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Chapter 1 : The Algebra of Invariants - John Hilton Grace, Alfred Young - Google Books

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Linear homogeneous diophantine equations and magic labelings of graphs by Richard P. Stanley - Duke Math. J , " Hence G is a pseudograp in the terminology of [10]. Also if an edge e is incident to a vertex v, we write v e. Any undefined graph-theoretical terminology used her Any undefined graph-theoretical terminology used here may be Show Context Citation Context Every solution is an N-combination o]]undamental solutions. For a simple proof of Lemma 2. The following two conditions are equivalent. This article is an expanded version of the material presented there. The main topic is the calculation of the invariant ring of a finite group acting on a polynomial ring by linear transformations of the indeterminates. By "calculation" I mean finding a finite system of generators for the In this exposition particular emphasis is placed on the case that the ground field has positive characteristic dividing the group order. We call this the modular case, and it is important for several reasons. First, many theoretical questions about the structure of modular invariant rings are still open. I will address the problems which I consider the most important or fascinating in the course of the paper. Thus it is very helpful to be able to compute modular invariant rings in order to gain experience, formulate or check conjectures, and gather some insight which in fortunate cases leads to proofs. Furthermore, the computation of modular invariant ring can be very useful for the study of cohomology of finite groups see Adem and Milgram [1]. This exposition also treats the nonmodular case characteristic zero or coprime to the group order , where computations are much easier and the theory is for the most part settled. There are also various applications in this case, such as the solution of algebraic equations or the study of dynamical systems with symmetries see, for example, Gatermann [11], Worfolk [26]. There are three projective invariants of a set of six points in general position in space. It is well known that these invariants cannot be recovered from one image, however an invariant relationship does exist between space invariants and image invariants. This invariant relationship is first deriv This invariant relationship is first derived for a single image. Then this invariant relationship is used to derive the space invariants, when multiple images are available. This paper establishes that the minimum number of images for computing these invariants is three, and the computation of invariants of six points from three images can have as many as three solutions. Algorithms are presented for computing these invariants in closed form. The accuracy and stability with respect to image noise, selection of the triplets of images and distance between viewing positions are studied both through real and simulated images. Applications of these invariants are also presented. Both the results of Faugeras [1] and Hartley et al. Show Context Citation Context The paper is organized as follows. Patches of quadric curves and surfaces such as spheres, planes and cylinders have found widespread use in modeling and recognition of objects of interest in computer vision. In this paper, we treat use of more complex higher degree polynomial curves and surfaces of degree higher than two, which have In this paper, we treat use of more complex higher degree polynomial curves and surfaces of degree higher than two, which have many desirable properties for object recognition and position estimation, and attack the instability problem arising in their use with partial and noisy data. The scenario discussed in this paper is one where we have a set of objects that are modeled as implicit polynomial functions, or a set of representations of classes of objects with each object in a class modeled as an implicit polynomial function, stored in the database. Then, given partial data from one of the objects, we want to recognize the object or the object class or collect more data in order to get better parameter estimates for more reliable recognition. Two problems arising in this scenario are discussed in this paper: An example of Euclidean invariants are the lengths of the major and minor axes of an ellipse. These are invariant to translation and rotation of the ellipse. Abstractâ€”For shapes represented as closed planar contours, we introduce a class of functionals which are invariant with respect to the Euclidean group and which are obtained by performing integral operations. While such integral invariants enjoy some of the desirable properties of their differential While such integral invariants enjoy some of the desirable properties of their differential counterparts, such as locality of computation which allows matching under occlusions and uniqueness of representation asymptotically , they do not exhibit the noise sensitivity associated with differential quantities and, therefore, do not require presmoothing of the input shape. Our formulation allows the analysis of shapes at multiple scales. Based on integral invariants, we define a notion of distance between shapes. The proposed distance measure can be computed efficiently and allows warping the shape boundaries onto each other; its computation results in optimal point correspondence as an intermediate step. Numerical results on shape matching demonstrate that this framework can match shapes despite the deformation of subparts, missing parts and noise. As a quantitative analysis, we report matching scores for shape retrieval from a database. Index Termsâ€"Integral invariants, shape, shape matching, shape distance, shape retrieval. In particular, one can construct primitive invariants of algebraic entities such as lines, conics, and polynomial curves, based on a global descriptor of shape [59], [28]. Smooth and Algebraic Invariants of a Group Action: We provide an algebraic formulation of the moving frame method for constructing local smooth invariants on a manifold under an action of a Lie group. This formulation gives rise to algorithms for constructing rational and replacement invariants. The latter are algebraic over the field of rational i The algebraic algorithms can be used for computing fundamental sets of differential invariants. A central problem is to compute a generating set of invariants and the relations syzygies among them. A typical example is the discriminant of a binary form as an invariant of an action of the special linear group. The differential invariants appearing in differential geometry are smooth functions o We completely determine necessary and sufficient conditions for the normalizability of the wave functions giving the algebraic part of the spectrum of a quasiexactly solvable Schrodinger operator on the line. Methods from classical invariant theory are employed to provide a complete list of canonica Methods from classical invariant theory are employed to provide a complete list of canonical forms for normalizable quasi-exactly solvable Hamiltonians and explicit normalizability conditions in general coordinate systems. Mathematics Subject Classification We introduce the essentials, see e. We interpret a polyn Computation of canonical forms for ternary cubics by Irina A. In this paper we conduct a careful study of the equivalence classes of ternary cubics under general complex linear changes of variables. Our new results are based on the method of moving frames and involve triangular decompositions of algebraic varieties. We provide a computationally efficient algor We provide a computationally efficient algorithm that matches an arbitrary ternary cubic with its canonical form and explicitly computes a corresponding linear change of coordinates. We also describe a classification of the symmetry groups of ternary cubics. A set of rational covariants is called fundamental if any other rational covariant can be expressed as a rational function of the fundamental ones. The existence of a finite fundamental On equations defining coincident root loci by Jaydeep V. We revisit an old problem in classical invariant theory, viz. We construct a complex of SL2â€"representations such that the desired algebraic conditions are expressible as a specific co We construct a complex of SL2â€"representations such that the desired algebraic conditions are expressible as a specific cohomology group of this complex. Preliminaries In the next three subsections, we recall a few matters from the invariant theory of binary forms. See [6] and [16] for the modern theory and [17] for a discussion of algorithms for the computation of invariants and covariants. Representations of SL2 C. In the sequel, V denotes a two dimens

Chapter 2 : Kung , Rota : The invariant theory of binary forms

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The algebra of invariants, by J. I a Grace, John Hilton. I a Cambridge, [b University Press, c THE object of this book is to provide an English introduction to the symbolical method in the theory of Invariants. Such readers should bear in mind that this treatise is only concerned with one part of a very extensive subject. The remainder of the book is mainly of geometrical interest: The only complete system of ternary forms given is that for two Quadratics: The number of references to Mathematical Journals etc. We wish to thank Dr H. Baker for help given to us in our early reading and Professor Forsyth for encouragement while writing. For reading of proof-sheets we are indebted to Mr J. Our thanks are also due to the officials of the University Press for great help received during the course of printing. French translation by Fehr; Gauthier-Villars, Paris, Italian translation by Vivanti; Pellerano, Naples, Article, Invariantentheorie in, the Encyclopddie der mathematischen Wissenschaften. In the present work we shall give an account of the theory and structure of functions of the coefficients possessing properties analogous to that described above; but before proceeding to generalities we shall give some further examples. Thus we have here a function of the coefficients of two expressions such that the new value differs from the original value by a factor depending only on the transformation employed 3. This identity indicates a property quite similar to that illustrated in the two previous examples, but the function, which is unaltered except for the factor -: The result we have written down may be verified directly, but more easily as follows: Let us now explain the phraseology in common use when dealing with questions such as arise in our subject. A rational integral homogeneous algebraic function of any number of variables x,, x2, The degree in the variables is called the order of the quantic, and according as the number of variables is two, three, four Thus a binary quantic of order n is a rational integral homogeneous algebraic function of two variables which is of the nth degree in those variables. The former of these expressions is now commonly written ao, a,. Passing now to the case of any number of variables, we call the quantic a p-ary q-ic when it is homogeneous and of degree q in p variables. If D vanishes it is evident that xl and x2 are virtually identical, for their ratio is constant, and hence, as the variables are always supposed to be independent, we shall throughout only deal with transformations which have a non-vanishing determinant. This is called the inverse of the original transformation; it is evident at once that its determinant is equal to. Let us now regard a linear transformation as an operator, which acting on xj, x2 changes them to X1, X2, and let us consider the effect of two such operators acting successively. The product of a transformation and its inverse is a transformation which does not affect the variables, i. The determinant of this is unity, and, as we have pointed out, the product of the determinants of a transformation and its inverse is also unity. The idea of a linear transformation admits of immediate extension to any number of variables xa, x, The determinant D formed with the: In the earlier portion of this work we shall deal almost entirely with binary forms, and although we shall be constantly considering linear transformations and their effects, yet the fact that they form a group will not be explicitly used. Our only object, in introducing these elementary properties of groups, is to point out that the connection between invariants and groups is intimate and universal-in other words, that every group has its accompanying invariants and, conversely, every set of invariants belongs to a group. Invariants of Binary Forms. An exactly similar definition applies to a joint invariant of several binary forms, e. For the present we shall confine our attention to invariants which are rational integral functions of the coefficients. It is easy to see that there is no further loss of generality if we suppose the invariants to be homogeneous in each set of coefficients that they contain. Hence a non-homogeneous invariant is the sum of several homogeneous invariants. This result can be at once extended to any number of binary forms. Covariants of Binary Forms. If a binary form f is changed into a form F by a linear transformation, and a function C of the coefficients of F and the new variables X1, X2 be equal to the same function of the coefficients off and the old variables x,, x2 multiplied by a factor depending only on the transformation, then

C is called a covariant of the binary form. We shall confine our attention to covariants which are rational integral functions both of the coefficients and the variables, and, as in the case of invariants, there is no difficulty in seeing that there is no further loss of generality in supposing such covariants to be homogeneous in the variables and in each set of coefficients involved. In fact if a covariant be not homogeneous it is the sum of several parts each of which is a covariant and homogeneous. Degree and Order of a Covariant. The degree of a covariant of a single form is its degree in the coefficients of that form-the order is the degree in the variables. The covariant - a2 - x ax of a binary form of order n is of degreetwo and order 2n - 4. A covariant of several binary forms has a definite partial degree in each set of coefficients involved and the order is as before the degree in the variables. The Jacobian of f and q is of degree one in the coefficients of each of the two forms, and its order is the sum of the orders of f and 4 diminished by two. This representation is startling at first sight, but consider how the use of it would introduce errors into calculation. They would arise because relations of the type 2n â€"2 2 aF aoao - al - a2 al between the coefficients prevent our binary form from being a general one. There is one method of determining the symbolical representation which is very convenient because it often leads to the expression most suitable for our purpose. Suppose, in fact, that P is a homogeneous function of the mth degree in aO, a, Proceeding in this way we can find an expression Pm-which is linear in each of mn sets of symbols a, b, c, Now having formed the expression Pml we replace each a by the symbol a, each b by the symbol,, each c by the symbol y, and so on. Since the expression is linear in each set of letters, each symbol will occur exactly n times in every term, and then, regarding the symbols as referring to the same quantic, we have the required symbolical expression. I and the convenience of this expression in terms of a, 8f will be abundantly evident in the sequel. By the same method shew that for any binary form a, 12 X 2 2 2 l 2 a - a21 2 axnxn Shew that for a binary form of odd order al32 - a n is zero and write down its value for a form of even order in terms of the coefficients. The expression i- r. The numerical factor - r! Hence the rth polar of f with respect to y is n n - Effect of a Linear Transformation. Accordingly in the transformed expression the coefficient of XIn is found by replacing x by 4 in the original form, and the coefficients of Xn- X2, Xn-2X Of course suitable numerical multipliers must be introduced. Symbolical expressions representing Invariants. Hence I is an invariant. Thus I is an invariant and the multiplying factor is now If this condition be not satisfied the invariant property still holds but the expression has only a symbolical meaning. On the other hand, if every symbol occur to the right degree but the expression be not reducible to the form above, it is an actual function of the coefficients which is not an invariant. I As an example we have an invariant of the second degree a3i n for a binary form of order n. In every case it will be observed that the multiplying factor is a power of 6. A similar method exists for constructing covariants. Hence w is the same for every term. We can thus easily construct any number of covariants of one or more forms, e. As an exercise the reader may prove that the last one vanishes identically. We have seen how useful the symbolical methods are in constructing invariants and covariants. In the next chapter we shall prove that they constitute an ideal calculus when we shew that every invariant and covariant can be represented as a sum of symbolical products of factors of the types as, and ao. Meanwhile anticipating this result we shall indicate the methods of transforming symbolical expressions. These depend on two principles: According to i if a symbolical expression have an actual meaning and contain two equivalent symbols then its value is not altered by interchanging those symbols. More generally the covariant ai3? I , as can easily be verified. From this identity many others may be deduced. II , a result useful in transforming invariants. We are now going to establish the general truth of these properties. As a matter of history, we may observe that the original definition of an invariant stated that the multiplier was of the form mentioned; but following the logical, rather than the historical order, we shall first prove that the multiplier must be a power of the determinant and then proceed to prove the proposition relating to the symbolical forms for invariants and covariants. The solution of this equation is not difficult. In the first place we remark that since: Consequently since F is homogeneous and of degree r F ,. But inasmuch as D is obviously irreducible-i. Hence the theorem is established. The actual work requires two lemmas of great importance in the present subject, and we shall give them separately. To ensure perfect generality we consider Qr P. With the notation of the text prove that ur P. Q contains every term of type there written r! Suppose now that F ao,, a.. II we have seen that ac becomes at and a2 becomes a,; so that if the new form be AO, A,, By definition F Ao, A

Chapter 3 : Alfred Young - Wikipedia

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Chapter 4 : John Hilton Grace - Wikipedia

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