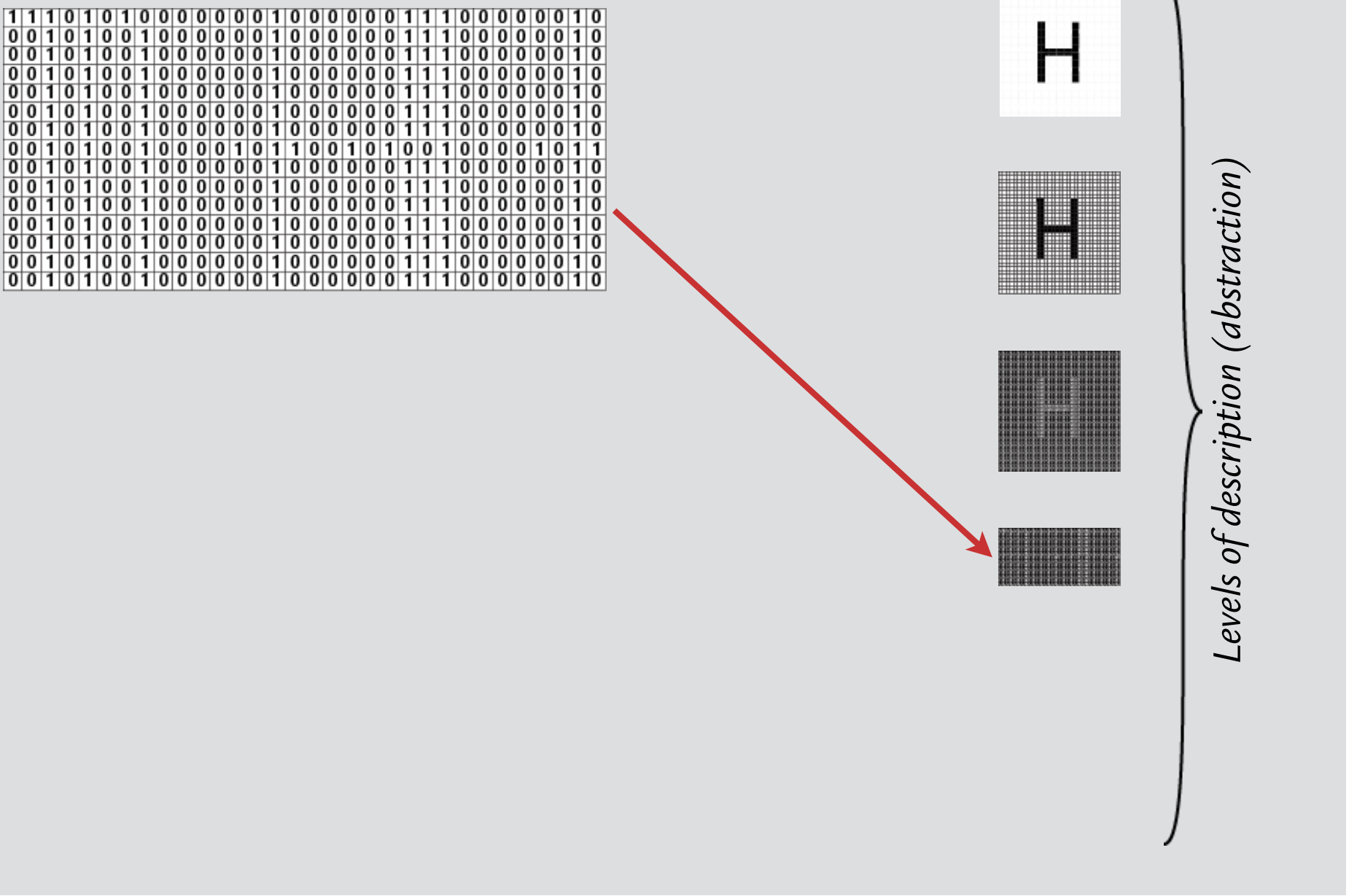


twice as efficient!

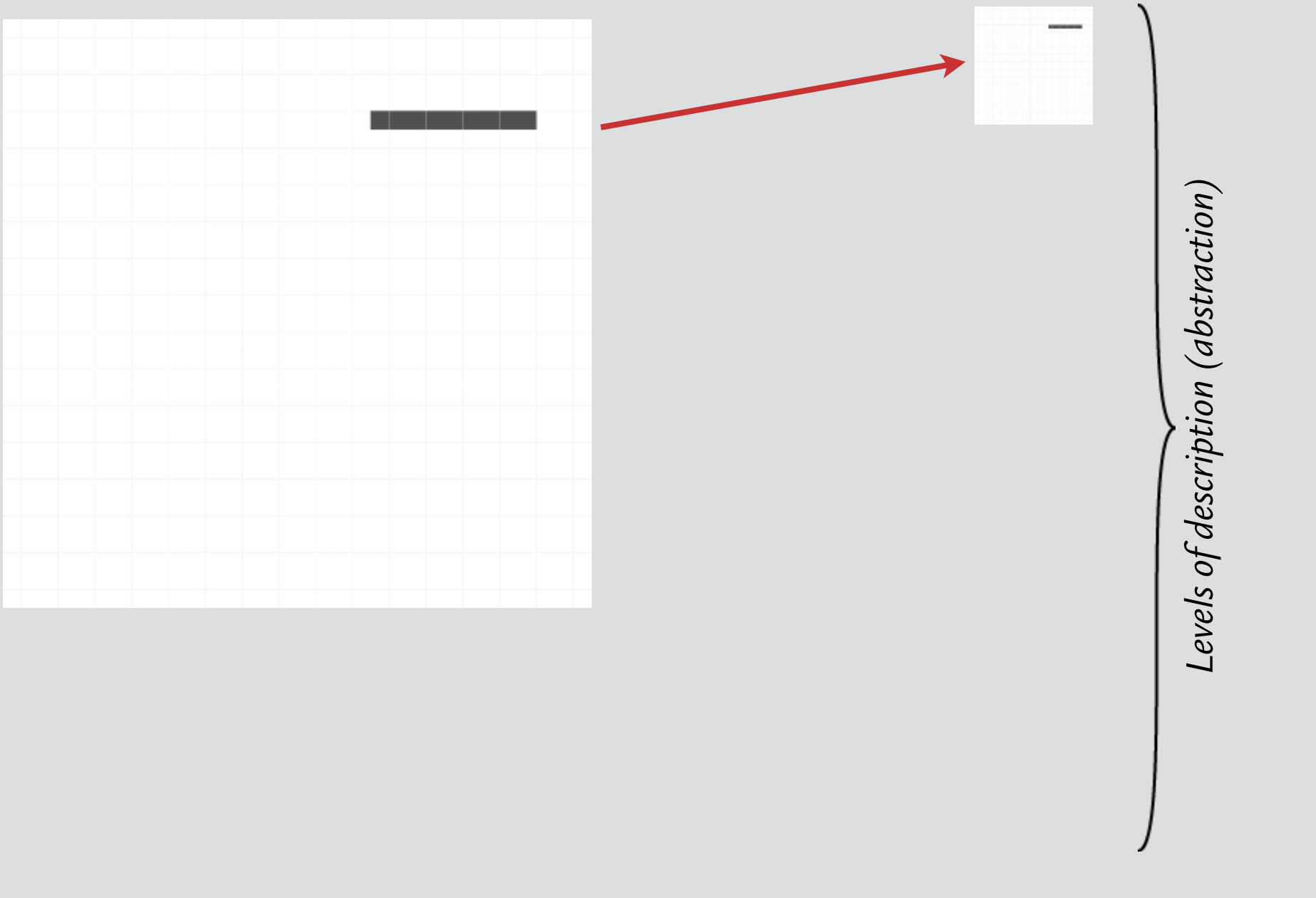
in realistic computational situations, the efficiency gain is likely to be be *much* greater)

A bitmap implementation

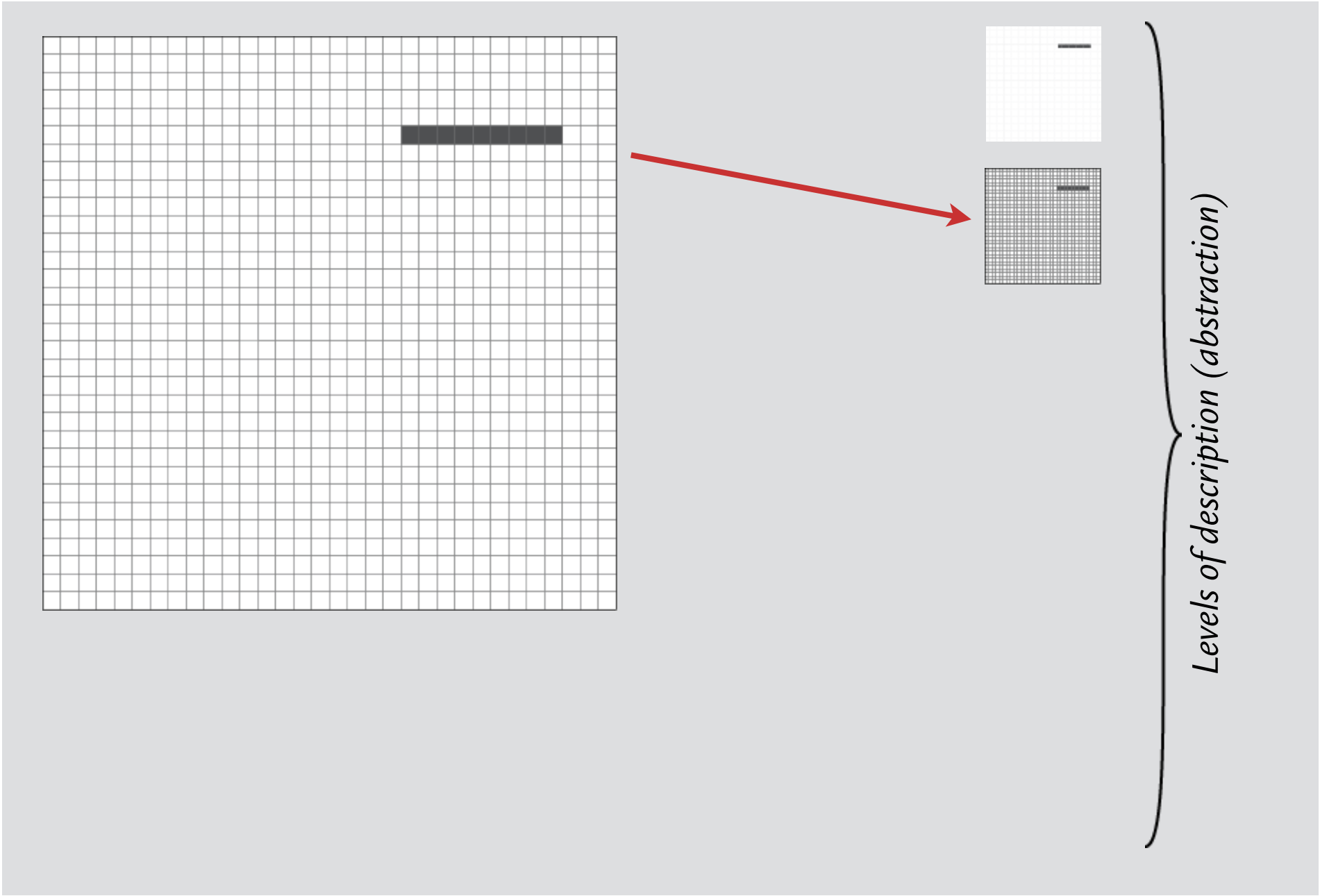


Now let's damage this machine's brain…

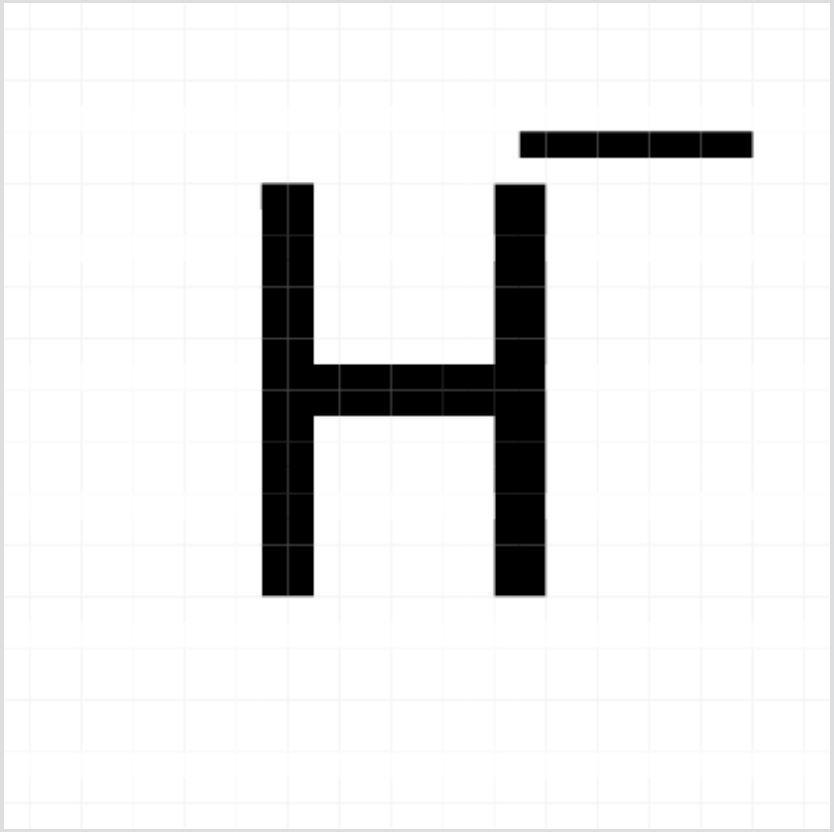
What we see (when trying not to display anything)



In more detail

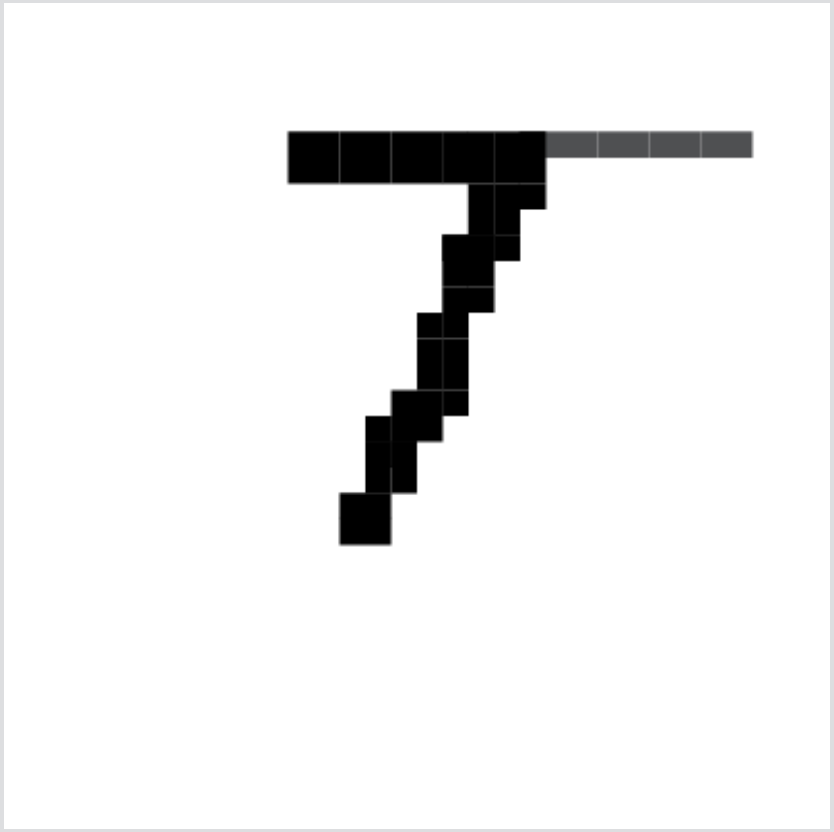


What we see



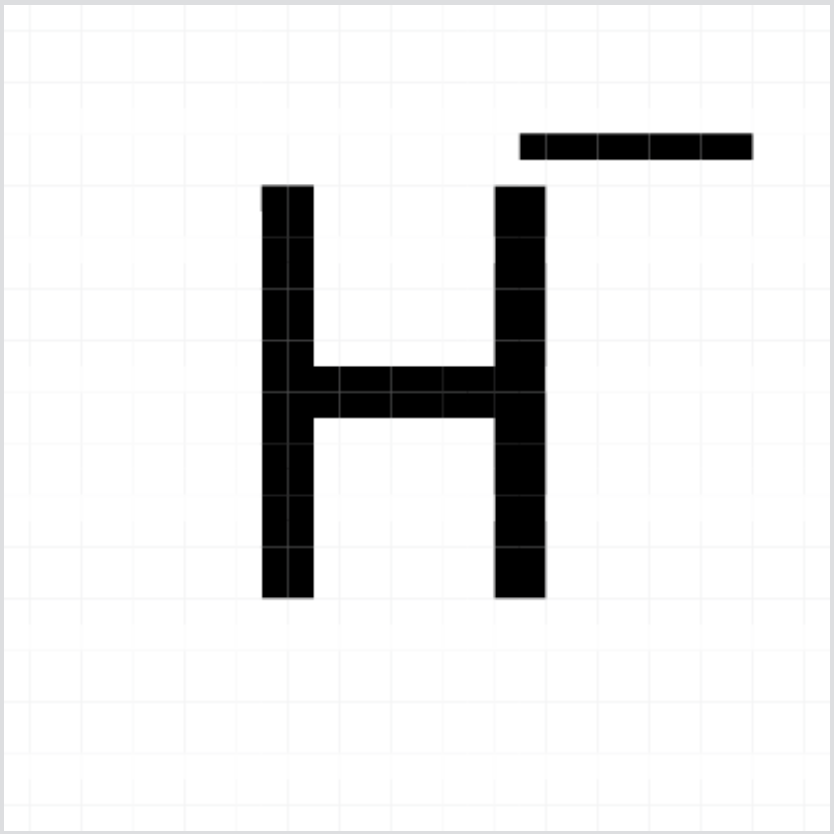
Levels of description (abstraction)

What we see



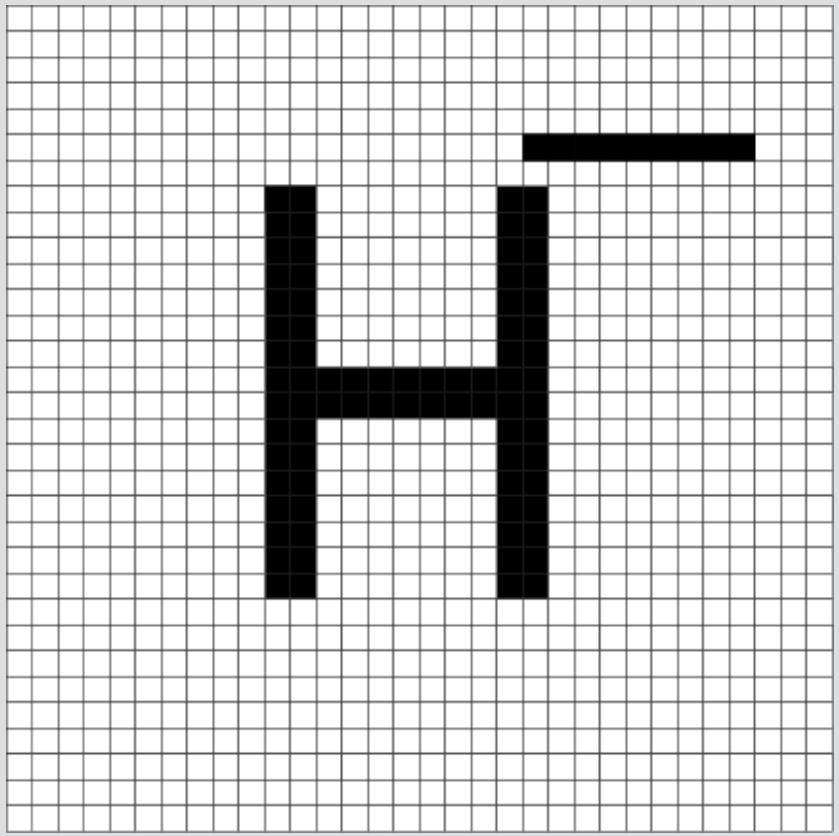
Levels of description (abstraction)

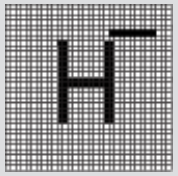
What we see



Levels of description (abstraction)

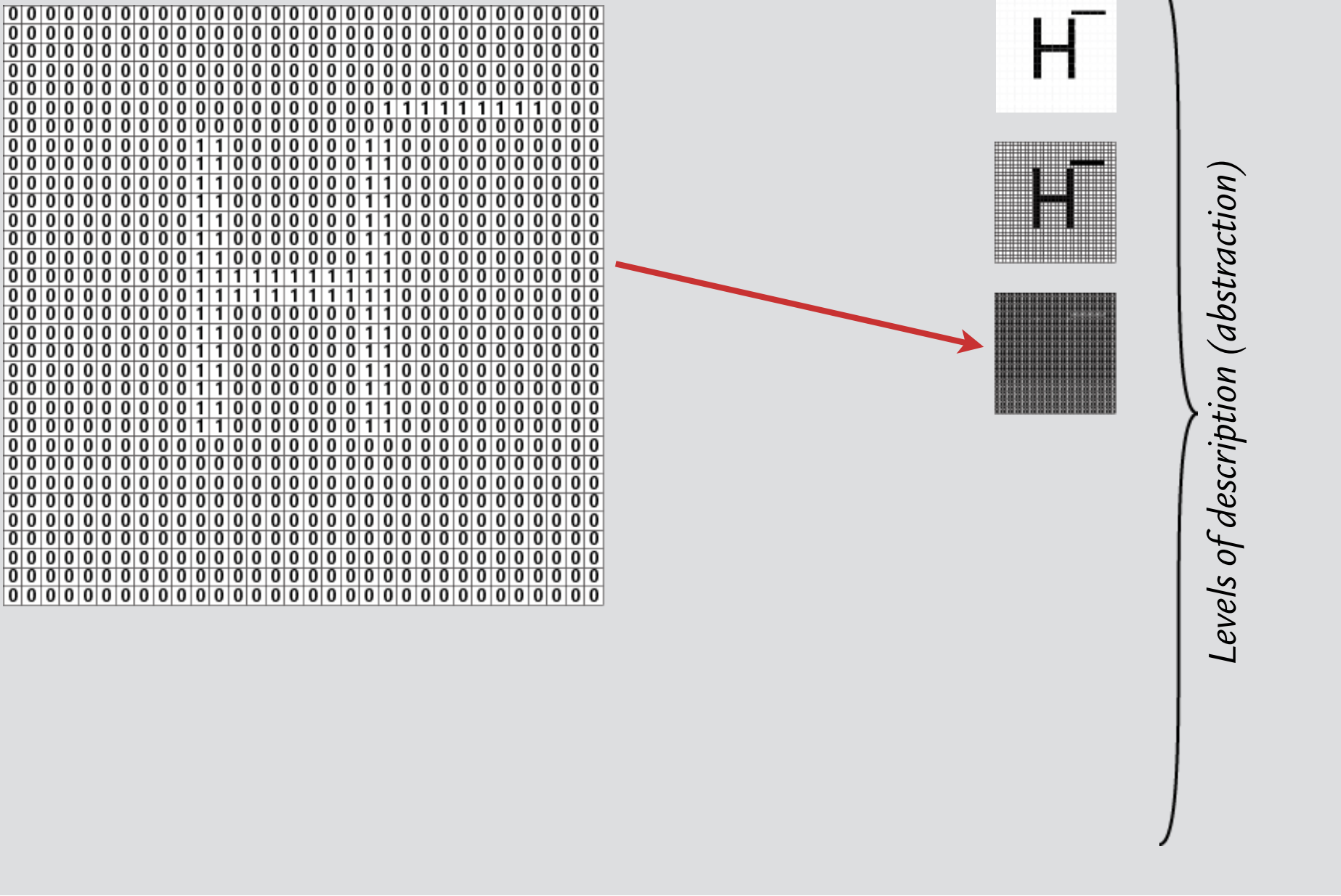
What we see



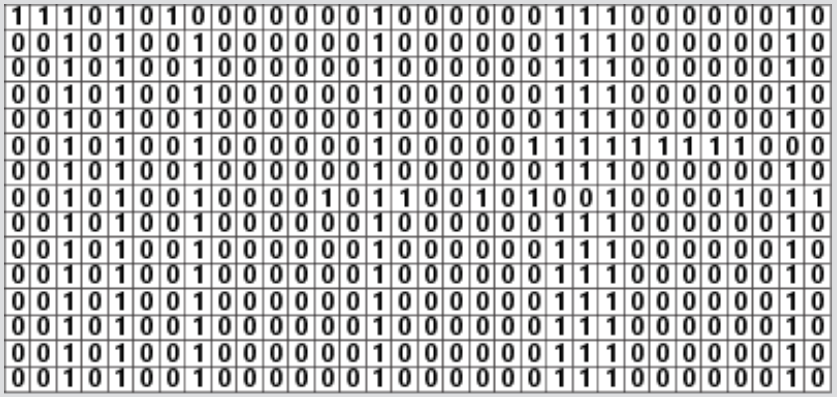


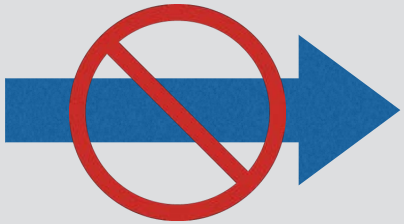
Levels of description (abstraction)

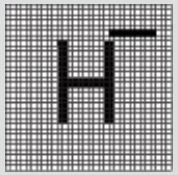
Bitmap

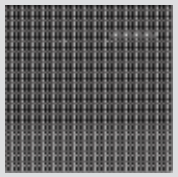


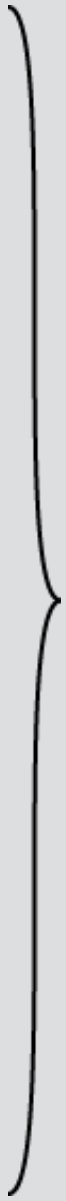
Run-length encoding











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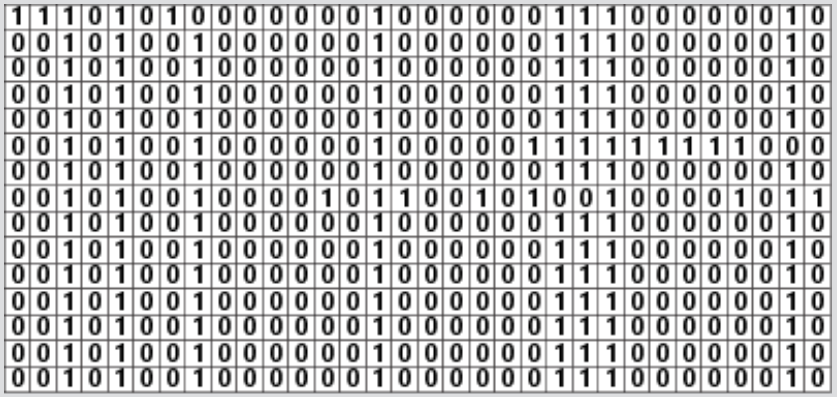

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7	(off)	15	(off)	7	(off)
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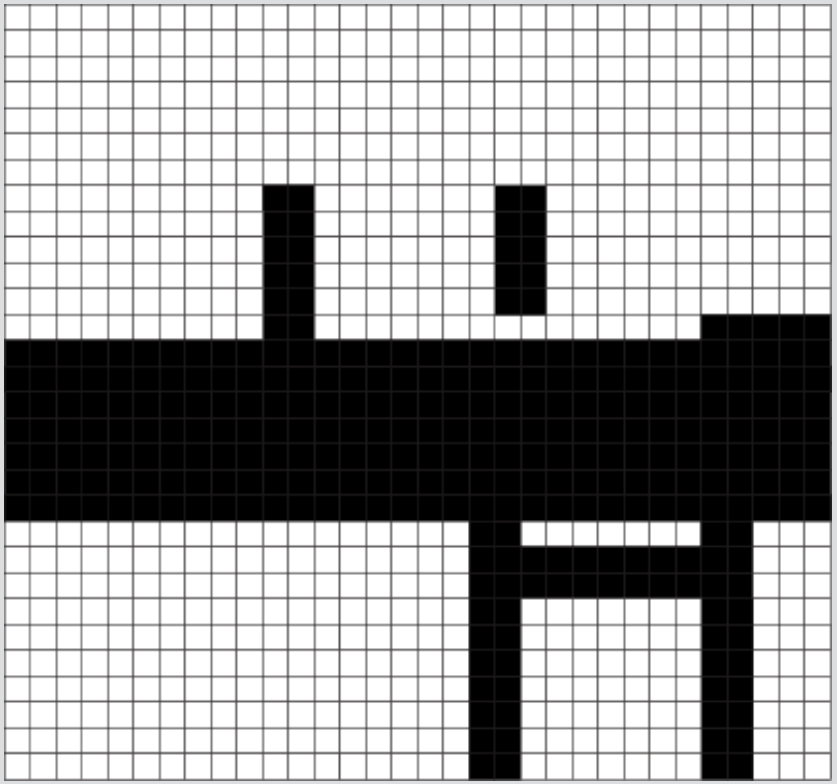
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	11	(on)	2	(on)
7	(off)	21	(off)	7	(off)
2	(on)	11	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)

Run-length encoding

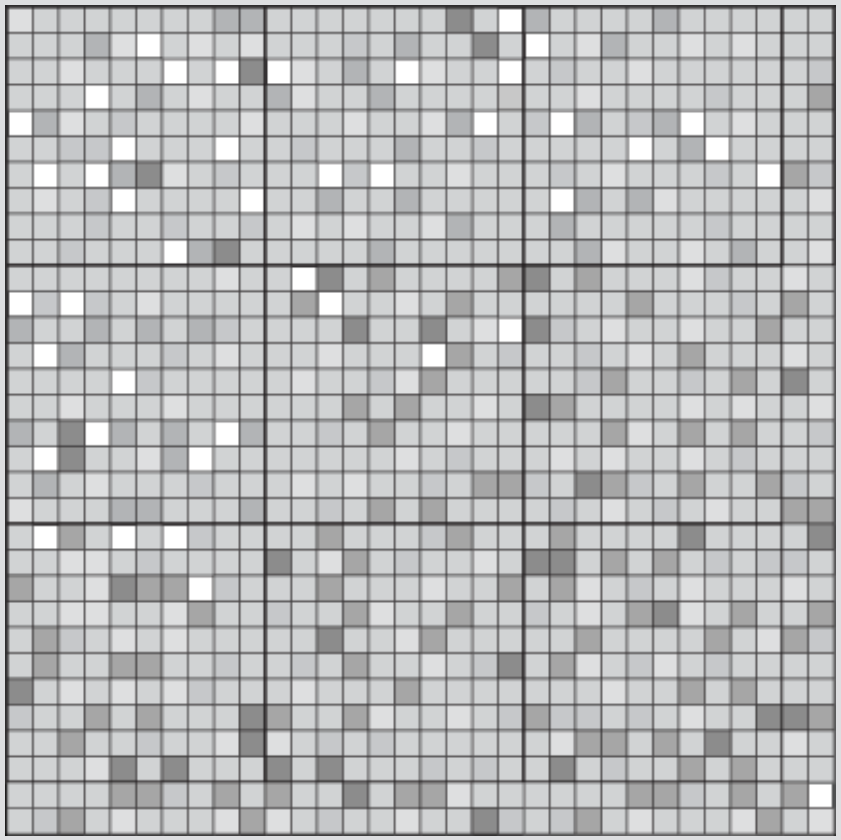


234	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	15	(off)	7	(off)
2	(on)	248	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	11	(on)	2	(on)
7	(off)	21	(off)	7	(off)
2	(on)	11	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)
21	(off)	21	(off)	21	(off)
2	(on)	2	(on)	2	(on)
7	(off)	7	(off)	7	(off)
2	(on)	2	(on)	2	(on)

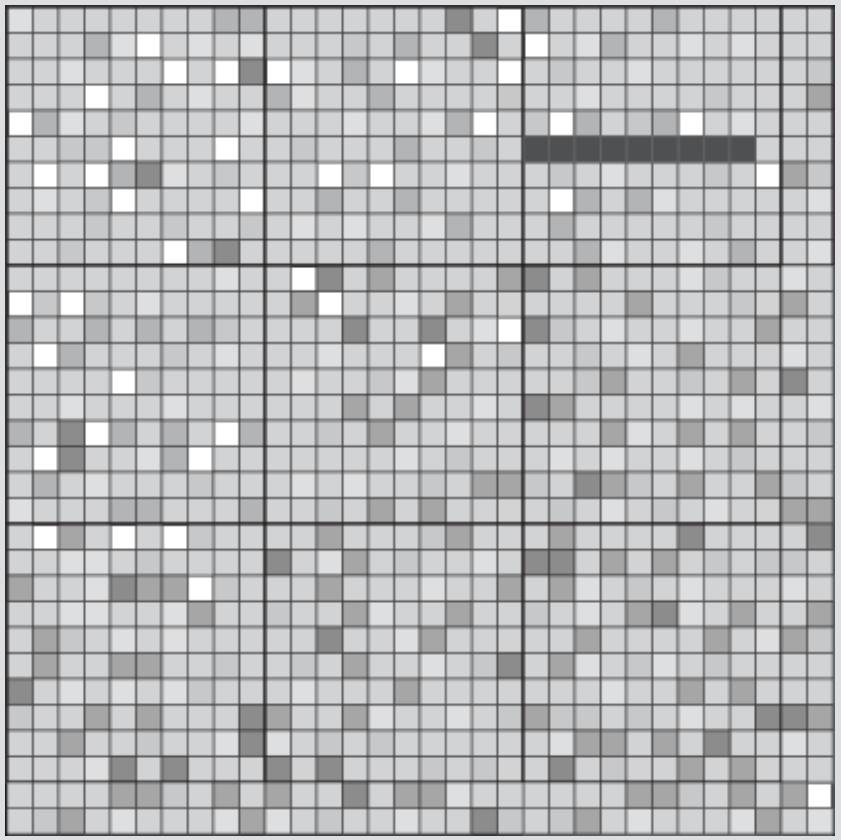
Moral

The "intelligibility" of the non-standard behaviour is always with respect to a given level of description

fMRI of standard brain



fMRI of brain with lesion



Example #2

“Carrying”

Correct behaviour

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

…

⋮

“Carrying”

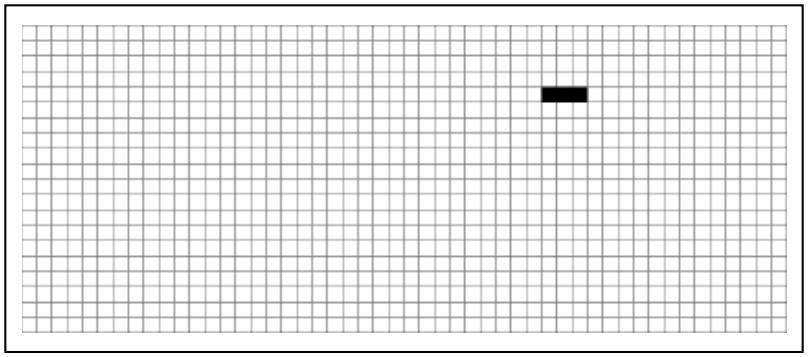
Incorrect behaviour

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	2	3	4	5	6	7	8	9	0	11	12	13	14	15	16	17
2	3	4	5	6	7	8	9	0	1	12	13	14	15	16	17	18
3	4	5	6	7	8	9	0	1	2	13	14	15	16	17	18	19
4	5	6	7	8	9	0	1	2	3	14	15	16	17	18	19	10
5	6	7	8	9	0	1	2	3	4	15	16	17	18	19	10	11
6	7	8	9	0	1	2	3	4	5	16	17	18	19	10	11	12
7	8	9	0	1	2	3	4	5	6	17	18	19	10	11	12	13
8	9	0	1	2	3	4	5	6	7	18	19	10	11	12	13	14
9	0	1	2	3	4	5	6	7	8	19	10	11	12	13	14	15
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
11	12	13	14	15	16	17	18	19	10	21	22	23	24	25	26	27
12	13	14	15	16	17	18	19	10	11	22	23	24	25	26	27	28
13	14	15	16	17	18	19	10	11	12	23	24	25	26	27	28	29
14	15	16	17	18	19	10	11	12	13	24	25	26	27	28	29	20
15	16	17	18	19	10	11	12	13	14	25	26	27	28	29	20	21
16	17	18	19	10	11	12	13	14	15	26	27	28	29	20	21	22

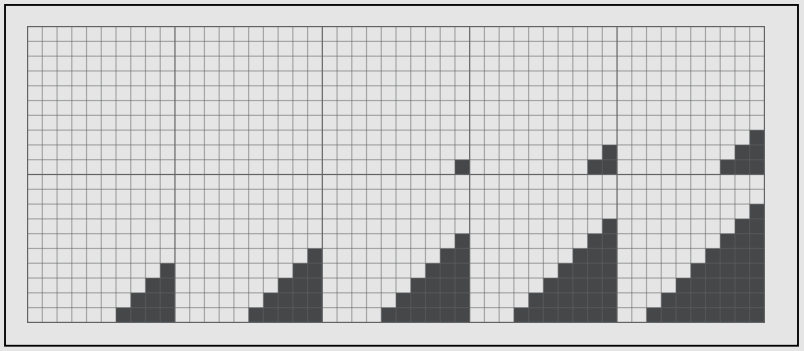
…

⋮

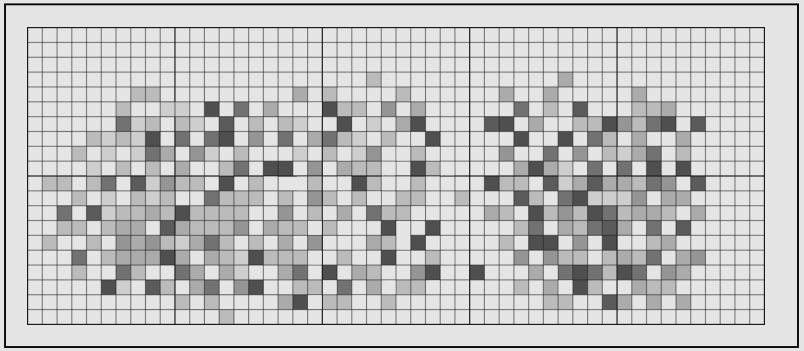
The "carry" problem



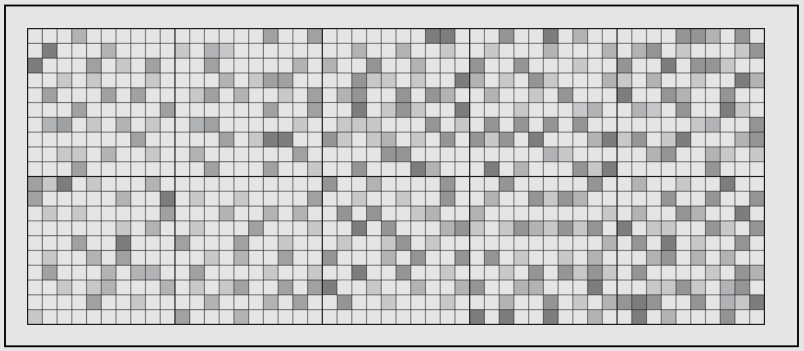
highest level — *rules*



higher level — *tables*



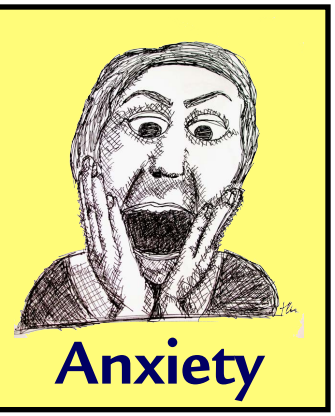
middle level — *bits*



lowest level — *chemistry*

Levels of description (abstraction)

Example #3



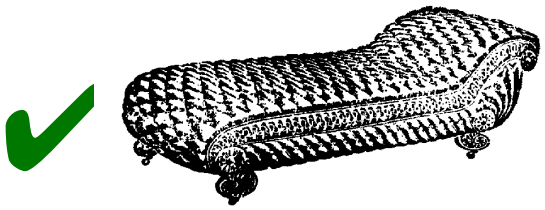
highest — *symbols/ stories*

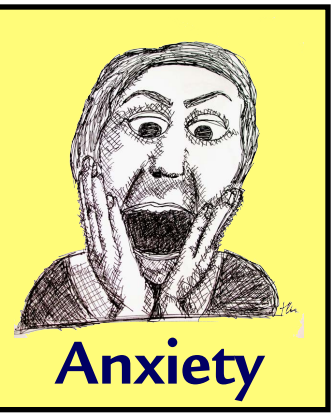
higher — *neural config*

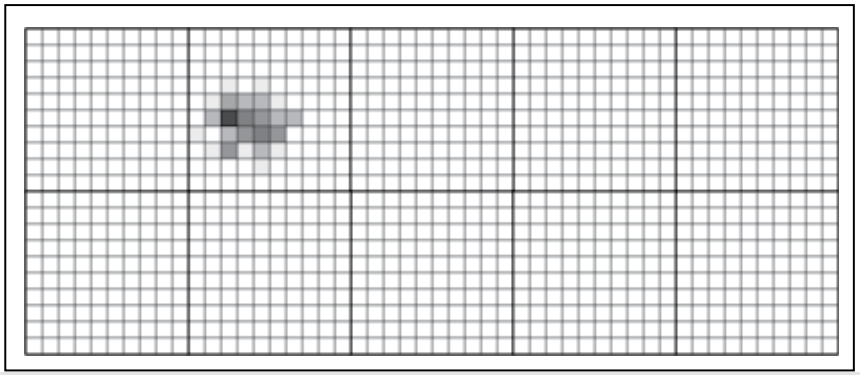
middle — *neuro-chemistry*

lowest — *chemistry*

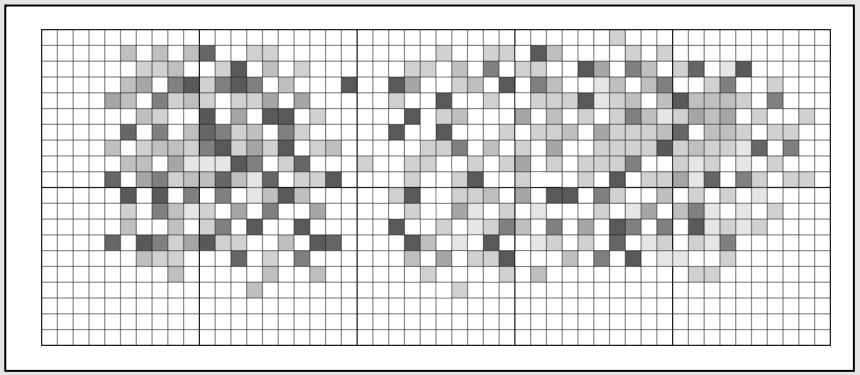
Levels of description (abstraction)



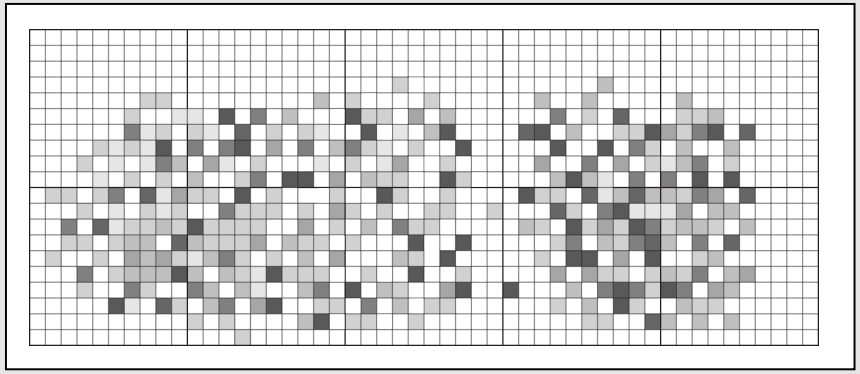




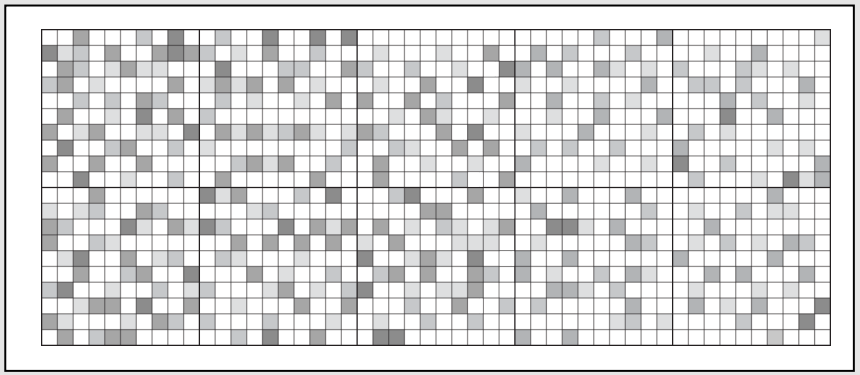
highest — *symbols/ stories*



higher — *neural config*

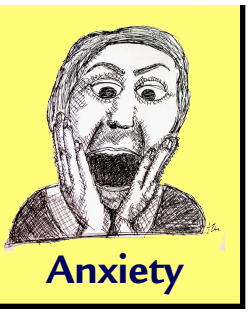


middle — *neuro-chemistry*



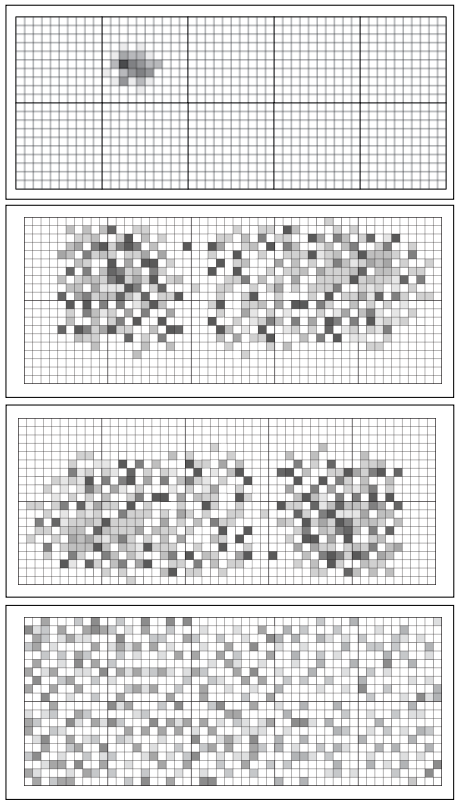
lowest — *chemistry*

Levels of description (abstraction)



Five Practice Questions

1. What about that *other* kind of bottle? At what level do you think its impact on the mind is intelligible?
2. What property of the mind would you expect to be the *least* correlated with the level of analysis that examines *physical arrangements of neuronal activity* (for example, of the sort provided by fMRI)?
3. Do you know at what level (the syndrome we call) schizophrenia was thought to be intelligible in the 19th century? At what level it is *now* thought to be intelligible?
4. Can you think of some important properties of mind (or consciousness) that are not intelligible at *any* level of description of the *brain*?
5. What level of description do you think would be the best one at which to test to see whether someone you've just met is someone that you would like to go out with?



If this has made your brain hurt …

at what level is that pain intelligible?

Thanks for coming on the trip!

A Philosophical Digression on *Reductionism and Supervenient*

Physicalism and reductionism

1. **Physicalism**: roughly the idea that
   a) Ultimately, everything that exists (that is occurrent) *is*, or *is made of*, or *rests on*, or *arises out of*, an underlying physical plenum (the physical world)
   b) There's no metaphysically separate realm (such as Descartes' *res cogitans*)
      i. So: if the physical world went away, *so would everything else*
2. **Reductionism**: roughly the idea that
   a) "Higher-level" things can be *explained* in terms of the underlying physical things they are made of
      i. E.g.: *water* = H_2O
      ii. E.g., *heat* = *mean molecular kinetic energy*
      iii. E.g., *light* = *electro-magnetic radiation 4,000–7,000 angstroms*
   b) Reductionist explanation has been a *huge success* in some parts of science

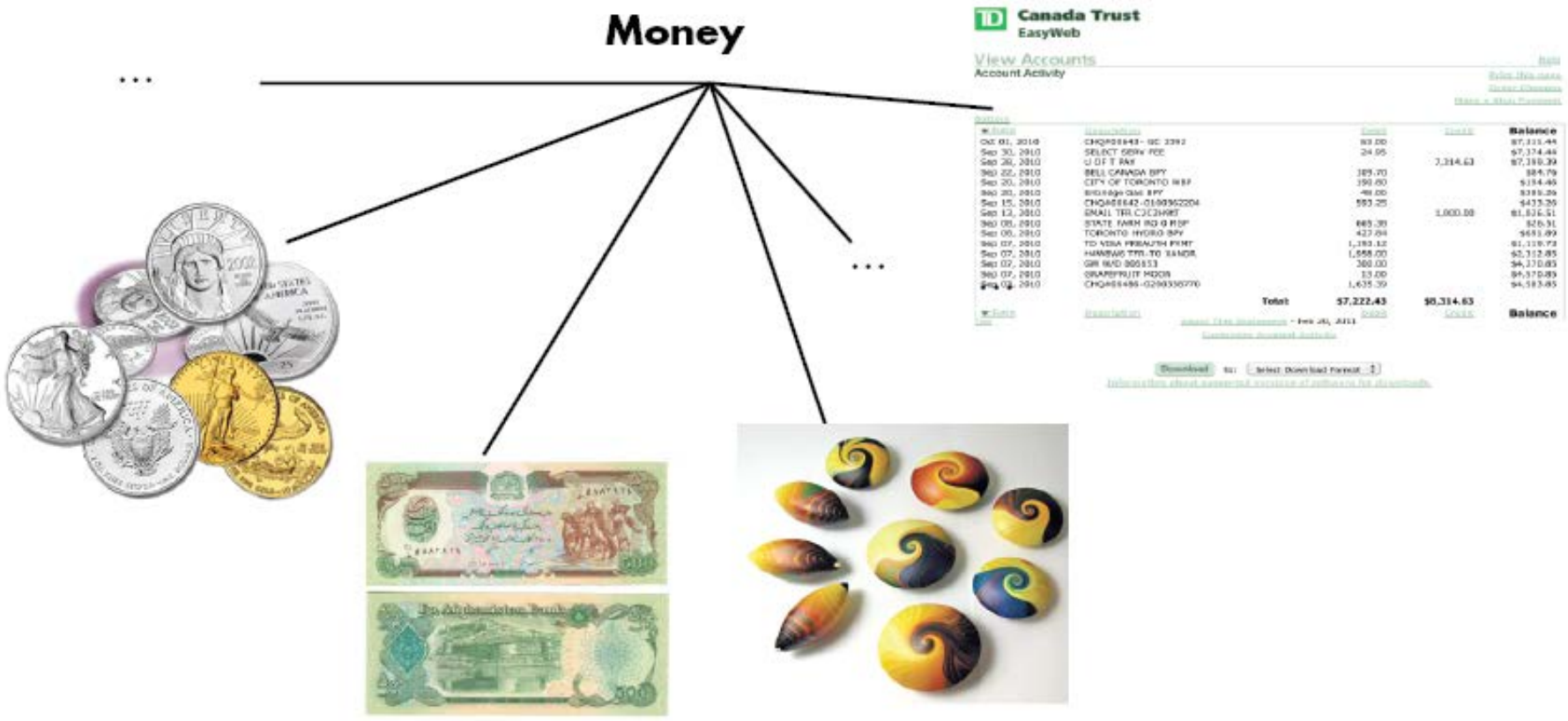
Physicalism and reductionism (cont'd)

3. While not quite right, a good initial way to understand this:
   a) **Physicalism** ⇐ a **metaphysical** thesis about *what the world is like*
   b) **Reductionism** ⇐ an **epistemological** thesis about *how we understand the world*
4. The most important thing to understand:

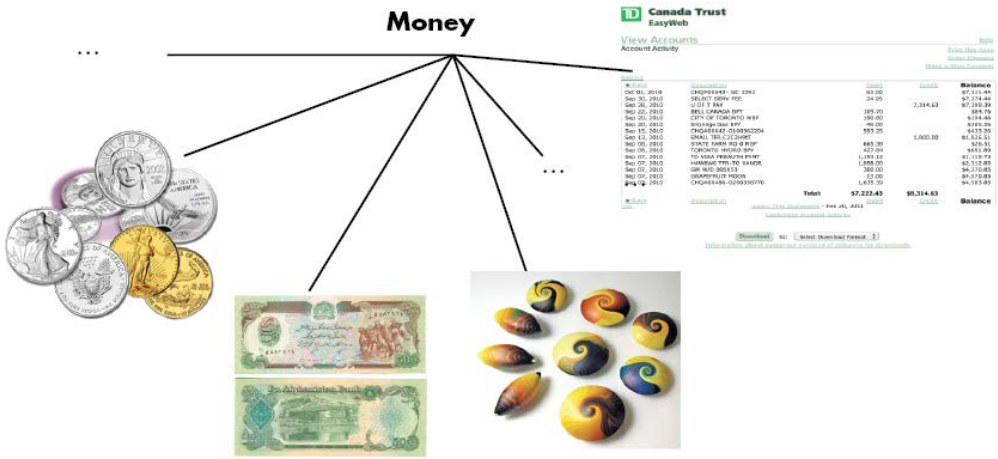
Physicalism *does not imply* **reductionism** ✔

5. So there are two varieties of physicalism:
   a) ***Reductive*** **physicalism**
   b) ***Non-reductive*** **physicalism**

An example of a non-reducible (physicalist?) phenomenon



Non-reductive physicalism and multiple realizability



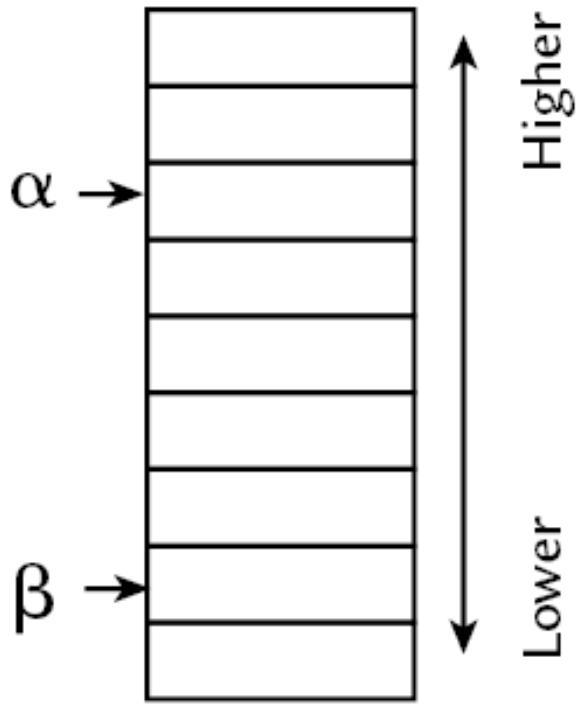
1. Many non-reducible physical things (money, buildings, furniture) can be implemented or realized in myriad different ways (called "**multiple realizability**" in AI and philosophy of mind)
2. To try to state generalizations about systems that are multiply realizable that hold *in virtue of the higher level concept* become **wildly disjunctive** if one tries to state them in physical terms.
3. Cf. "Gresham's law" (that bad money drives out good). How could that possibly be stated in physical terms?

Supervenience

A phenomenon α is said to **supervene** on some lower-level (typically physical) phenomenon or arrangement β just in case

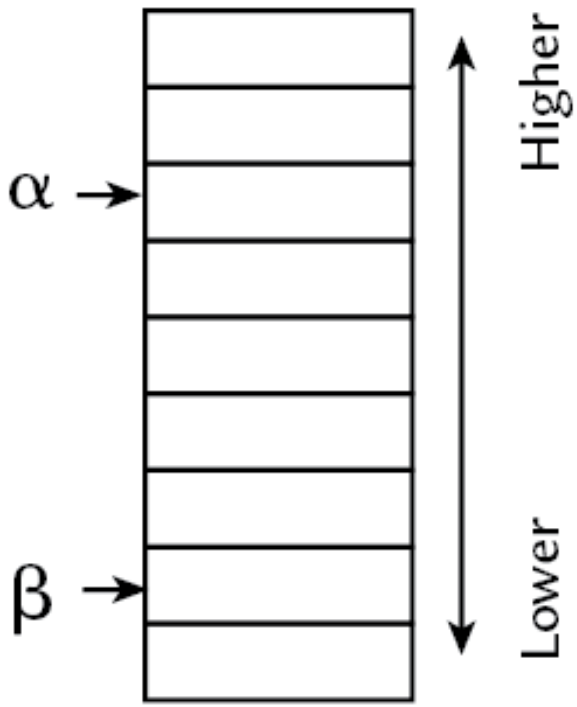
1. You can't change α without making a change in β; or
2. If all the β facts were the same, that would guarantee that the α facts were the same as well.

(These two alternatives are taken to be equivalent.)



Observation

1. If α **reduces** to β, then α *necessarily supervenes* on β
2. However, the words 'supervene' and 'supervenience are normally used only in cases where α does *not* reduce to β
3. That is, 'supervenience' is used as a term for *non-reductive materialism*
4. So if someone says "X supervenes on Y," you should assume (unless there is explicit evidence to the contrary) that what is being said is that "X supervenes on, *but does not reduce to*, Y"



Questions for Cognitive Science

BCS

1. **Reduction**
   a) Will the mind be reducible to ***neuroscience***? ✗
   b) Will the mind be reducible to ***theories of body***? ✗
   c) Will the mind be reducible to ***theories of body*** plus accounts of our ***interaction*** with the world? ✗
2. **Supervenience**
   a) Does the mind supervene on the ***brain***? ✗
   b) Does the mind supervene on the ***body***? ✗
   c) Does the mind supervene on the ***physical world in toto***? ✔!

Crossing Implementation Boundaries

✔ — *yes*
✘ — *not necessarily*
? — *unclear*

		Digitality	*Semantics*	*Algorithmic*	*Universal*	*Real-time*	*Abstract*	*Individuals*	…	*Computation*
Higher (implemented) levels of abstraction	…									
	n + *1*	✘	✘	✘	✘	✘	✔	✘		?
Given level →	*n*	✔	✔	✔	✔	✔	✔	✔		✔
Lower (implementing) levels of abstraction	*n* - *1*	✘	✘	?	✔	✔	✘	✘		✘
	…									