Technology

The Future

Moore's law

Exponential change

The Singularity

Generations of technologies

The bleeding edge

The sweet spot

GRIN technologies

Why do you care about the future of technology?

Because knowing something about the future will help you make better choices today.

For example, what computing technologies should you buy?

Well, there are two questions you should ask:

Does the system meet my needs right now??

How far into the future will the system be useful?

In short,
you need a
TECHNOLOGY STRATEGY.


One piece of the
puzzle is .....

how quickly the technology is changing.

Moore's Law states that since ~1965,

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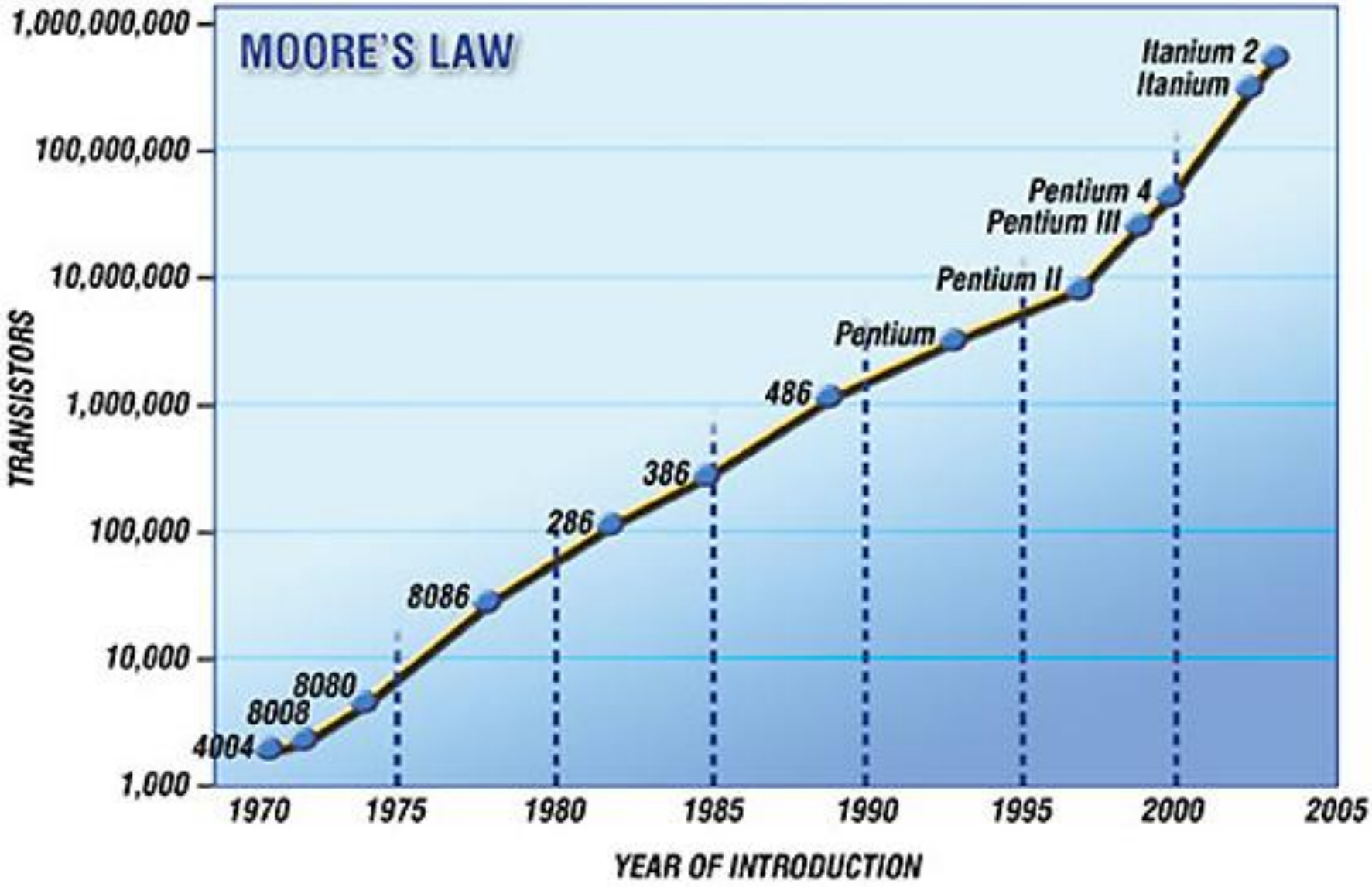
the # of transistors that can be inexpensively placed on an integrated circuit

...is increasing exponentially,

doubling
~ every 2 years.

That means
there is a
NEW
GENERATION
of technology
~ every 2 years.


MOORE'S LAW
TRANSISTORS
1,000,000,000
100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
4004
8008
8080
8086
286
386
486
Pentium
Pentium II
Pentium III
Pentium 4
Itanium
Itanium 2
1970
1975
1980
1985
1990
1995
2000
2005
YEAR OF INTRODUCTION

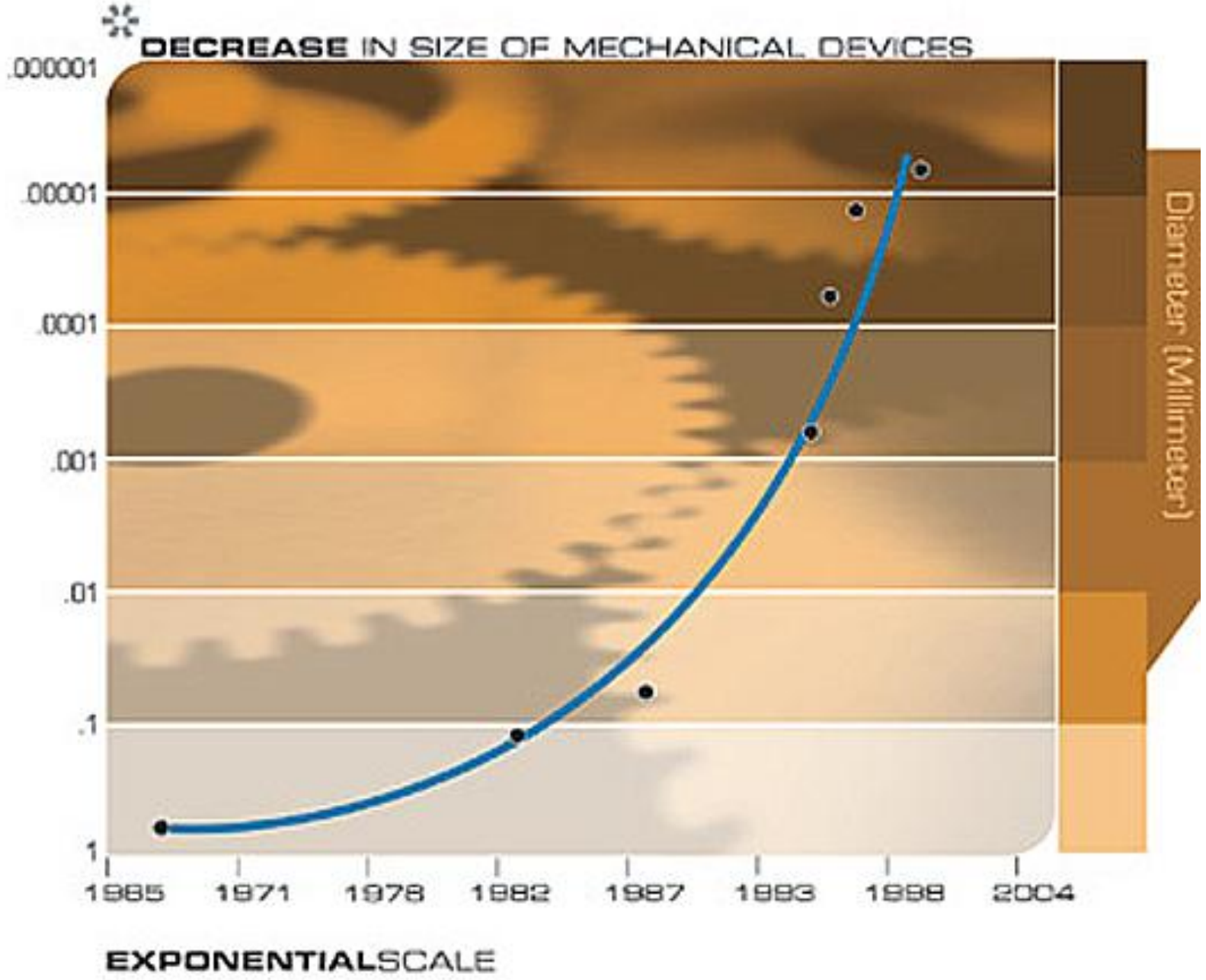
Almost every measure of digital devices is linked to Moore's law:

-processing speed,

-memory capacity,

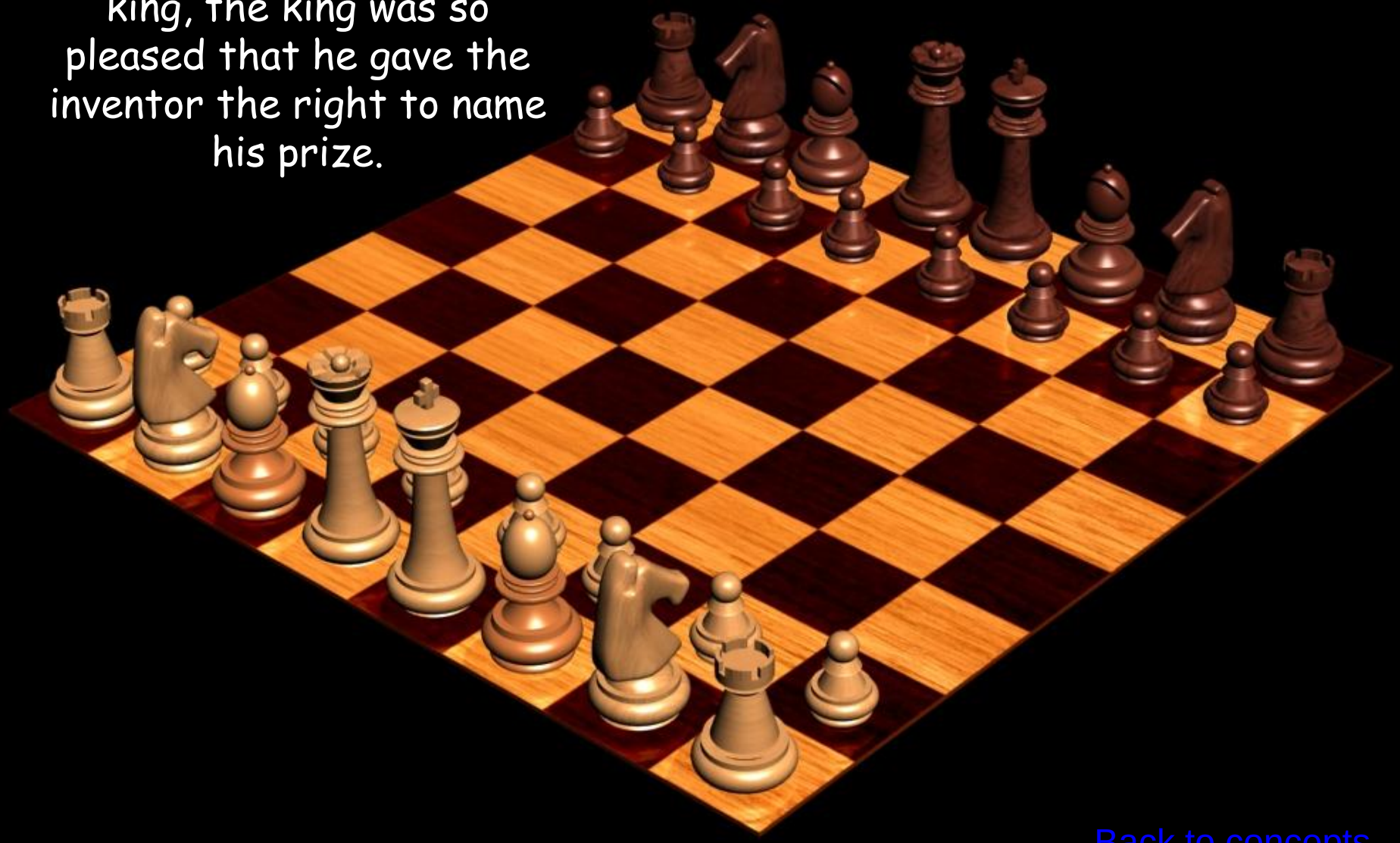
-even the resolution of digital cameras.

All of these are improving at (roughly) **exponential** rates.


DECREASE IN SIZE OF MECHANICAL DEVICES
.000001
.00001
.0001
.001
.01
.1
1
1965
1971
1978
1982
1987
1993
1998
2004
Diameter (Millimeter)
EXPONENTIAL SCALE

The classic story that illustrates exponential change is this…

When the creator of chess showed his invention to the king, the king was so pleased that he gave the inventor the right to name his prize.



Back to concepts

The inventor asked the king for this:

One grain of wheat for the first square of the chess board,

Two for the second square,

Four on the third square…

and so forth, doubling the amount each time.

The ruler quickly accepted the offer, even believing that the inventor was asking a low price.

In fact,

- While the amount of wheat on the **first half** of the chessboard is very large but economically viable for the king,
- The amount on the **second half** is so vastly large, that it would be impossible for any king, or even the entire world, to provide it.

"The Second Half of the Chessboard"

-is a phrase, coined by Ray Kurzweil-

to refer to the point when an exponentially growing factor begins to have a significant economic impact on an organization


The total wheat needed for the chessboard is ~80 times what would be produced in one harvest, at modern yields, if all of Earth's arable land could be devoted to wheat.

Back to Moore's Law…

So, where are we on the chessboard?

~22 generations in, (6 generations from the halfway point).

1966 250	1968 500	1970 1K	1972 2K	1974 4K	1976 8K	1978 16K
1980 32K	1982 64K	1984 128K	1986 256K	1988 512K	1990 1M	1992 2M
1994 4M	1996 8M	1998 16M	2000 32M	2002 64 M	2004 128M	2006 256M
2008 512 M	2010 1B	2012 2B	2014 4B	2016 8B	2018 16B	2020 32B
2022 64B	2024 128B	2026 256B	2028 512B	2030 1T	2032 2T	2034 4T
2036 8T	2038 16T	2040 32T	2042 64T	2044 128T	2046 256T	2048 512T
2050 1Q	2052 2Q	2054 4Q	2056 8Q	2058 16Q	2060 32Q	2062 64Q

Hundreds

Thousands

Millions

Billions

Trillions

Quadrillions

Quintillians

And, what happens when we get past the halfway point?

Ray Kurzweil suggests that past the halfway point

is a theoretical point in the future of unprecedented technological progress, something he calls **the Singularity**

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caused in part by the ability of machines to learn and improve themselves using Artificial Intelligence.


But, that's another topic.

Alright, technology is changing at an incredible rate

and the implications of that may be like some science fiction story.

But, what are the short term practical implications?

Don't buy something and leave it on the shelf for 2 years.

Replace systems **that need to be top performers** ~ every 2 years. (You can use older systems for more mundane tasks).

Because everything is moving so fast, first generation technologies are untested, immature, expensive and buggy.

In fact, the "leading edge" is often called the "bleeding edge".

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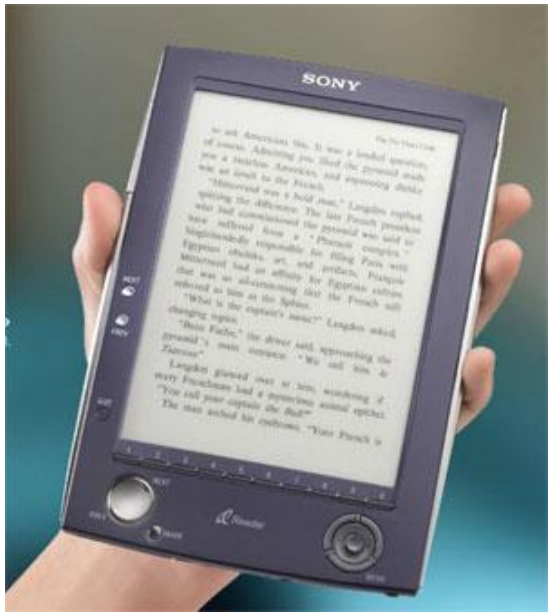
This means that 2nd generation products are a better choice -- the prices have come down, and they have become mature (tested and stable).

2006


SONY

2010


Plastic Logic Series C reaches $24 million with investment by BASF, Intel, Morningside and Quest for Growth

20??


LG.PHILIPS LCD

You want to find the "Sweet Spot"

Find the price point where you get the best bang for your buck.

There will be less bleeding

It will cost less money

Back to concepts

And plan to take advantage of new technologies as they **mature**, not as they arise.

What can we predict about the future of the technologies we care about for neuroimaging?

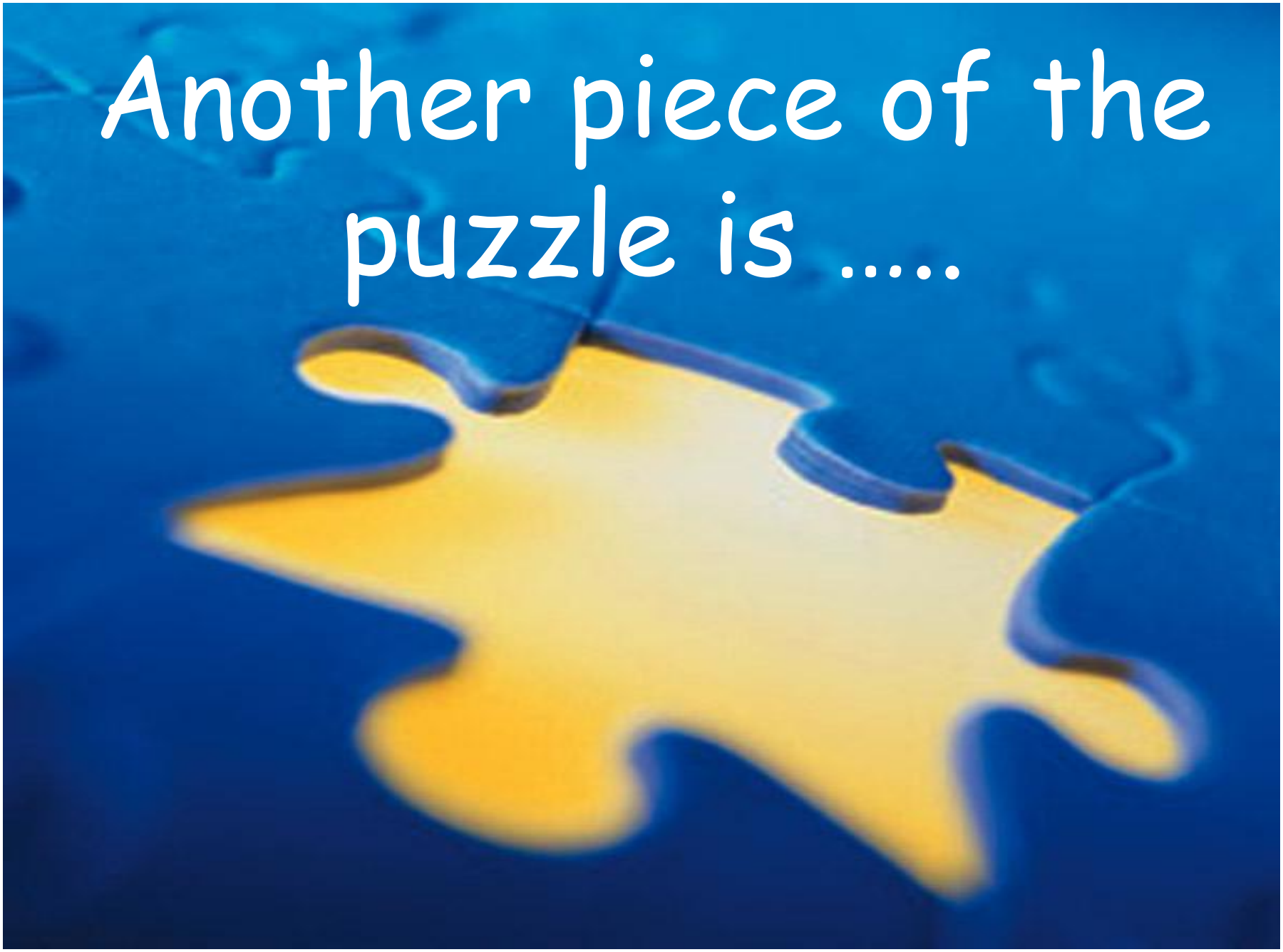
MRI scanners will get cheaper and have better resolution.

Imaging technologies will be **combined** to provide multifaceted data.

The higher resolution multifaceted images will require more **storage**.

Manipulating these big images will require more **processing power**,

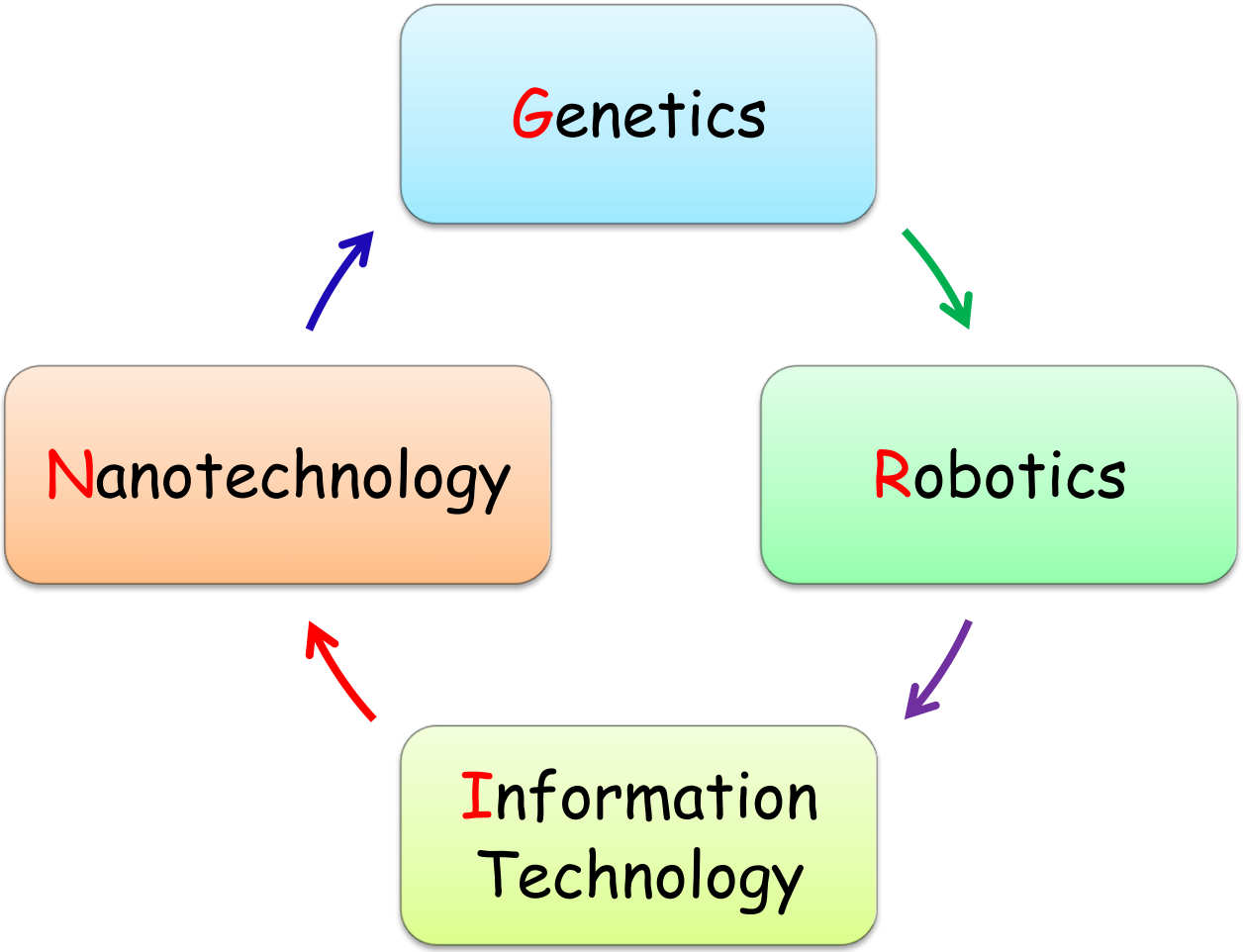
and new computers will be available to handle the new demands.


Another piece of the puzzle is .....

What kinds of new questions will you ask as a result of technological change?

Watch the GRIN technologies…

GRIN Technologies



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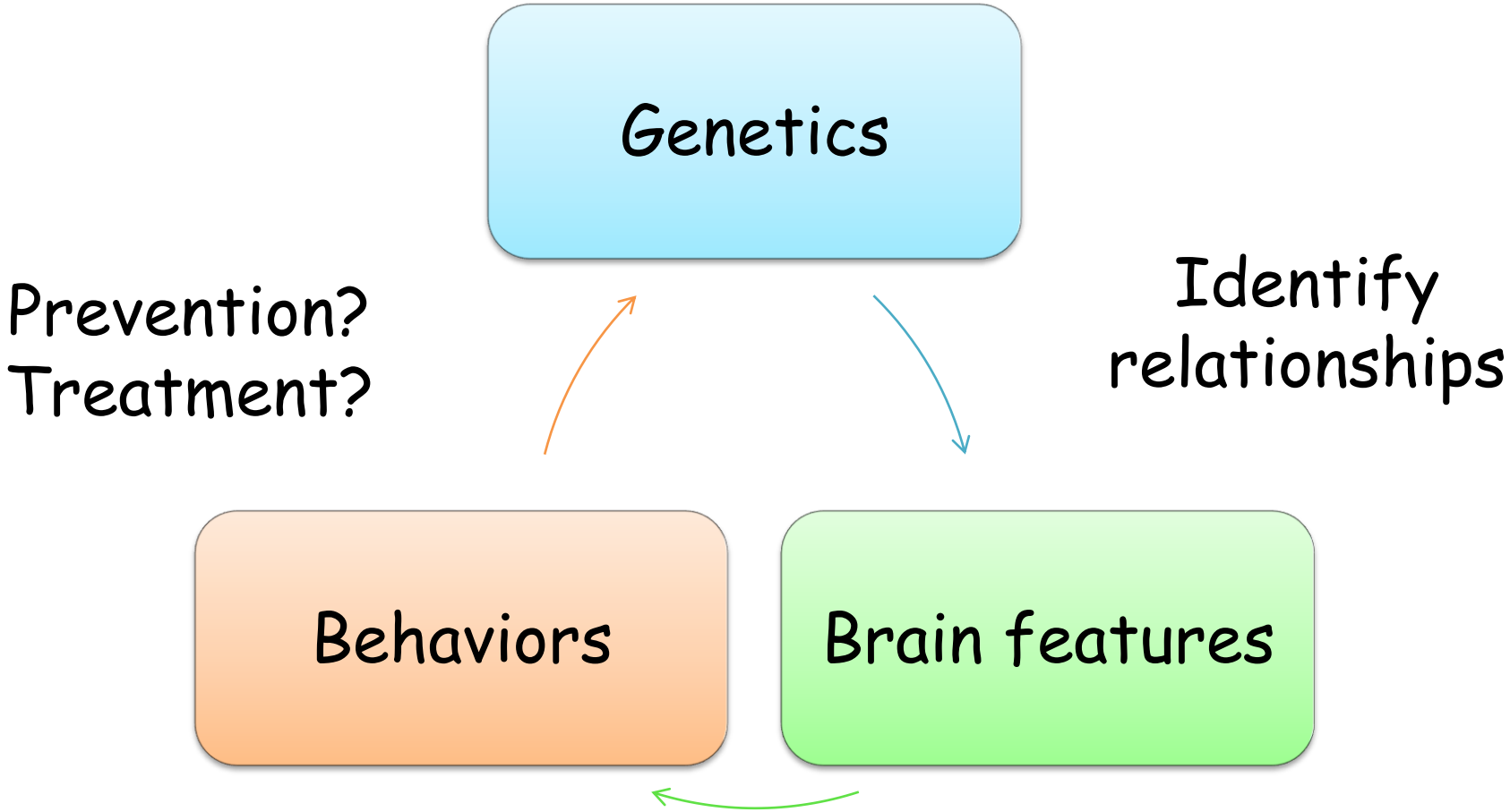
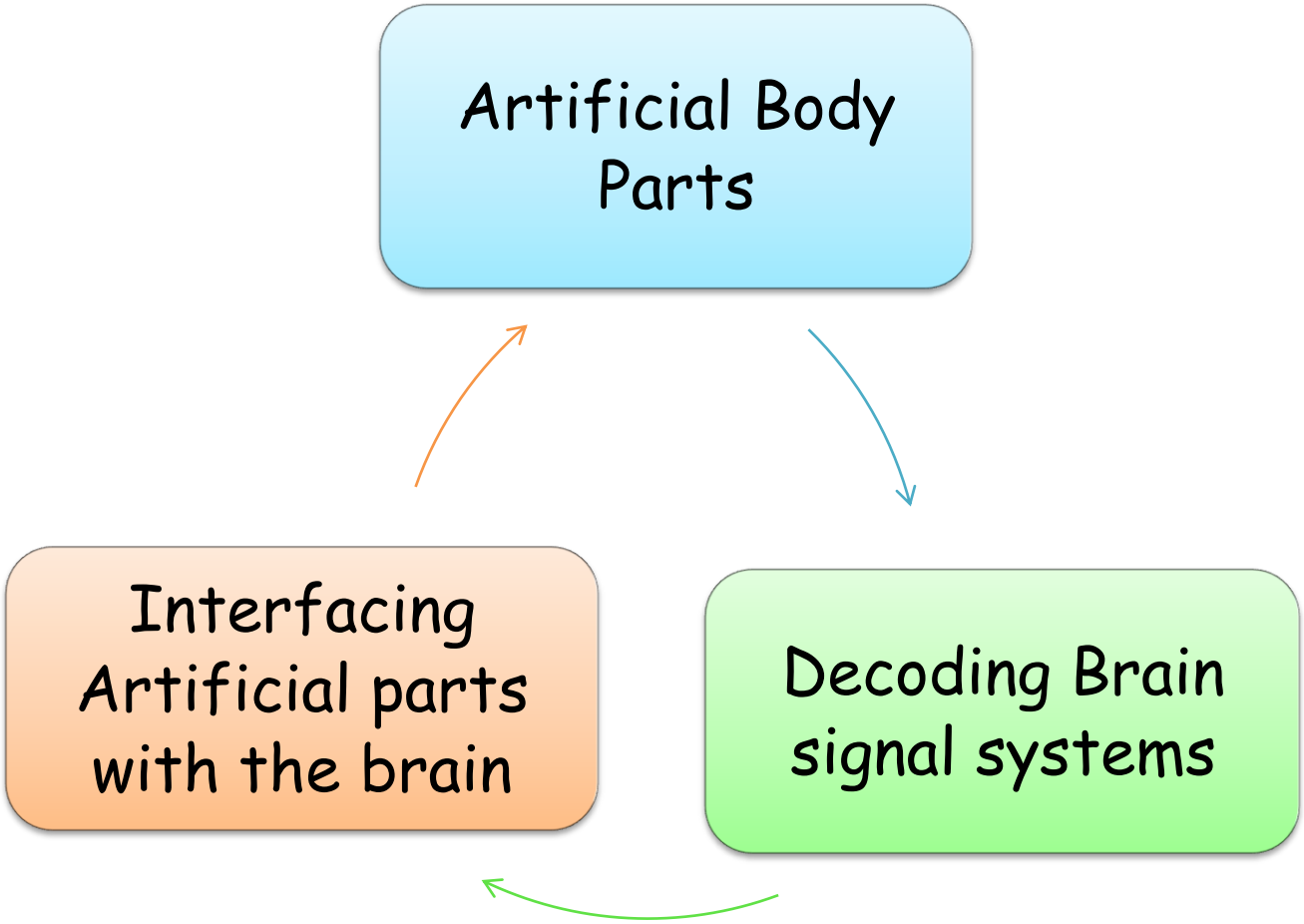
Genetics
will generate new questions about the relationship between genes, brains, and behavior.

Genetics


Genetics
Identify relationships
Brain features
Behaviors
Prevention?
Treatment?

Robotics will generate questions as we develop brain-computer interfaces.

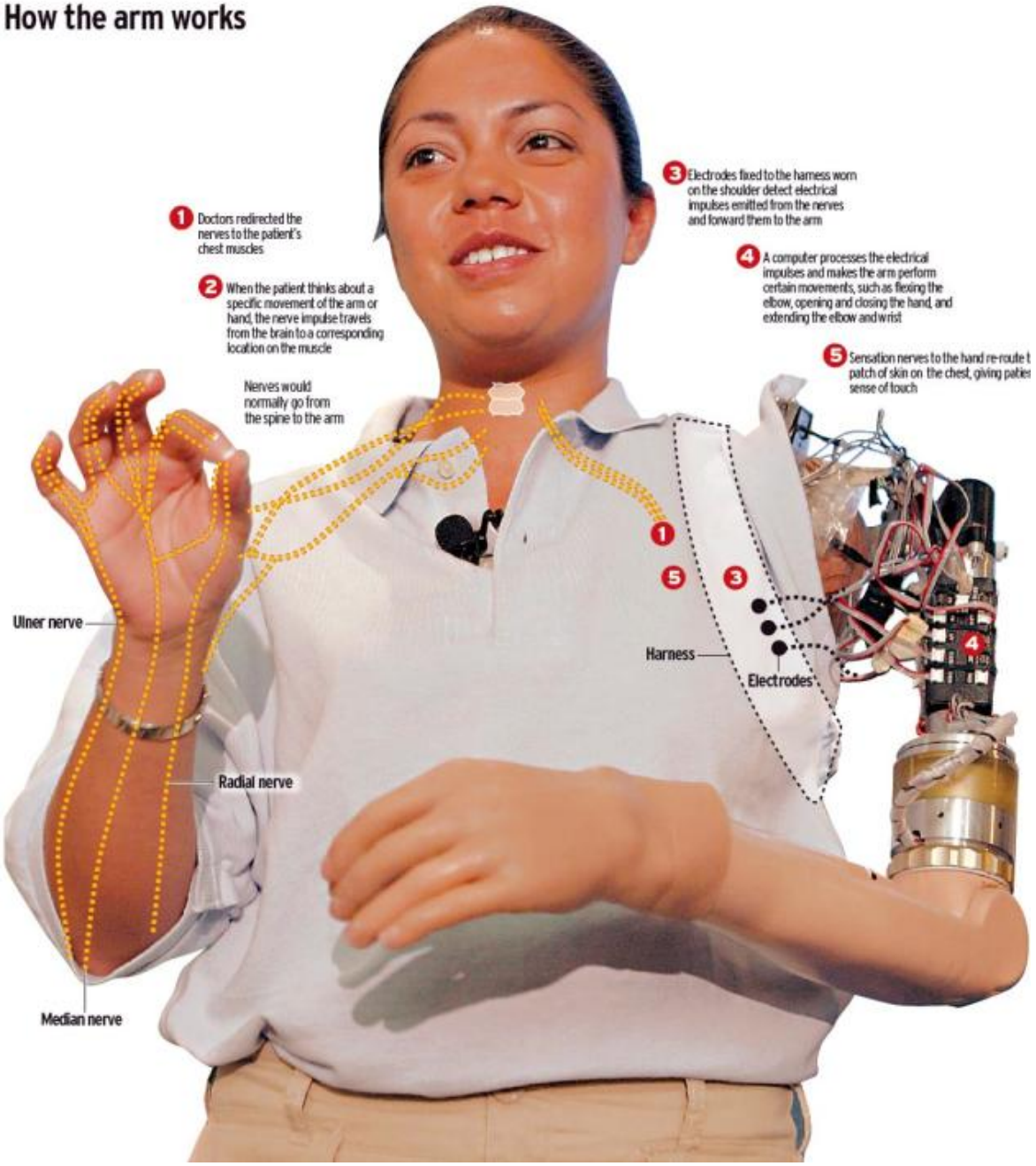
Robotics



Send signals to and from artificial parts

HAL: Hybrid Assistive Limb

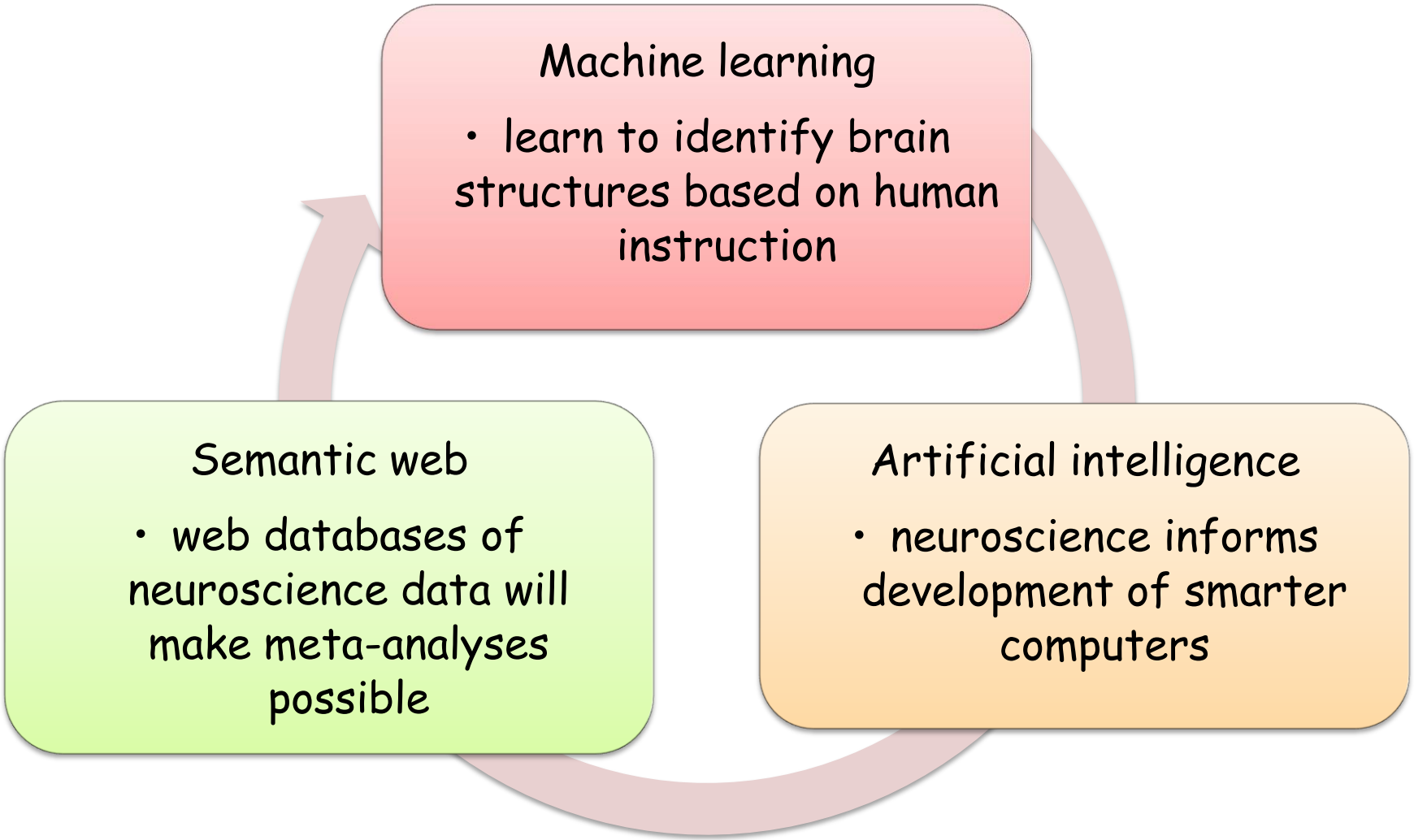
How the arm works



Bionic Eye

Bionic Legs

Information Technology



Nanotechnology will result in..

Advanced molecular imaging,

Hybrid molecules used in neural regeneration and neuro-protection,

Nanomaterials that advance brain-computer interface technologies….

Summary

Technology is changing very rapidly.

Understanding the patterns and direction of change will help you

make smart decisions about spending your money……

For example, about every 2 years the capabilities of a digital technology doubles for the same price.

When a technology first emerges, it is usually buggy and expensive. That is the bleeding edge (where you don't want to be).

You can expect a more mature (dependable) version of the technolgy to appear in ~ 2 years, often at a better price.

In addition, we can make predictions about future research.

Images will be higher resolution and datasets will be more complex.

Datasets will be shared and stored in central repositories, requiring more standardization and making metastudies possible.

So, you'll need more powerful machines, excellent network connectivity and more storage to take advantage of the changes.

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