Congreso RSME / Santiago de Compostela

21-25 enero de 2013

***Matemáticas y Universidad, retos en tiempos de crisis***

# *Expectativas y Experiencias*

SEBASTIAN XAMBÓ DESCAMPS

UNIVERSITAT POLITÈCNICA DE CATALUNYA

***Poética de Imaginary: Metáfora y Analogía en la (re)creación matemática*** (Albacete, 11 de mayo de 2012)

En la exposición RSME-Imaginary, el visitante se puede aproximar a formas matemáticas desde ángulos más propios de las artes (***belleza***) que de las ciencias (***verdad***).

Inversamente, puede crear formas y estructuras de innegable belleza, y **experimentar** con ellas, mediante las ***pantallas interactivas***.

El objeto de esta charla será reflexionar sobre los ***gozos*** que estas fructíferas circunstancias pueden aportar al visitante y también sobre su posible ***papel en la formación***.

## ¿Universidad y Matemáticas: retos en tiempos de crisis?

**Reinhold Niebuhrs (1892-1971), *Serenity Prayer*:**

*God grant me the serenity*
*to accept the things I cannot change;*
*courage to change the things I can;*
*and wisdom to know the difference.*

*Man's capacity for justice makes democracy possible; but man's inclination to injustice makes democracy necessary.*

**Docencia**: Master in Information Tecnologies

- *Information and coding theory* (web>Online>ICT)
- *Data and image compression* (Deaubechies) (>DIC)

**Investigación**

PFC Narcís Sayols

- *Pattern modeling and pattern processing in image and speech signals* (Mumford)

ICAIB

Inteligencia computacional para el análisis de la imagen biomédica (Zadeh)

**Charles R. Hadlock** (editor)

*Mathematics in **service** to the community. Concepts and models for service-learning in the mathematical sciences.* Notes #66, MAA, 2005.

**John Dewey** (1859-1952), *Experience and Education* (1938) Traducción por Lorenzo Luzuriaga [1939], con estudio introductorio de Javier Sáenz Obregón (Biblioteca Nueva, 2004).

*Education is not preparation for life; education is life itself.*

*Every great advance in science has issued from a new audacity of imagination.*

*(The belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative).*

Experiencia = Totalidad de las relaciones con el ambiente, o Un momento dentro de la "continuidad" de la vida, entre el presente y el futuro.

**J. Boswell** (1740-1795), *Life of Johnson* (1791, p. 238):

I know not anything *more pleasant*, or more instructive, than to compare experience with expectation, or to register from time to time the difference between idea and reality. It is by this kind of observation that we grow daily less liable to be disappointed. [⋯] Let me know what you expected, and what you have found. [⋯] It is rule never to be forgotten, that whatever strikes strongly, should be described while the first impression remains fresh upon the mind.

# DIC / Fall 2012 / Tentative schedule

| September | | | | | | |
|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S |
| - | - | - | - | - | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| October | | | | | | |
|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | - | - | - | - |

| November | | | | | | |
|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S |
| - | - | - | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | - | - |

| December | | | | | | |
|---|---|---|---|---|---|---|
| M | T | W | T | F | S | S |
| - | - | - | - | - | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | - | - | - | - | - | - |

**Approximate distribution of topics:**

Information theory and lossless compression (September)

Information and entropy. Huffman's algorithm and arithmetic coding. Dictionary and context-based techniques. Lossless image compression.

Lossy coding: general principles (up to Oct 24)

Basic ideas on lossy coding. Scalar quantization. Vector quantization. Differential/predictive methods. Transform coding. Filters and subband coding. Wavelet-base compression. Audio coding.

Image and video compression standards (up to Nov 28)

JPEG2000: bit assignment and entropy coding. Wavelets and wavelet transform (WT). Discrete wavelet transform (DWT). Multiresolution analysis. Lifting method for the DWT. The EZW algorithm. The JPEG2000 standard. Video compression.

Roundup and special topics (up to Dec 17)

Analysis/Synthesis schemes. Compressed sensing.

**70 h:** 14 MON = 28 h, 14 WED = 42 h

**Sep:** 10a, 10b, 12a, 12b, 12c, 17a, 17b, 19a, 19b, 19c, 26a, 26b, 26c;

**Oct:** 1a, 1b, 3a, 3b, 3c, 8a, 8b, 10a, 10b, 10c, 15a, 15b, 17a, 17b, 17c, 22a, 22b, 24a, 24b, 24c, 29a, 29b, 31a, 31b, 31c

**Nov:** 5a, 5b, 7a, 7b, 7c, 12a, 12b, 14a, 14b, 14c, 19a, 19b, 21a, 21b, 21c, 26a, 26b, 28a, 28b, 28c

**Dec:** 3a, 3b, 10a, 10b, 12a, 12b, 12c, 17a, 17b, 19a, 19b, 19c

Organizational and introductory matters

T=Theory, L=Laboratory, P=Problems,

W=Project Paper (Oct 31c: first discussion of topics; Nov 28c: second discussion of topics; Dec 19a,b,c: presentation of outline and discussion)

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**JPEG2000**: bit assignment and entropy coding. **Wavelets** and wavelet transform (WT). Discrete wavelet transform (DWT). Multiresolution analysis. Lifting method for the DWT. The EZW algorithm. The JPEG2000 standard. **Video compression**.

Roundup and special topics (up to Dec 17)

Analysis/Synthesis schemes. **Compressed sensing**.

72 sessiones

2 presentación general

T 25 teoría

L 25 laboratorio

P 12 problemas

W 2 preparación proyectos + 3 exposición proyecto

3 examen final (T+P+L)

Lectura trabajos y evaluación final

# DIC12 / L

## 11-07a

The goal of this lab is to master the computational aspects of the orthogonal projection.

**0.** Note that the orthogonal projection of $x$ to $\langle v\rangle$ is given by $\frac{x\cdot v}{v\cdot v}\,v$.

**1.** Design and implement a function

proj(x:Vector, A:Matrix)

that returns the orthogonal projection of $x$ to the linear space generated by the rows of $A$. Overload it to proj(x:Vector, a:Vector) defined as proj(x,[a]). Test it with examples.

***Resources.*** The function prune(A:Matrix) extracts $r$ linearly independent rows of $A$, where $r$ is the rank of $A$. So, with A=prune(A) we can assume that the rows of $A$ are linearly independent.

***Goal.*** Send a file with prefix 11-07a showing you understand the function and its meaning.

## 11-07c

**0.** The Haar transform of a vector $[a,b]$ is

$$\frac{1}{\sqrt{2}}(a+b,a-b)=[a,b]H, \text{ with}$$

$H=\frac{1}{\sqrt{2}}\begin{bmatrix}1 & 1\\ 1 & -1\end{bmatrix}$. If we write the vector as a column, $\frac{1}{\sqrt{2}}\begin{bmatrix}a+b\\ a-b\end{bmatrix}=H\begin{bmatrix}a\\ b\end{bmatrix}$. Thus, if we have a matrix $A=\begin{bmatrix}a & b\\ c & d\end{bmatrix}$, then $HAH$ is the result of doing a Haar transform to the rows and then to the columns, or the other way around. What is the actual expression of $AH$ ?

**1.** Write function haar_matrix(n:Pos) that constructs the matrix of the Haar transform for vectors of length $n$ (assumed to be even) and a function haar1(A:Matrix) that gives the Haar transform of an $n\times n$ matrix by rows and columns.

***Goal.*** Send a file with prefix 11-07c showing you understand the function and its meaning.

# Example

1. Design and implement a function

proj(x:Vector, A:Matrix)

that returns the orthogonal projection of x to the linear space generated by the rows of A. Overload it to proj(x:Vector, a:Vector) defined as proj(x,[a]). Test it with examples.

Resources. The function prune(A:Matrix) extracts r linearly independent rows of A, where r is the rank of A. So, with A=prune(A) we can assume that the rows of A are linearly independent.

Goal. Send a file with prefix 11-07a showing you understand the function and its meaning.

```
proj(x:Vector,A:Matrix) ≔ solve(A*Aᵀ,x*Aᵀ)*A ;
proj(x:Vector,a:Vector)≔ proj(x,[a]) ;
```

# DIC12 W

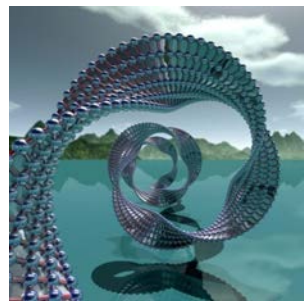
## *Project Presentation's Program*

| | | |
|---|---|---|
| 17:00-17:30 | Quer, Jannes<br>Allayen, Sofiane | *JPEG-2000* |
| 17:30-17:45 | Dias, André | *High precision probability coding* |
| 17:45-18:15 | Creemers, Daan<br>Denisen, Niels | *Audio algorithms and implementations* |

| | | |
|---|---|---|
| 18:15-18:45 | Clotet, Roger<br>Sebio, Santiago | *Compressing genomic data* |
| 18:45-19:00 | Carraca, Ana | *Genetic algorithms* |

| | | |
|---|---|---|
| 19:00-19:30 | Esteve, Aitor | *Compression with Daubechies wavelets* |
| 19:30-19:45 | Carol, Alex<br>Giralt, Adrià | *Compressed sensing* |

Matemáticas



Programas

Algoritmos

## Conclusiones

- Asistencia muy buena a todas las sesiones.
- El método de los laboratorios se ha mostrado eficaz para fomentar la comprensión de los conceptos (a veces con actividades de repaso y consolidación), la colaboración en clase y la comunicación alumnado-profesor.
- Los trabajos de fin de curso, con sus tres fases (preparación general, exposición de los proyectos, redacción de un trabajo escrito) contribuyen de manera significativa a la formación como futuros ingenieros.
- Aumento de la confianza en las matemáticas como base para la modelización (algoritmos y programas).
- El esfuerzo ha valido la pena. Sinergias con investigación.


¡Muchas gracias!