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Applications of Modularity in Arithmetic Geometry and Number Theory

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Modular forms are connected to several areas of arithmetic geometry and number theory, for example through the Langlands program. They have the useful property that they are amenable to computations. We give an introduction to the theory of classical modular forms, their relation to elliptic curves and abelian varieties and the Galois representations attached to them, as well as how to perform computations with them.

As an application we (1) show how Hilbert modular forms can be used to solve new cases of the inverse Galois problem and (2) indicate how (a) Hilbert and (b) Siegel modular forms can be used to establish (a) strong BSD over totally real fields and (b) the BSD rank conjecture in infinitely many generic cases in dimension 2 over the rationals, respectively.

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