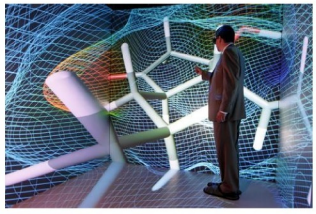
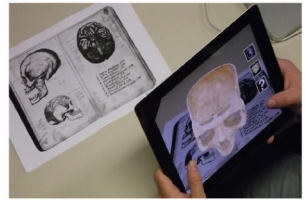
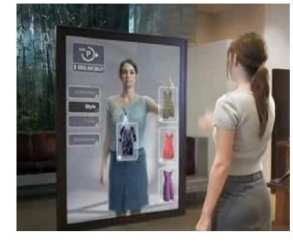




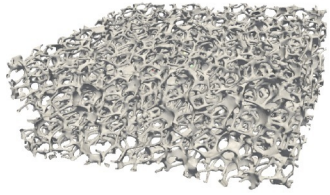
Image, Modélisation et Informatique

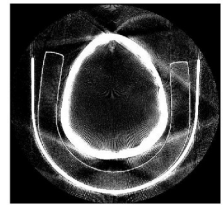
Image, Modeling & Computing

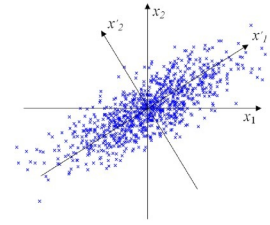


$$\frac{1}{\sqrt{2\pi}} \int_{\mathbf{x}\in\mathbf{R}^2} f(\mathbf{x}) e^{-i\omega\mathbf{x}\cdot\Theta} d\mathbf{x}$$

```
for(std::list<int>::iterator it=valid_index->begin();it!=valid_index->end();++it)
{
    int k=*it;
    if(k!=k0 && k!=k1 && k!=k2)
    {
        const v2& x=v_vertices[k];

        if( (x-x0).det(u0)<0 && (x-x1).det(u1)<0 && (x-x2).det(u2)<0 )
        {
            std::list<int>::iterator it_temp=it;++it;
            valid_index->erase(it_temp);
        }
```







LYON CPE

Image, Modélisation et Informatique

Analyse d'images

Analyse d'images

Tracking

Modélisation

Détection de contours
Contours déformables
Morphologie mathématique
Descripteurs d'images
Optimisation

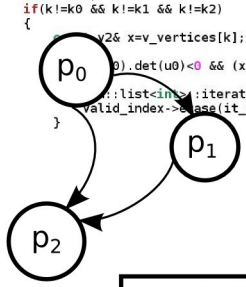
$$E(\gamma) = \oint \lambda_1 \|\gamma'\|^2 + \lambda_2 \|\gamma''\|^2 - \lambda_3 \|\nabla I(\gamma)\|^2$$

$$A \ominus B = \{z \in E | B_z \subset A\}$$

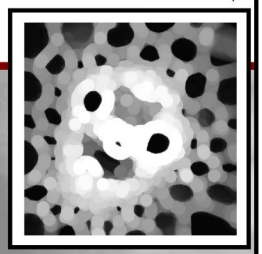
Informatique

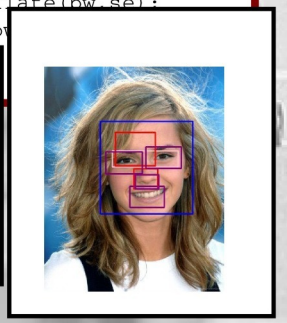
Dijskstra
Graphes
Algorithmique
Structures
de données

```
for(std::list<int>::iterator it=valid_index->begin();it!=valid_index->end();++it)
{
    int k=*it;
    if(k!=k0 && k!=k1 && k!=k2)
    {
        v2& x=v_vertices[k];
        0).det(u0)<0 && (x-x1).det(u1)<0 && (x-x2).det(u2)<0 )
        ::list<int>::iterator it_temp=it;++it;
        valid_index->erase(it_temp);
    }
```




```
bw=imread('pic.png')
se=strel('line',11,90);
bw2=imdilate(bw,se);
imshow(bw
```

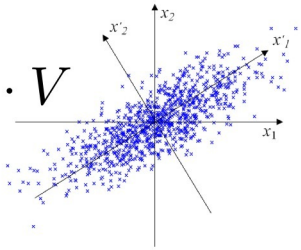




Suivi de mouvement

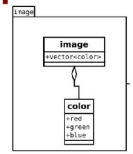
Modélisation

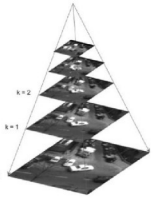
$$\frac{\partial I}{\partial t} = -\nabla I \cdot V$$



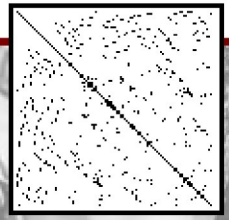
Flux optique
Apprentissage
Encodage vidéo (ondelette, signal)

Informatique





Multi-echelle
HTML5
Librairies compressions



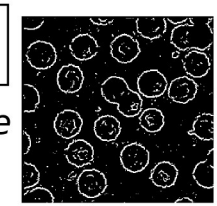
Analyse d'images

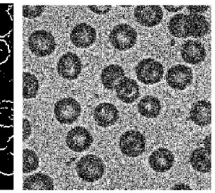
Modules

S8: **Traitement d'images** | **Analyse d'images** | **Optimisation**

S9: **Compression & Apprentissage** | **Acquisition au calibrage**

télésurveillance





bio-imagerie

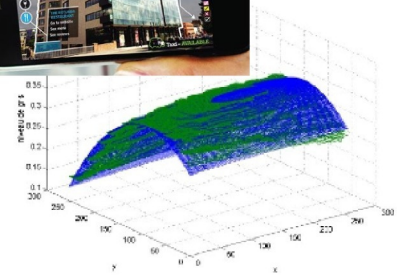
Entreprises

Aliance Vision
Multitel
IRIS
Observatoire astro
Motion Analysis Corp
Signoptic
IFP
NEC
ONERA
Cliris
Univ. Kagoshima
HTTV
Emotion3D
...

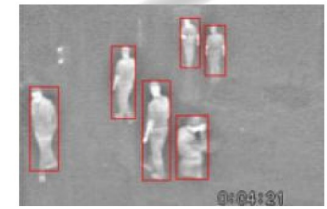
Imagerie astronomique

Imagerie satellite

réalité augmentée



tracking

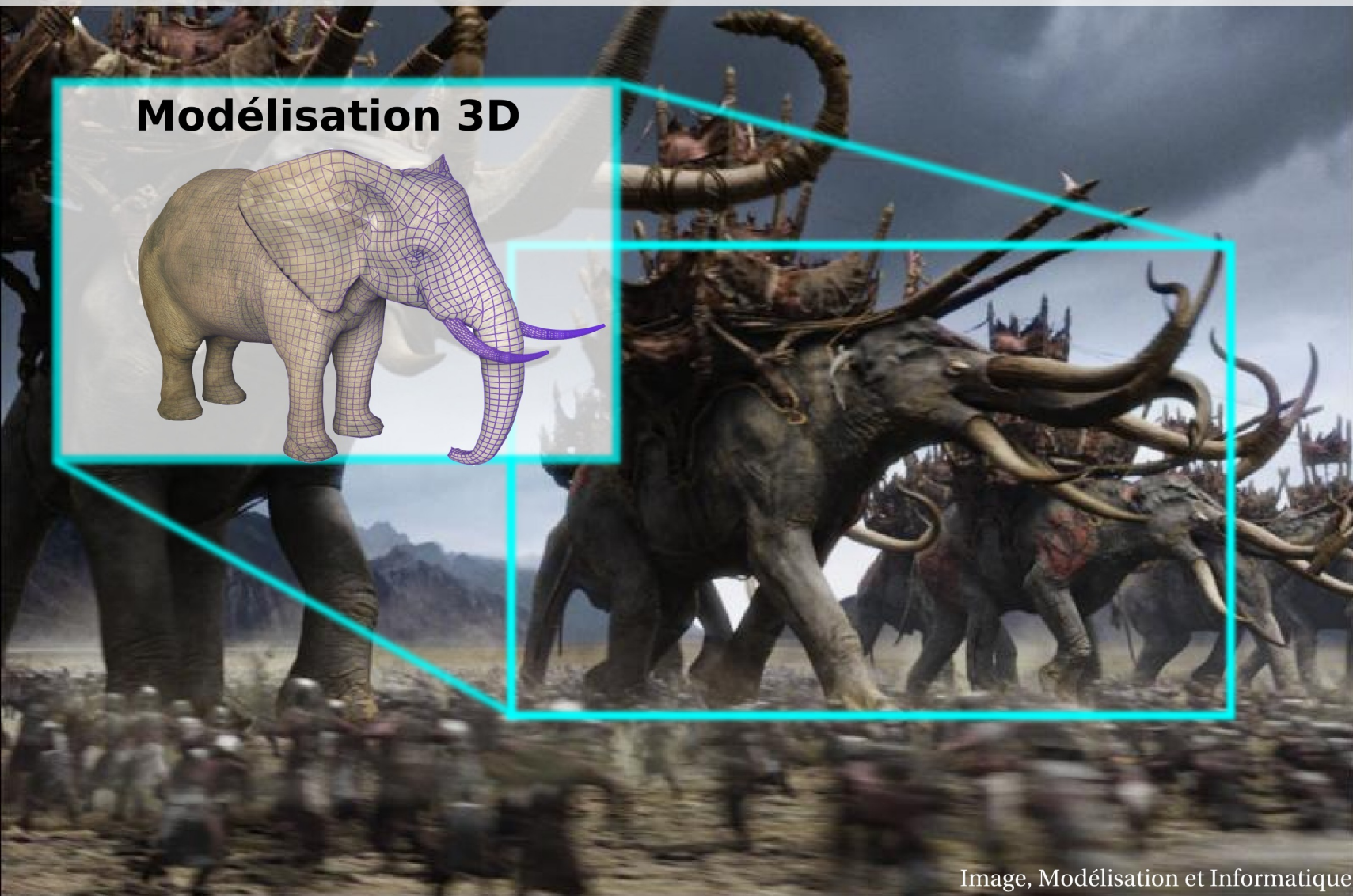


Lord of the rings

Synthèse d'images, 3D

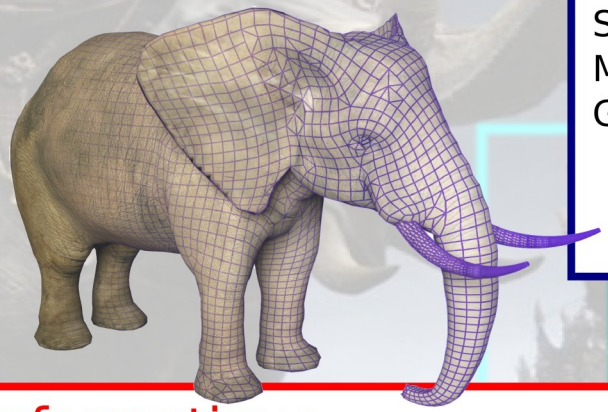
Lord of the rings

Synthèse d'images, 3D



Synthèse d'images, 3D

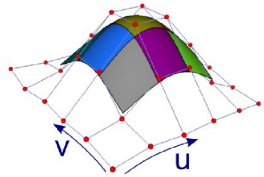
Modélisation 3D



Modélisation

$$f(u,v) = \mathbf{u}\,\mathrm{M}\,\mathrm{P}\,\mathrm{M}^T\,\mathbf{v}^T$$

Géométrie
Surfaces paramétriques
Maillages
Géométrie différentielle

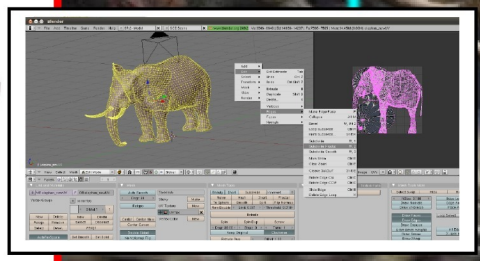


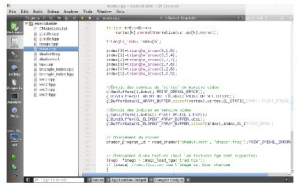
$$\mathrm{I}_S = \begin{pmatrix} S_{,u}^2 & < S_{,u}, S_{,v} > \\ < S_{,u}, S_{,v} > & S_{,v}^2 \end{pmatrix}$$

Informatique

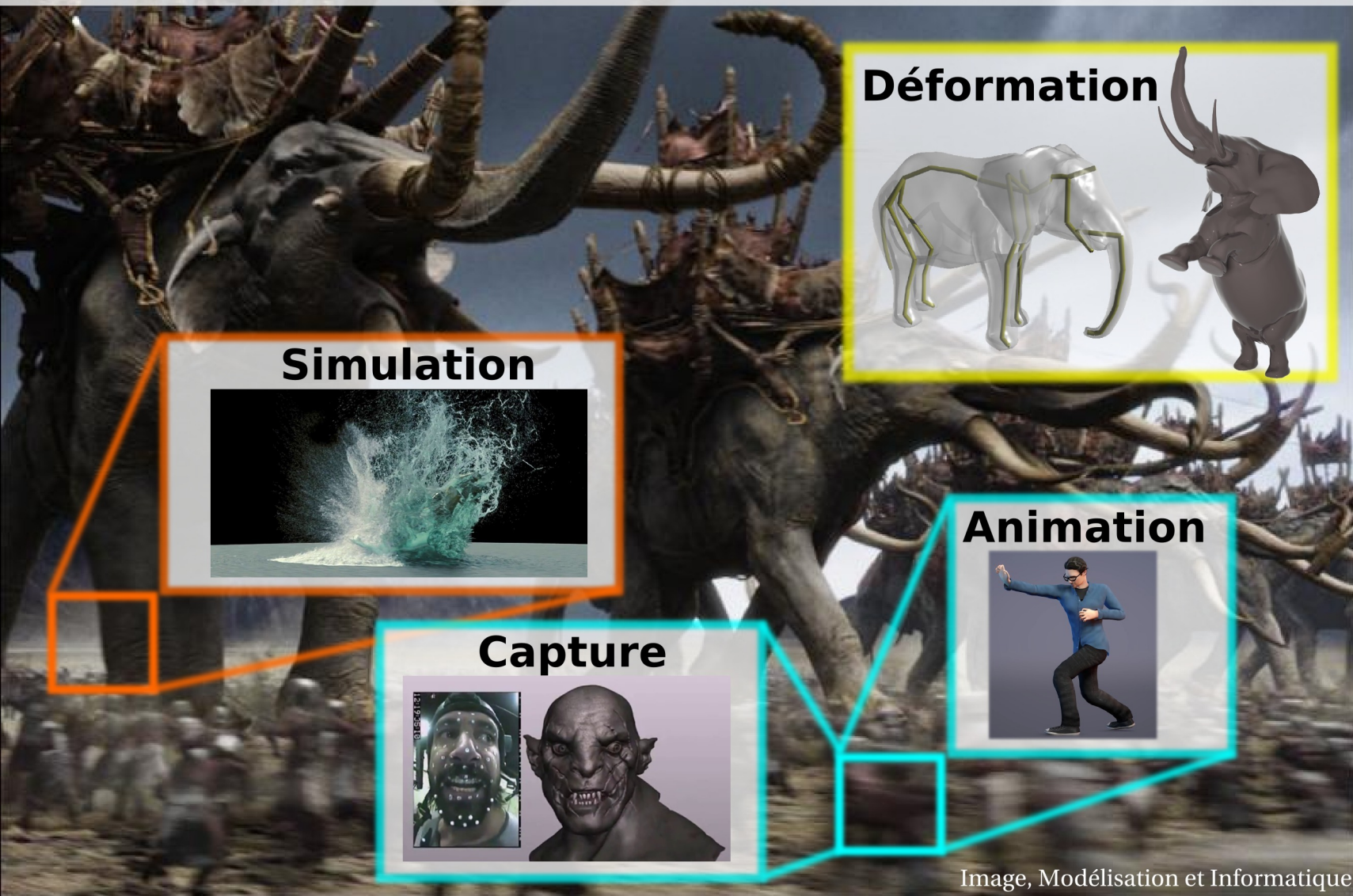
C++
Programmation GPU
Jeux Vidéos
Rendu
Logiciels 3D (Blender)
IHM: Qt

```
varying vec3 normal;
varying vec4 vertex_3d_original;
varying vec4 vertex_3d_modelview;

uniform sampler2D texture;

vec3 light=vec3(0.5,0.5,6);

void main (void)
{
    vec3 n=normalize(normal);

    vec3 p=vertex_3d_modelview.xyz;
    vec3 vertex_to_light=normalize(light-p);
    vec3 reflected_light=reflect(-vertex_to_light,n);
    vec3 user_to_vertex=normalize(-p);
```





Animation, simulation

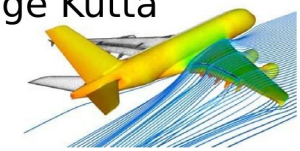


Animation, simulation

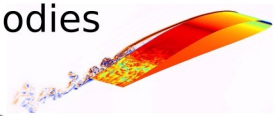
Modélisation

Equations différentielles
Géométrie
Calcul numérique

Runge Kutta

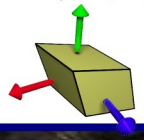


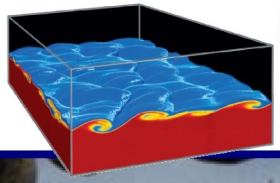
Rigid bodies



FEM

$$\nabla \cdot \sigma + \mathrm{F} = \eta u''$$





Déformation

Informatique

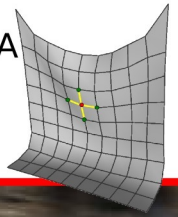
GPU
C++
Programmation optimisée
Code de calcul
Jeux vidéos

OpenCL

OpenGL

CUDA

nVIDIA



Synthèse d'images, 3D

Modules

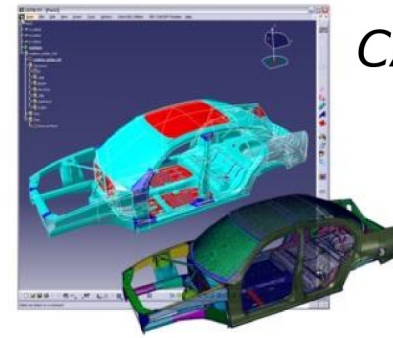
High performance computing

S8: C++ | Programmation 3D | Analyse numérique

S9: Jeux vidéos | Animation et simulation 3D | Programmation GPU | Rendu

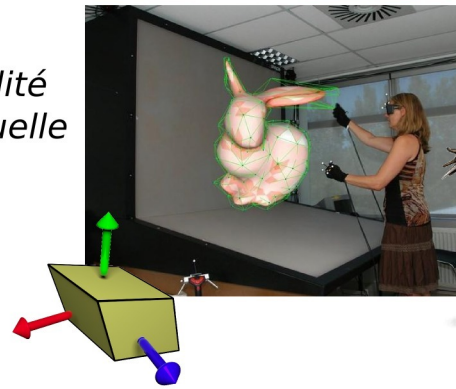
Entreprises

Dassault System
TeamTO
Pixar
Ubisoft
Buf
Weta
Crytek
Double Negative
Presagis
Unity 3D
Metrologic
CatalCAD
Ivory Tower
...

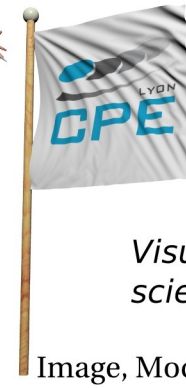


CAO

Réalité virtuelle



jeu vidéo



Simulation

Visualisation scientifique

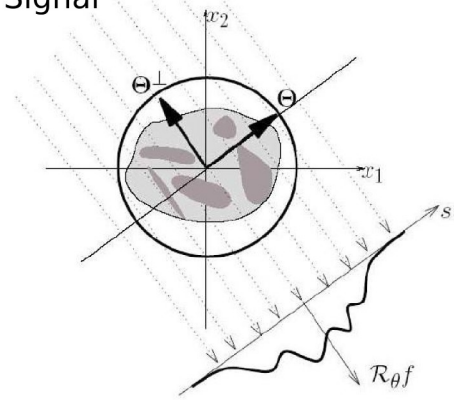
Imagerie médicale

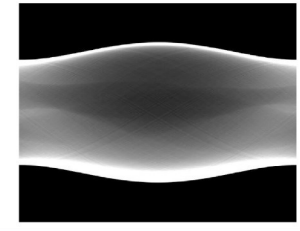
Reconstruction image

Modélisation

Problème inverse
Tomographie
Analyse numérique
Signal

$$\int_{x_0}^{x} f(u)\, e^{\int_{x_0}^{u} \alpha(t)\, \mathrm{d}t}\, \mathrm{du}$$

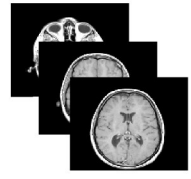


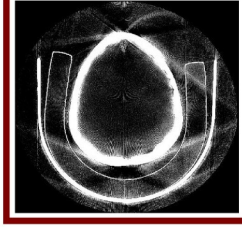


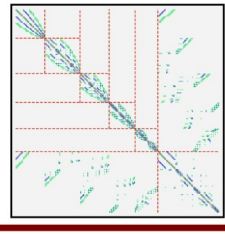
$$\frac{1}{\sqrt{2\pi}} \int_{\mathbf{x}\in\mathbf{R}^2} f(\mathbf{x}) e^{-i\omega \mathbf{x}\cdot\boldsymbol{\Theta}} d\mathbf{x}$$

Informatique

Matrices creuses
Inversion système
Voxels





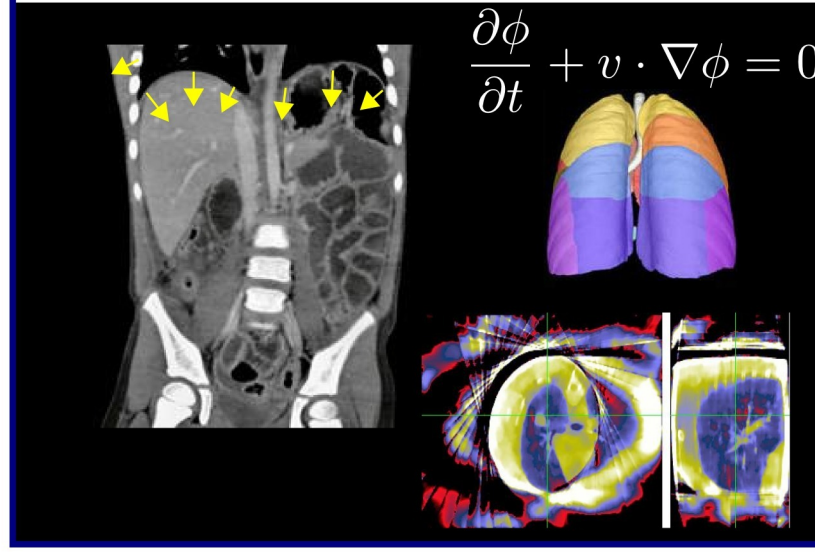


$$x_i^{k+1} = x_i^k \left(\sum_{j=1}^{J} a_{ij} \right)^{-1} \left[\sum_{j=1}^{J} a_{ij} y_j \left(\sum_{i=1}^{I} x_i a_{ij} \right)^{-1} \right]$$

Tomographie dynamique

Modélisation

Déformation
Modélisation
Recherche



Informatique

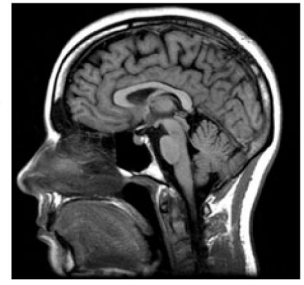
Calcul parallèle
Clusters
GPU

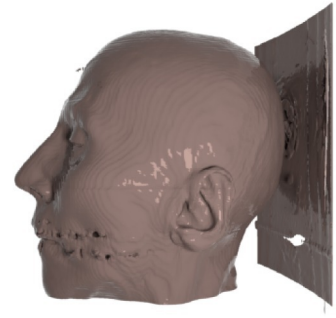
Thèse: Fabien Momey

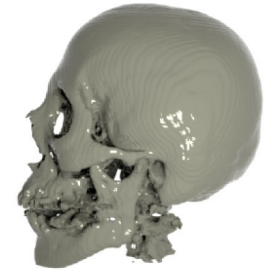
$$\arg\min_{\boldsymbol{f}} \sum_{\theta \in \Theta} \left(\boldsymbol{y}^{\theta} - \mathbf{R}^{\theta} \cdot \mathbf{S}^{t} \cdot \boldsymbol{f}\right)^{\mathsf{I}} \cdot \mathbf{W} \cdot \left(\boldsymbol{y}^{\theta} - \mathbf{R}^{\theta} \cdot \mathbf{S}^{t} \cdot \boldsymbol{f}\right) + \mathcal{J}_{\text{prior}}(\boldsymbol{f})$$

Visualisation

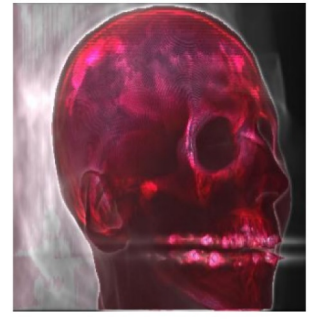
visu surface



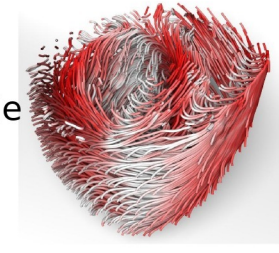


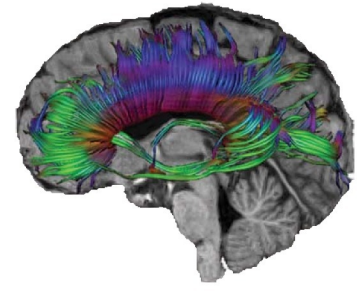


visu volume

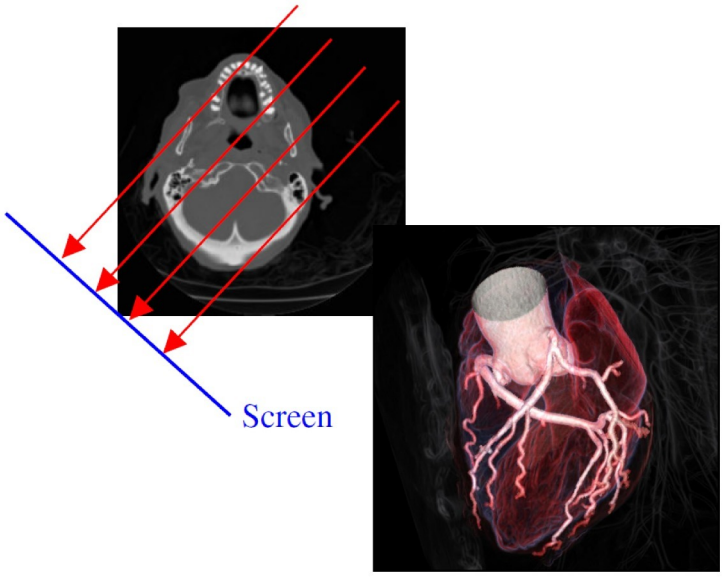


Analyse
fonctionnelle





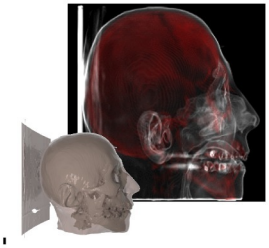
Visualisation



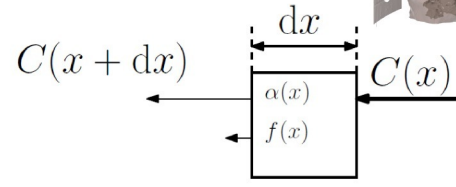
Modélisation

Imagerie Médicale

Rendu



$$\left(\int_{x_0}^{X} f(u)\, e^{\int_{x_0}^{u} \alpha(t)\,\mathrm{d}t} + C(x_0)\right) e^{-\int_{x_0}^{x} \alpha(t)\,\mathrm{d}t}$$



Informatique

Marching-Cubes

C++

GPU, Shaders

```
image Volume::slice_z(unsigned int kz) const
{
    assert(kz<Nz);

    image slice(Nx,Ny);
    for(unsigned int kx=0;kx<Nx;++kx)
    {
        for(unsigned int ky=0;ky<Ny;++ky)
        {
            slice(kx,ky)=get_data(kx,ky,kz);
        }
    }
    return slice;
}
```

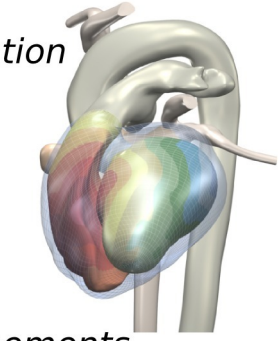
Imagerie médicale

Modules

S8: **Problèmes inverse** | **Traitement d'images** | **C++**

S9: **Imagerie Médicale** | **Rendu**

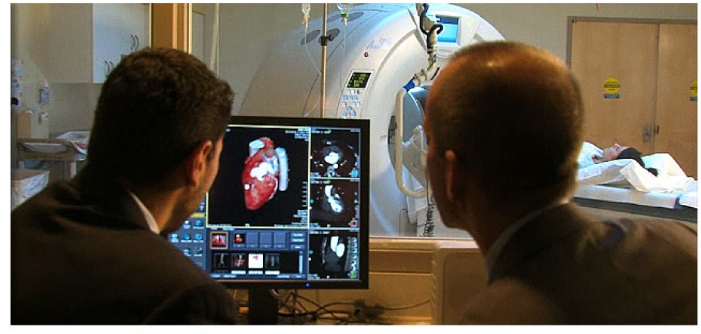
Simulation



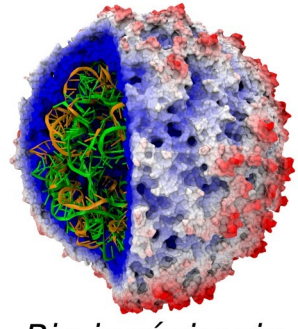
Entreprises

GE HealthCare
Bioclinica
UNC
Cermep
Dosisoft
3D Neo Vision
Elekta
ATH Medical
OneFit
Atys Medical
TIMC
Creatis
...

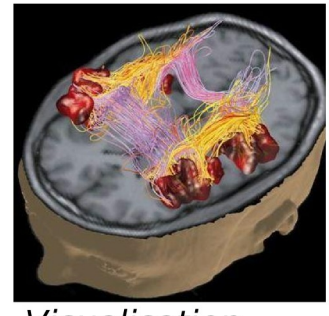
Imagerie scanner



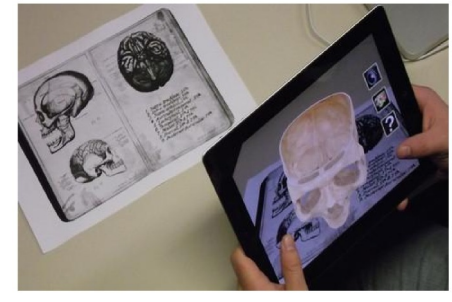
Environnements virtuels



Bio-ingénieurie

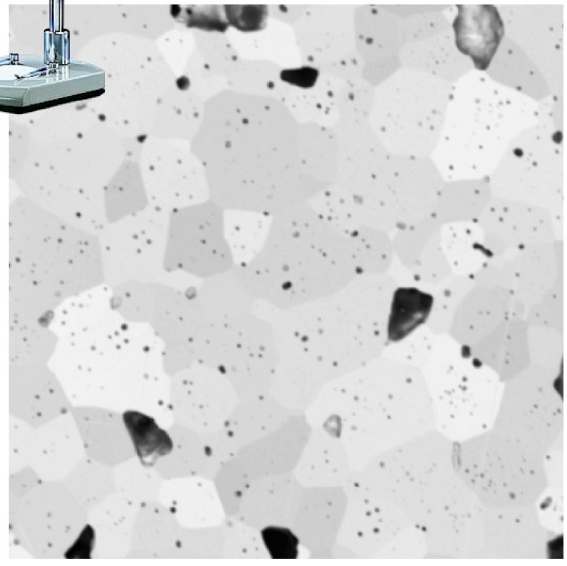


Visualisation

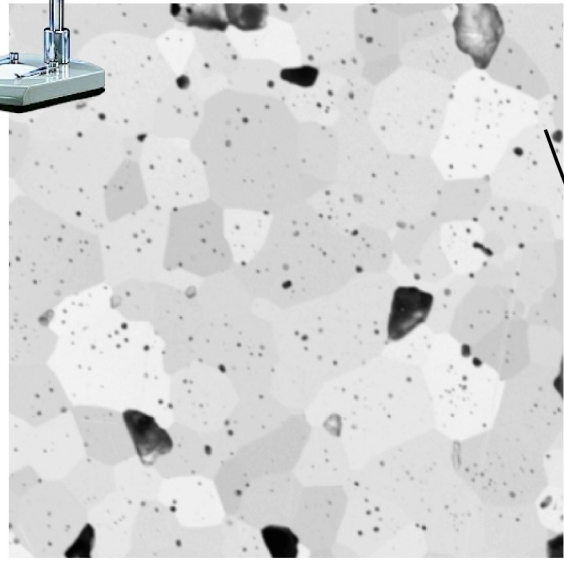


Chirugie virtuelle

Imagerie matériaux

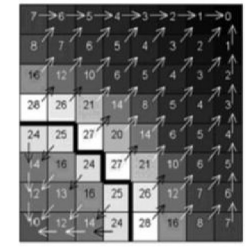


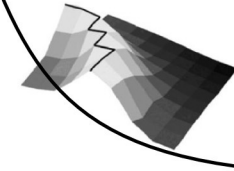
Imagerie matériaux

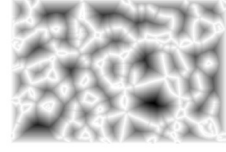


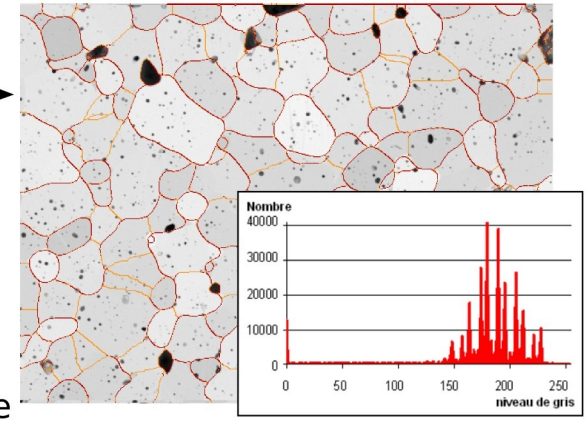
Informatique

Voisinages discrets
Morphomath
Traitement d'images





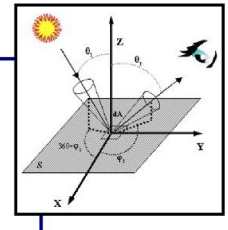




Nbr grains
Porosités
Aire moyenne
Pourcentage grains
...

Modélisation

LPE
Distribution aléatoires
Géométrie discrète



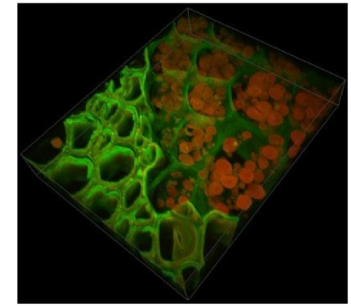
Imagerie matériaux

Modules

S8: **Traitement d'images** | **Analyse d'images** | **Géométrie**

S9: **Compression & Apprentissage**

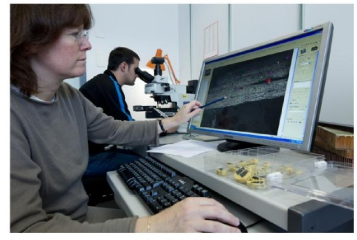
Imagerie CT 3D

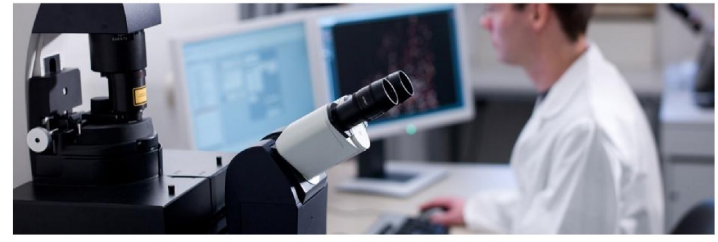


Entreprises

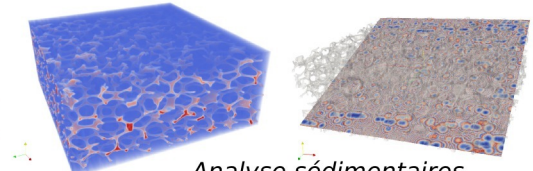
- Areva
- St Gobin
- Lafarge
- IFP
- CMM Paris
- Digisens
- LIM
- LIRIS
- ST Microelec
- CNES
- CEA
- ...

Imagerie microscopique



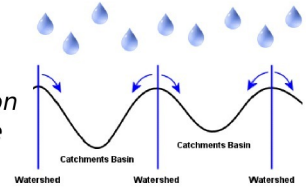


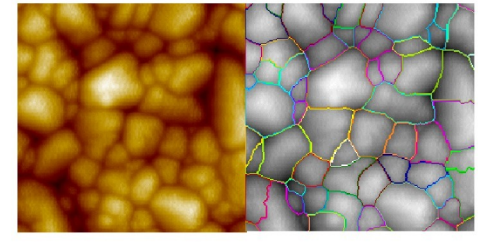
Reflectance matériaux



Analyse sédimentaires

Segmentation automatique





Image, Modélisation et Informatique

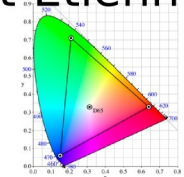
Préparation recherche

Modules S9: **Initiation à la recherche**

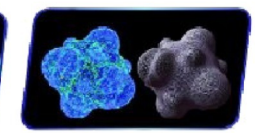
Articles scientifiques
LaTeX
Etude état de l'art
Comparaisons
...

Masters M2R (en + de CPE)

- Master Optique, Images, Vision (Saint-Etienne)
  Imagerie couleur, Cryptographie



- Master Information, Système, Signal & Image (Lyon)
  Signal, Imagerie médicale



- Master Informatique Graphique, Image (Lyon)
  Synthèse d'images, 3D, géométrie

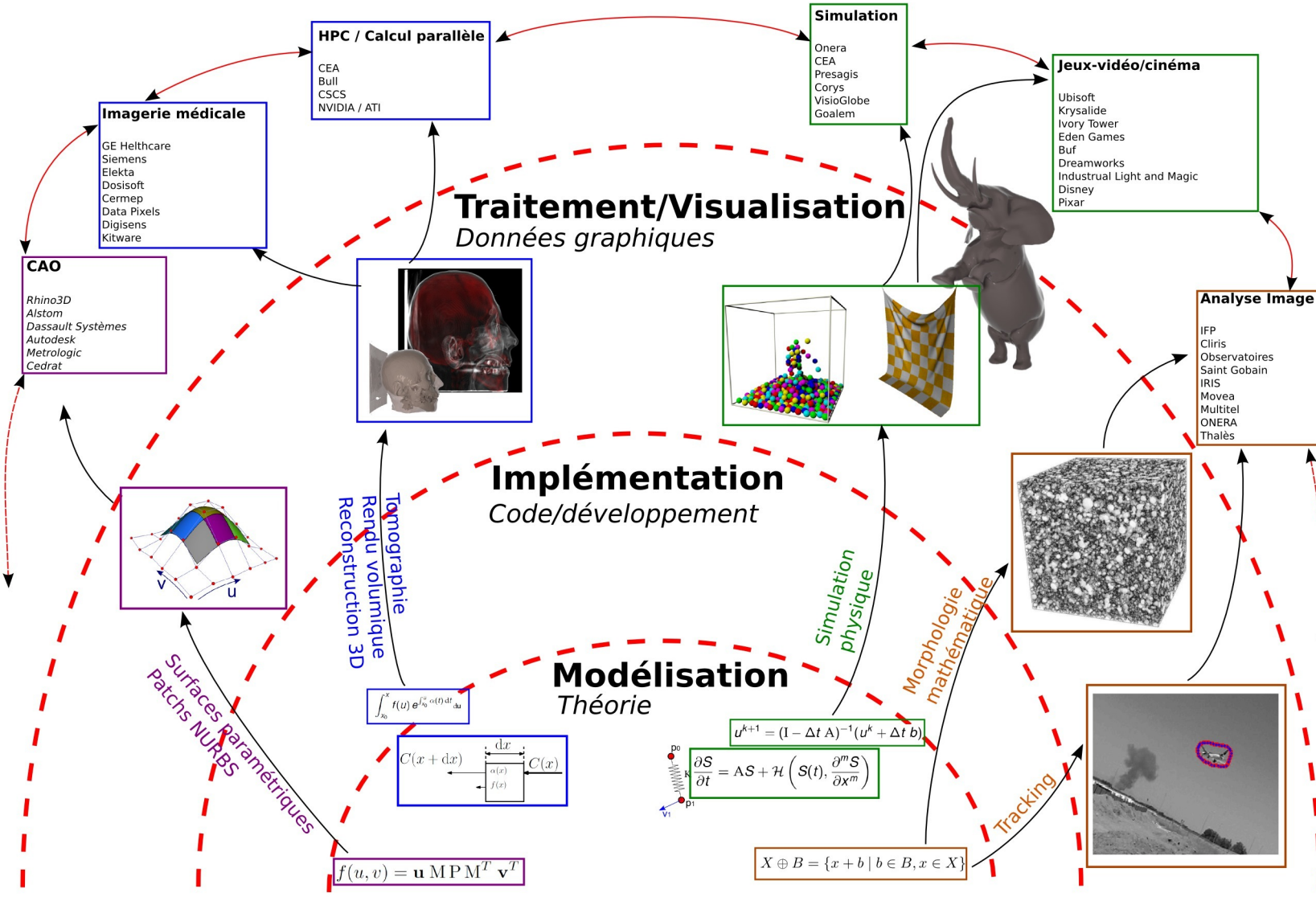
Modules

S8

- Programmation générique en C++
- Analyse numérique
- Traitement d'image
- Géométrie, modélisation graphique et programmation 3D
- Optimisation numérique et problèmes inverse
- Analyse d'image

S9

- Imagerie Médicale
- Jeux vidéo
- Animation et simulation 3D
- Rendu graphique
- Programmation GPU
- De l'acquisition au calibrage
- Compression et apprentissage d'images
- Projet initiation à la recherche
- Projet: Image, Modélisation et Informatique


HPC / Calcul parallèle
CEA
Bull
CSCS
NVIDIA / ATI
Simulation
Onera
CEA
Presagis
Corys
VisioGlobe
Goalem
Jeux-vidéo/cinéma
Ubisoft
Krysalide
Ivory Tower
Eden Games
Buf
Dreamworks
Industrual Light and Magic
Disney
Pixar
Imagerie médicale
GE Helthcare
Siemens
Elekta
Dosisoft
Cermep
Data Pixels
Digisens
Kitware
CAO
Rhino3D
Alstom
Dassault Systèmes
Autodesk
Metrologic
Cedrat
Traitement/Visualisation
Données graphiques
Analyse Image
IFP
Cliris
Observatoires
Saint Gobain
IRIS
Movea
Multitel
ONERA
Thalès
Implémentation
Code/développement
Modélisation
Théorie
Tomographie
Rendu volumique
Reconstruction 3D
Simulation physique
Morphologie mathématique
Tracking
Surfaces paramétriques
Patchs NURBS
v
u
$\int_{x_0}^{x} f(u)\, e^{\int_{x_0}^{u} \alpha(t)\,\mathrm{d}t}\,\mathrm{d}u$
$C(x+\mathrm{d}x)$
$\mathrm{d}x$
$C(x)$
$\alpha(x)$
$f(x)$
$u^{k+1} = (\mathrm{I} - \Delta t\, \mathrm{A})^{-1}(u^k + \Delta t\, b)$
$\frac{\partial S}{\partial t} = \mathrm{A}S + \mathcal{H}\left(S(t), \frac{\partial^m S}{\partial x^m}\right)$
$f(u,v) = \mathbf{u}\,\mathrm{M}\,\mathrm{P}\,\mathrm{M}^T\,\mathbf{v}^T$
$X \oplus B = \{x + b \mid b \in B, x \in X\}$

Intitulés métiers:

Développeurs logiciels / Software engineer
Ingénieur recherche
Chercheur Académique/Appliqué
Analyste programmeur
Ingénieur developpement
Ingénieur d'études
Editeur logiciels
Intégrateur

Secteurs d'activité/Mots clés:

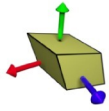
Reconstruction 3D
GPU, HPC
Imagerie médicale
Imagerie matériaux
Tracking, analyse image
Debruitage, reconnaissance
Graphique, 3D, CAO
Moteur Physique, graphique, rendu
Jeux vidéo, serious game
Simulation, Calcul numérique

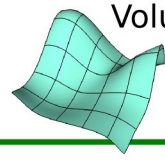
Compétences fondamentales:

Théorie:

Math
Analyse numérique
Physique
Optique
Mécanique

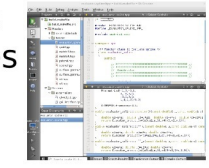
$$\frac{\mathrm{d}}{\mathrm{d}t}\int_{\Omega} f(\mathbf{x},t)\,\mathrm{d}V = \dots$$

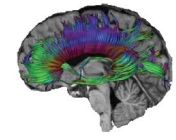




Développement:

Coeurs de calculs
Efficace: C++ / C
Haut niveau: Matlab/Python
Lib numériques
Volume données



Données graphiques:

API Graphiques: OpenGL, Ogre
Données scanners (IRM, CT, ...)
Parallélisme: GPU, CUDA, OpenCL