

# Sistemas Complejos

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<http://turing.iimas.unam.mx/~cgg/teach/Pamplona>





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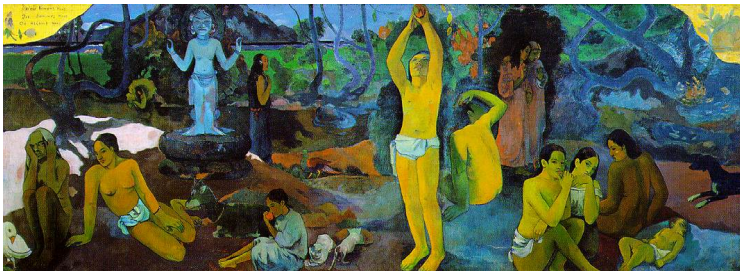
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- ¿De dónde venimos?
- ¿Qué somos?
- ¿A dónde vamos?





# Temario (I)

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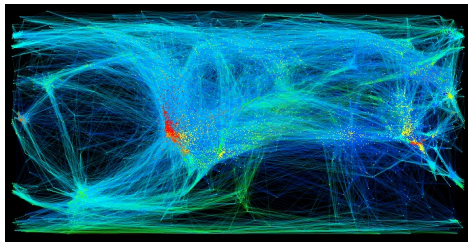
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- La Complejidad como Paradigma Científico
- Caos
- Cibernética
- Adaptación
- Auto-organización
- Sincronización



<http://www.stanford.edu/~dgleich/demos/worldofmusic/interact.html>



# Temario (II)

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- Aplicaciones
  - Semáforos
  - Transporte público
  - Burocracias
  - Multitudes
  - Hardware
- Redes complejas
  - Redes Booleanas aleatorias
  - Robustez
  - Modularidad
  - Degeneración
- Conclusiones y Oportunidades



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Página del curso

<http://turing.iimas.unam.mx/~cgg/teach/Pamplona>

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# Reduccionism

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- Science has been mainly reductionist since Galileo, Newton, Descartes, and Laplace.
- Separate and simplify to predict.
- Highly effective method.
- What are the limits of reductionism?
- And how does this affect philosophy?



# Complexity

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Conclusions

- From the Latin *plexus*: interwoven (*tantra* in sanskrit).
- Elements are difficult to separate.
- *Interactions* are relevant.
- Reductionism inadequate.
- Novel information—not present in initial nor boundary conditions—is generated by interactions.
- Predictability is limited.
- Complexity is everywhere...







# Epistemology or Ontology?

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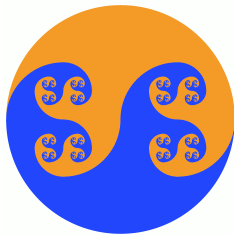
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Conclusions

- Complexity is more epistemological than ontological.
- Even ontology is epistemological.
- Interactions are as (un)real as matter and energy.
- Information as alternative epistemology (Gershenson, 2007).





# Non-reductionism

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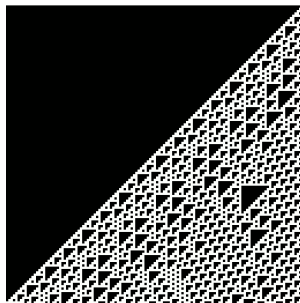
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Conclusions

- *Reduccionism*: Whole can be described completely by description of the parts  $\Rightarrow$  go to the lowest level (which is?) to describe everything.
- Novel information produced by interactions.
- Emergence.
- Computational irreducibility (Wolfram, 2002).
- Alternative: *Holism*.





# Non-materialism

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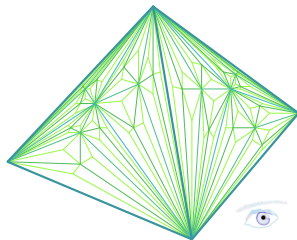
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Conclusions

- *Materialism*: Only matter and energy are real, all the rest are epiphenomena.
- Leads to dualism: how can we describe meaning in terms of matter?
- Interactions are as (un)real as matter and energy.
- e.g. is money real? isn't it a causal agent?
- Alternative: *informism* (Gershenson, Proc. ICCS 2007).





# Non-predictability

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Conclusions

- Classic scientific assumption: the world is predictable.
- Interactions generate novel information, not present on initial/boundary conditions.
- Again, computational irreducibility.
- Alternative: *adaptation*.
- Prediction still desired, but better to accept its limits and be prepared.





# Non-Platonism

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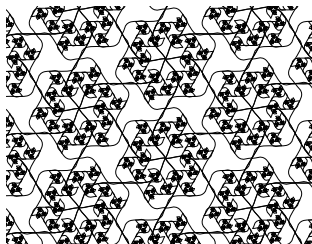
- *Platonism*: There is a single *true* description of the world.
- Wittgenstein: all descriptions are made in a language.
- Postmodernism: Anything goes?
- Silly theorem problem.
- Alternative: *contextuality*.
- Pragmatic, allows different descriptions to coexist.





# Non-nihilism

- If all explained by a GUT, what is the space for life, meaning, free will, art, humanity, etc.?  $\Rightarrow$  *nihilism*.
- But novel information and meaning in interactions.
- Space for amazement, since no story is predefined.
- Potentially infinite meanings to human life, process of discovering them already meaningful.
- Alternative: *meaningfulness*.



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# Conclusions

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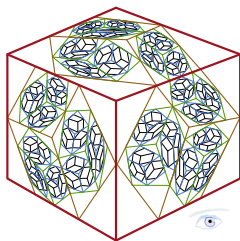
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- Reductionism isolates phenomena for convenience.
- But no phenomenon is isolated... everything is related.
- Neglecting interactions does not remove them.
- A broader understanding will lead to less conflicts.
- Separation between subject, object, and action is artificial.
- Time to change our worldview.





# Complexity Digest

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