Maximisation of building solar potential determined using Radiance

Jérôme H. KAEMPF

jerome.kaempf@epfl.ch

- Previous work / Motivation
- Methodology
- Results
- Conclusion

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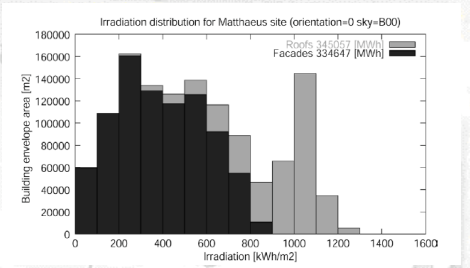
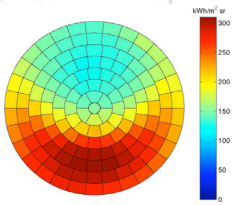
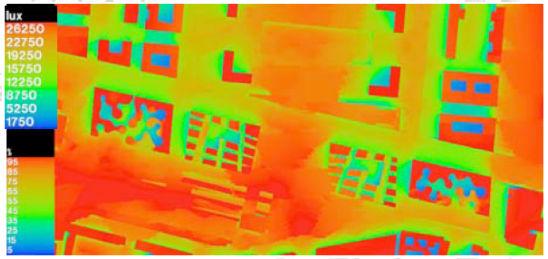
Ecole Polytechnique Fédérale de Lausanne (EPFL), CH-1015 Lausanne

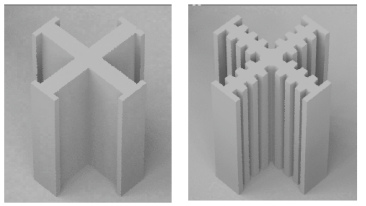
Previous work / Motivation

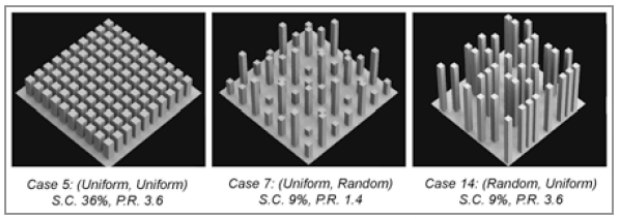
- Renewable Energy potential of urban sites
  - Compagnon (2000)
    - Radiance, PPF – histogrammes
  - Robinson (2004)
    - Cumulative sky
  - Montavon (2006)
    - La Ville Radieuse (Le Corbusier)
  - Cheng (2006)
    - Parametric study (18)











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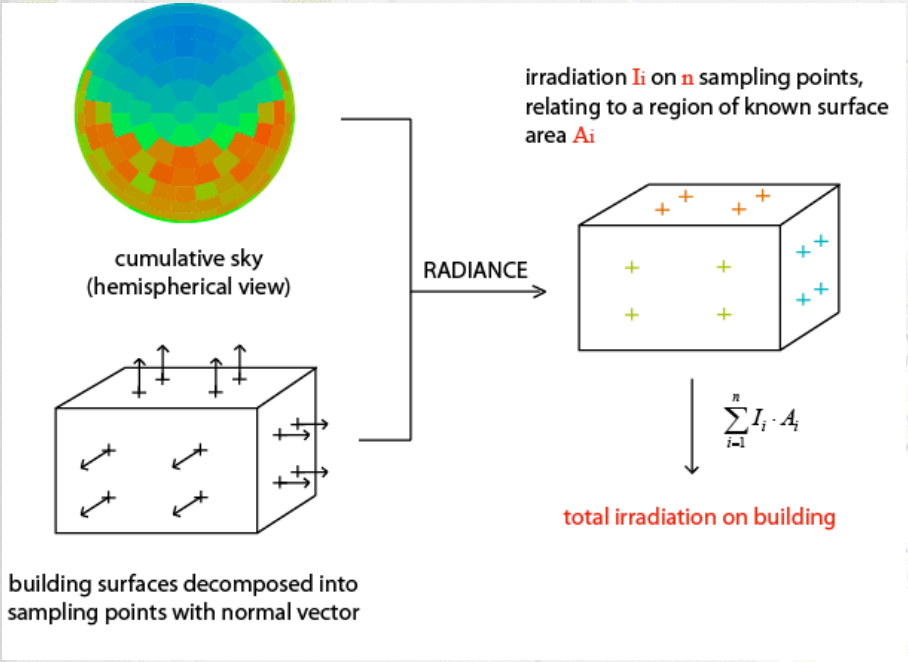
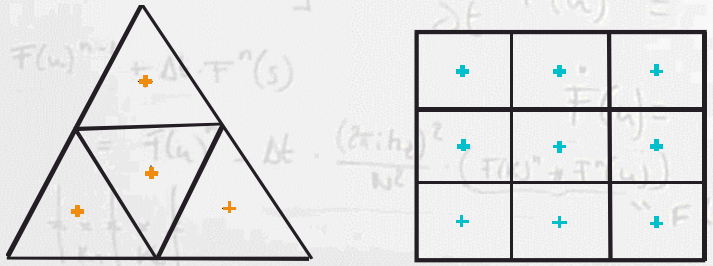
Methodology





Ambient calculation

-ab 2 -ad 1024 -as 512 -aa 0

Parametrisation of the form

$$\vec{x} \in M \subseteq \mathbb{R}^n$$

Maximisation

$$\sup\{f(\vec{x}) \mid \vec{x} \in M \subseteq \mathbb{R}^n\}$$

Using Evolutionary Algorithms

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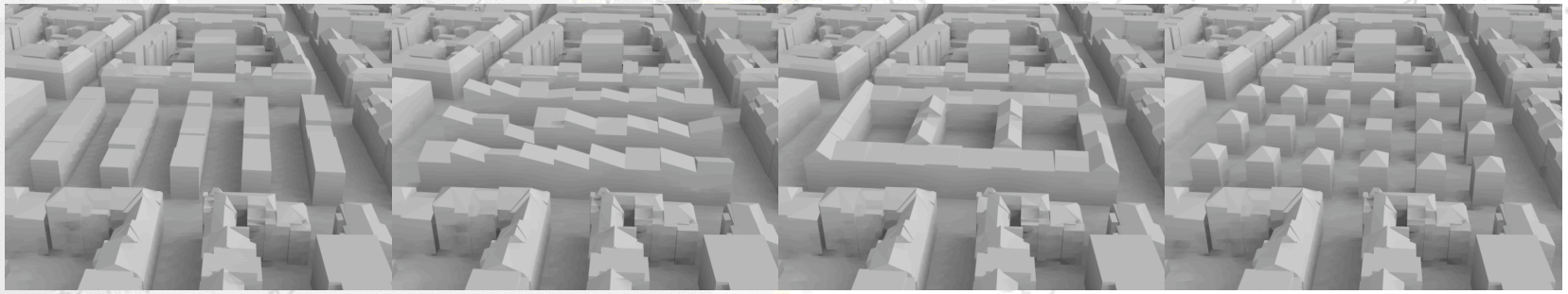
First study

Parameterisation



Irradiation deduced by the steady-state thermal losses

CISBAT'07 proceedings

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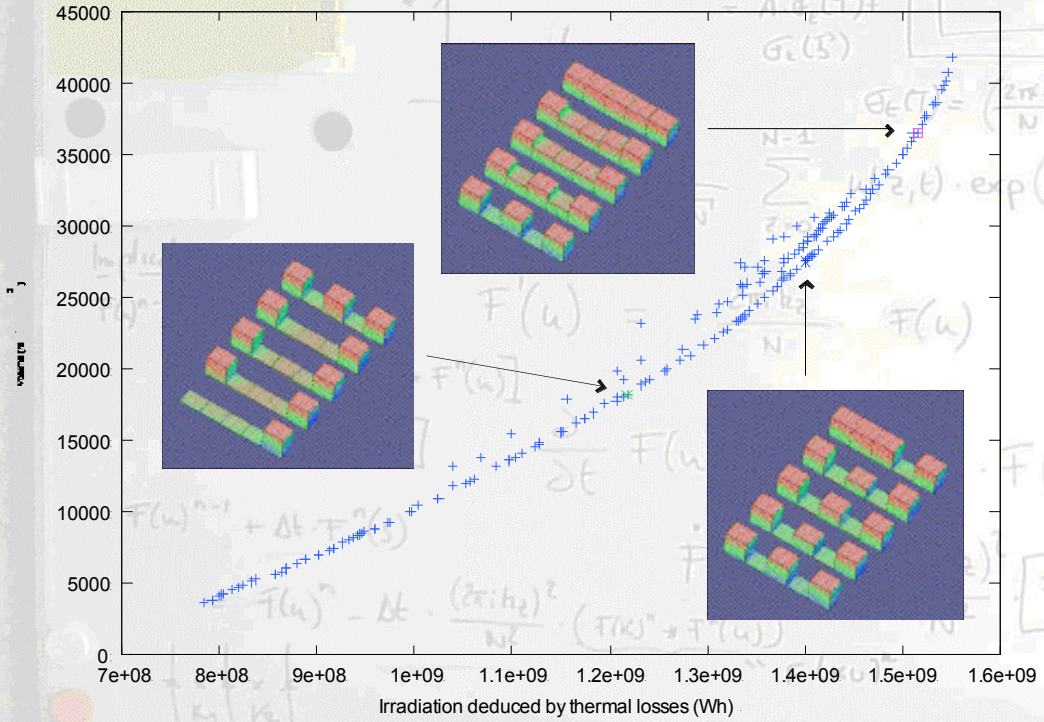
Second study

Irradiation deduced by the steady-state thermal losses BUT

taking the volume of the urban form as second objective



Terraces Flat Roofs

Pareto Front
(compromise)

Results to appear in:

Special Issue Solar Energy after CISBAT

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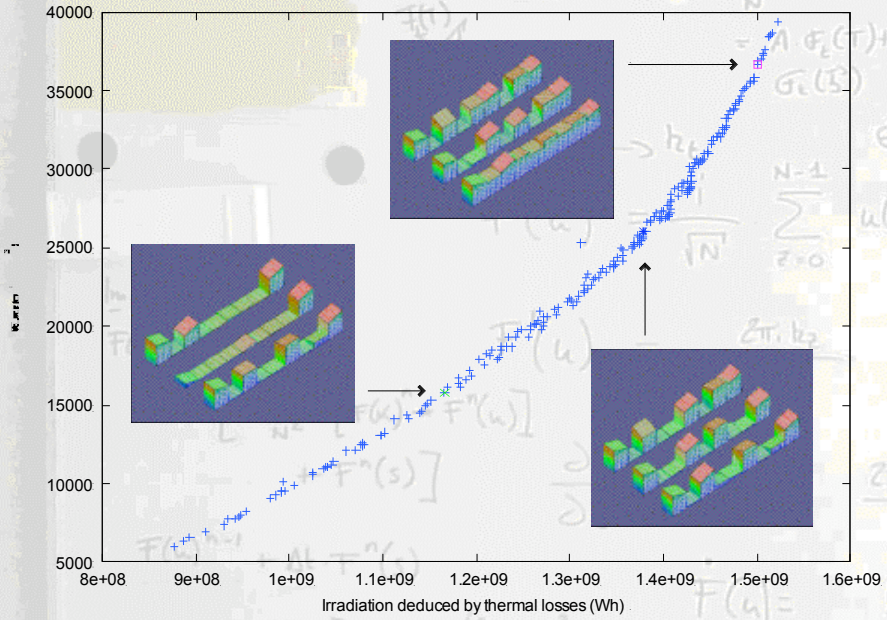
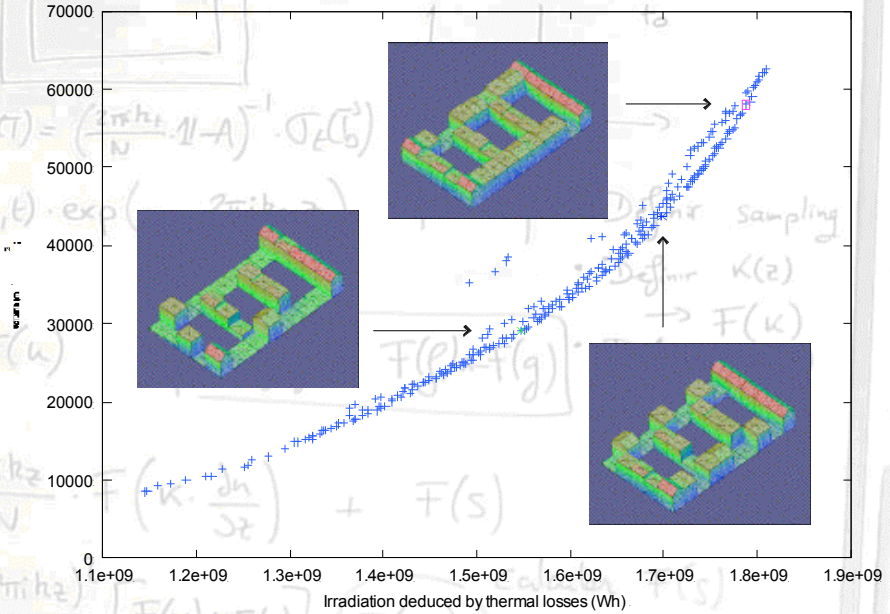


Slabs Sloped Roofs



Terrace Courts

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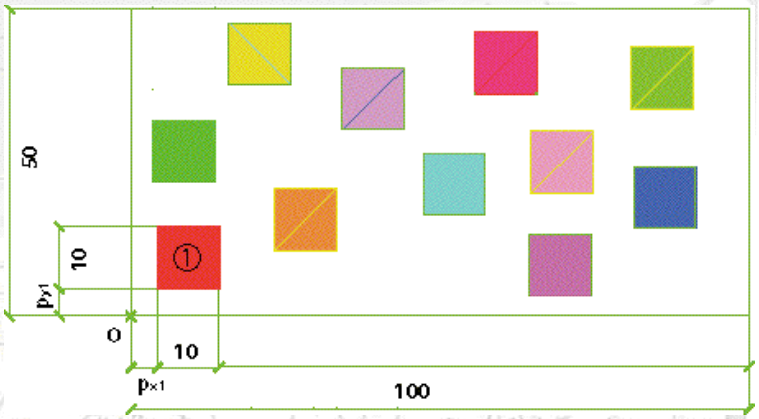
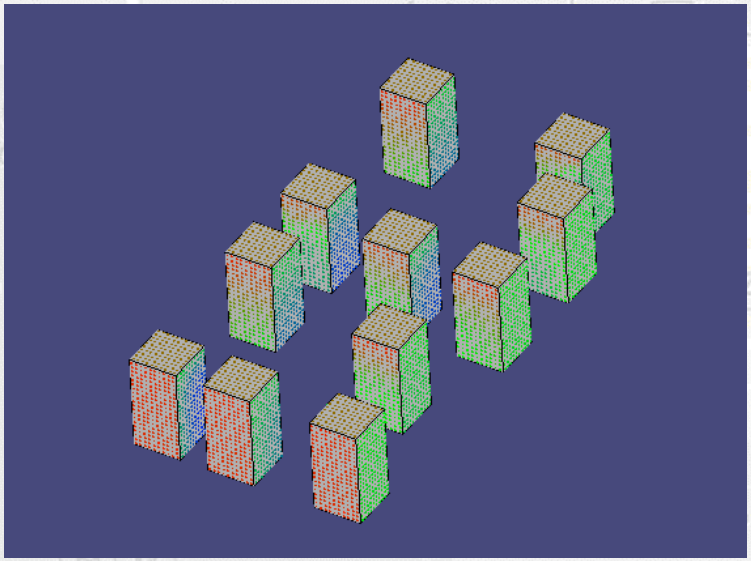
Third study

Placement of buildings on a ground

Self-constrained problem

→ shadowing effect





Using a hybrid CMA-ES/HDE

Appearing in:

Applied Soft Computing

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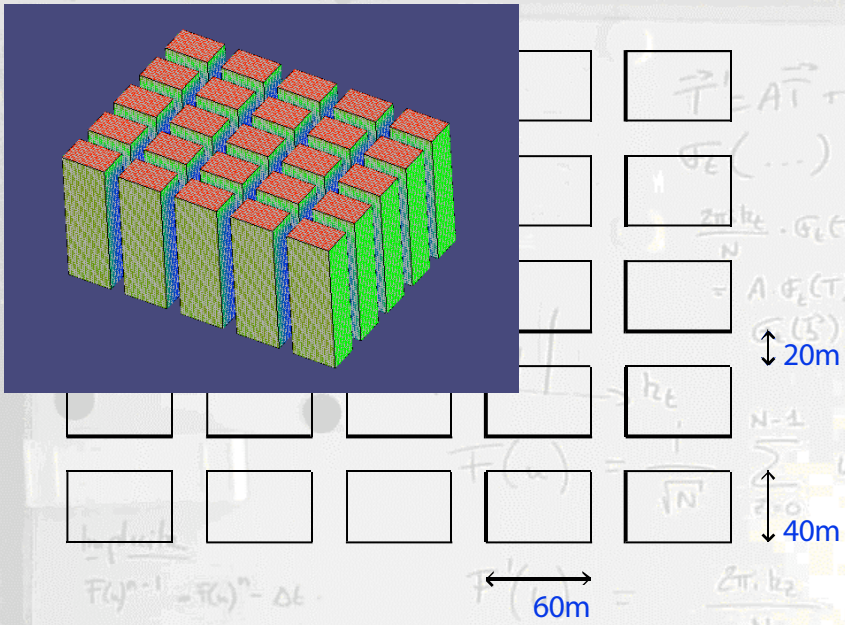
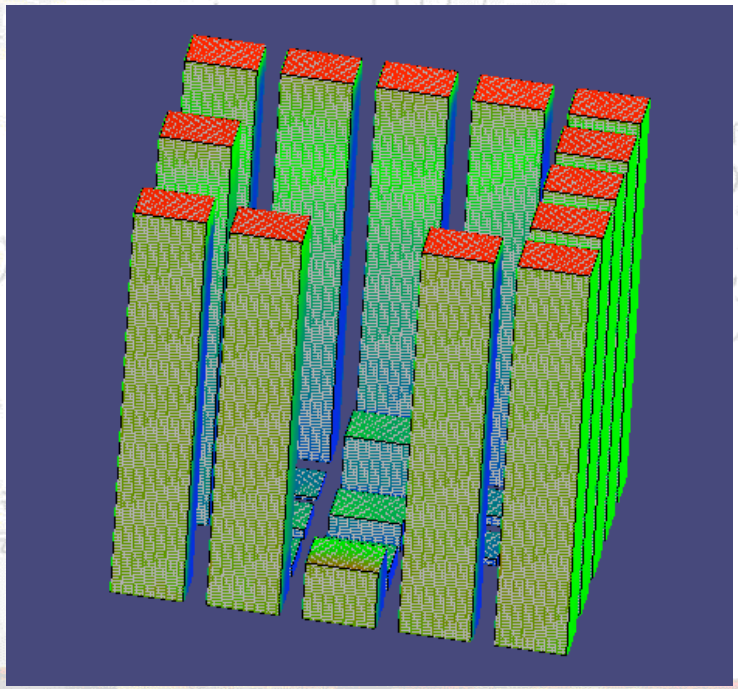
Fourth study



Heights parameterisation

$$\{\vec{x} \in \mathbb{R}^{25} \mid x_i \in [0, 123], i = 1..25\}$$



Volume constraints

Within 10% of half the maximum

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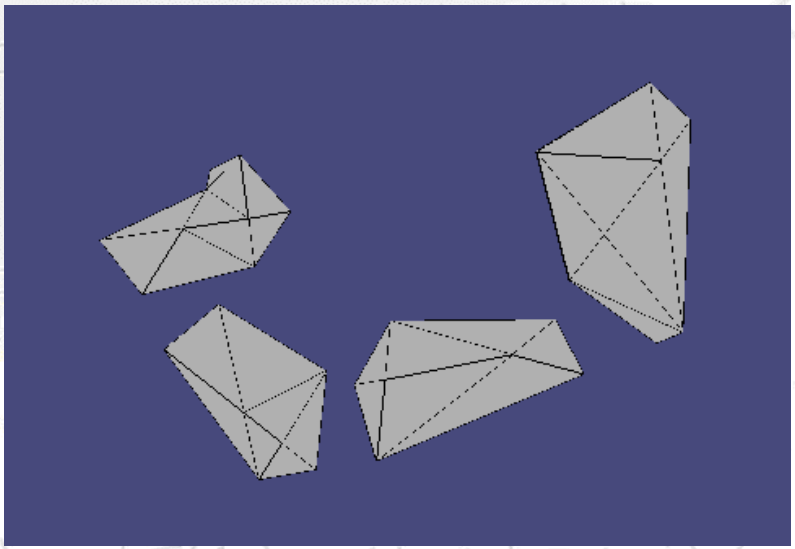
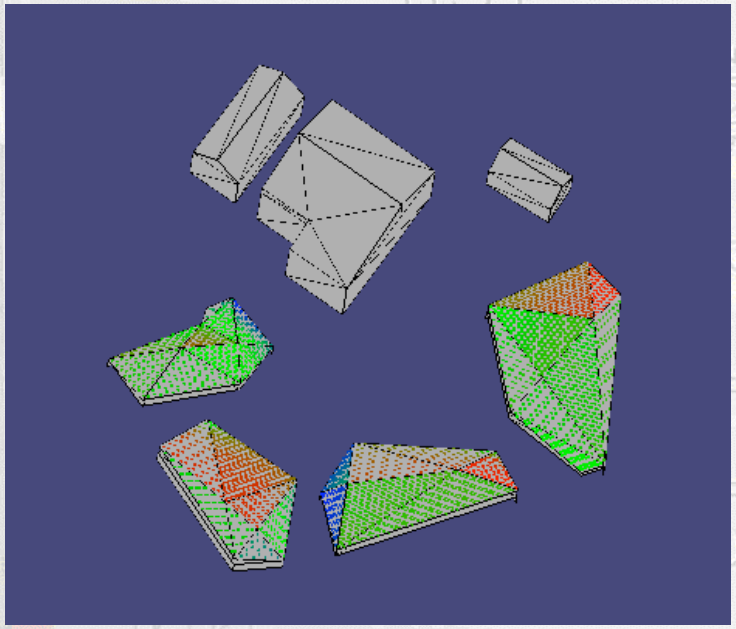
Fifth study

Heights parameterisation

$$\{\vec{x} \in \mathbb{R}^{31} \mid x_i \in [3,6], i = 1..31\}$$





Constraints: Convex shape

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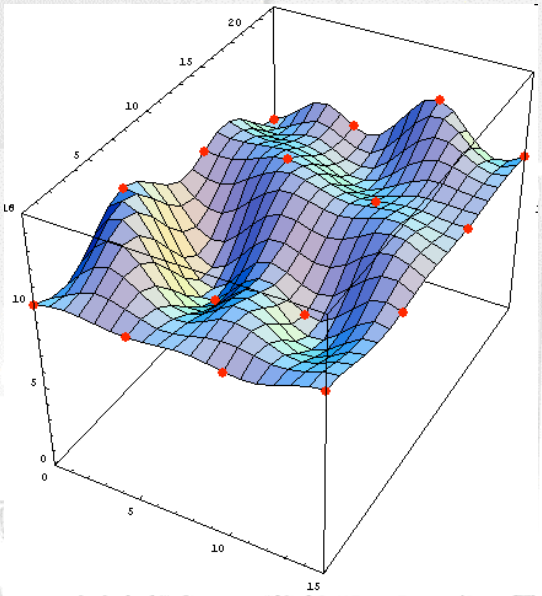
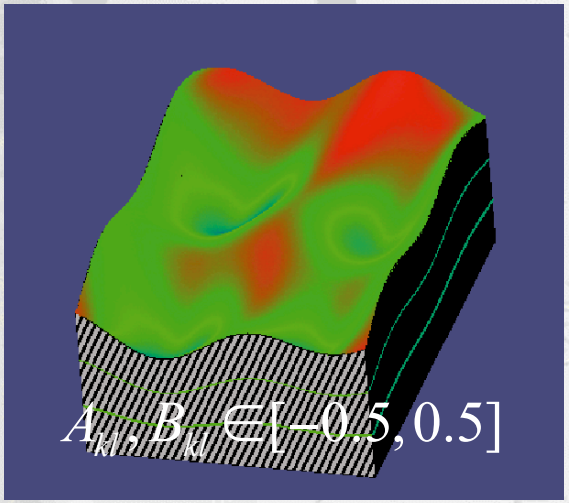
Sixth study

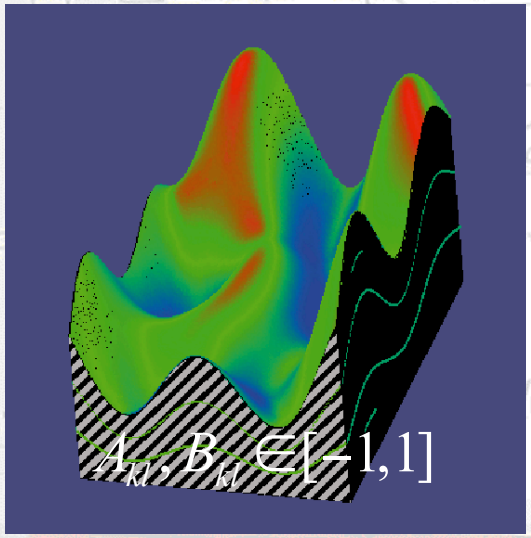
$$h(x,y) = \sum_{k=-2}^{2}\sum_{l=0}^{2} A_{kl}\cdot\cos\left(2\pi\cdot\left(\frac{x}{L_x}+\frac{y}{L_y}\right)\right)+B_{kl}\cdot\sin\left(2\pi\cdot\left(\frac{x}{L_x}+\frac{y}{L_y}\right)\right)$$

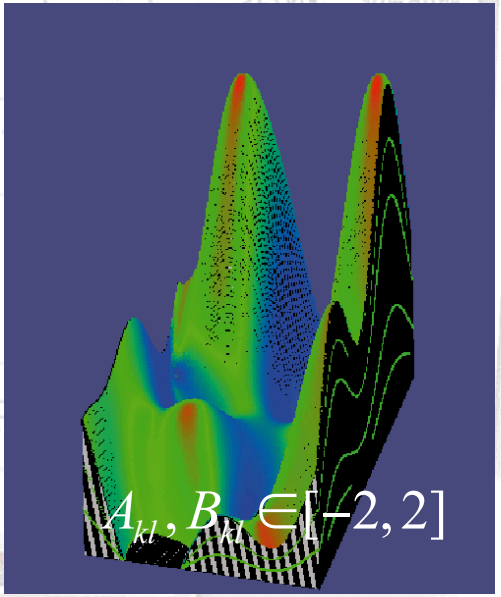


Fourier series

25 parameters







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Conclusion

RADIANCE is as very convenient tool for research:

Linux command line operations are very efficient

To speed up calculations, evaluations were parallelised

Thank you for your attention!

Jérôme H. KAEMPF

jerome.kaempf@epfl.ch

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