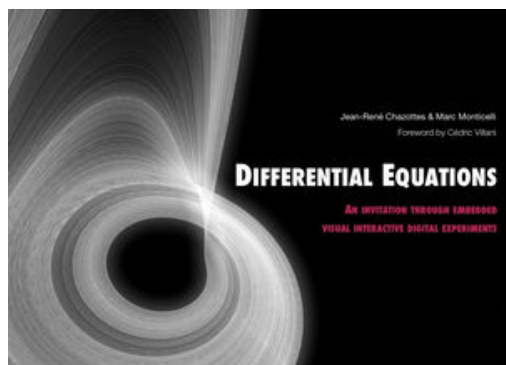


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Version française

Cet ebook est une introduction à la théorie qualitative des équations différentielles. Son originalité réside dans les 68 expériences numériques visuelles et interactives qu'il intègre. Elles permettent d'expérimenter et de visualiser les concepts introduits et les solutions des équations des modèles étudiés. Nul besoin de programmer, d'installer un logiciel de calcul en parallèle, ou d'être connecté à internet : ces expériences numériques sont autonomes, en symbiose avec le texte.

Cet ebook se concentre sur les processus qu'on peut mathématiquement idéaliser par des équations différentielles. De telles équations sont un des outils essentiels pour modéliser des systèmes physiques, biologiques, écologiques, chimiques, économiques, etc. A supposer qu'on puisse réduire l'étude d'un système réel à celle d'une équation différentielle, ce n'est pas la fin de l'histoire car la plupart de ces équations ne peuvent pas être résolues explicitement.

Fort heureusement, des méthodes qualitatives ont été développées pour comprendre le comportement des solutions sans devoir les connaître explicitement ! L'idée maîtresse est de visualiser toutes les solutions d'une équation différentielle à la fois en considérant un espace abstrait approprié, afin d'obtenir ce qu'on appelle un " portrait de phase ". Avec cet ebook, vous serez graduellement initié à cet art en développant votre intuition grâce aux nombreuses expériences numériques.

Les pré-requis mathématiques pour cet ebook sont une bonne connaissance des fonctions d'une variable réelle. Nous utiliserons également des connaissances de base sur les fonctions de plusieurs variables réelles (essentiellement deux), c-à-d, les dérivées partielles et les matrices jacobiniennes, ainsi qu'un peu d'algèbre linéaire (valeurs propres et vecteurs propres).

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Version anglaise:

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This ebook focuses on processes that can be mathematically idealized as differential equations. Such equations are among the major tools with which scientists make mathematical models of real systems in physics, biology, ecology, chemistry, economy, etc. Even if you can reduce the description of a real system to the mathematical study of a differential equation, this will not be the end of the story because most interesting differential equations are nonlinear.

This implies that, most of the time, we are not able to write down the solutions in terms of elementary functions.

Fortunately, qualitative methods were developed, yielding a general idea of how all the solutions behave without actually knowing them explicitly. The main idea is to visualize all solutions of a differential equation at once by considering an appropriate abstract space, to get what is called a 'phase portrait'.

Thanks to this ebook, you will be embarked on a journey during which we will gradually introduce these methods by using carefully chosen interactive digital experiments.

The essential prerequisite for this ebook is single-variable calculus, including curve-sketching, and a basic knowledge of Taylor series. Multivariable calculus (partial derivatives, Jacobian matrix) and linear algebra (eigenvalues and eigenvectors) are used, but no deep knowledge of these concepts is required.

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