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Chapter 1 : Portal:Linear algebra - Wikipedia

The book, Elements of Vector Algebra, is written for high school and engineering students who wish to gain elementary knowledge of vectors. Algebraic and geometric interpretations of vectors, along with examples and exercises in mathematical and engineering applications, have been provided to help develop a clear understanding of the vector concepts.

A sparse matrix obtained when solving a finite element problem in two dimensions. The non-zero elements are shown in black. In numerical analysis and computer science , a sparse matrix or sparse array is a matrix in which most of the elements are zero. By contrast, if most of the elements are nonzero, then the matrix is considered dense. The number of zero-valued elements divided by the total number of elements e. Conceptually, sparsity corresponds to systems that are loosely coupled. Consider a line of balls connected by springs from one to the next: By contrast, if the same line of balls had springs connecting each ball to all other balls, the system would correspond to a dense matrix. The concept of sparsity is useful in combinatorics and application areas such as network theory , which have a low density of significant data or connections. In linear algebra , the linear span also called the linear hull or just span of a set of vectors in a vector space is the intersection of all linear subspaces which each contain every vector in that set. The linear span of a set of vectors is therefore a vector space. Spans can be generalized to matroids and modules. For expressing that a vector space V is a span of a set S, one commonly uses the following phrases: In linear algebra , Gaussian elimination also known as row reduction is an algorithm for solving systems of linear equations. It is usually understood as a sequence of operations performed on the corresponding matrix of coefficients. This method can also be used to find the rank of a matrix, to calculate the determinant of a matrix, and to calculate the inverse of an invertible square matrix. To perform row reduction on a matrix, one uses a sequence of elementary row operations to modify the matrix until the lower left-hand corner of the matrix is filled with zeros, as much as possible. There are three types of elementary row operations: Swapping two rows, Multiplying a row by a nonzero number, Adding a multiple of one row to another row. Using these operations, a matrix can always be transformed into an upper triangular matrix , and in fact one that is in row echelon form. Once all of the leading coefficients the leftmost nonzero entry in each row are 1, and every column containing a leading coefficient has zeros elsewhere, the matrix is said to be in reduced row echelon form. This final form is unique; in other words, it is independent of the sequence of row operations used. For example, in the following sequence of row operations where multiple elementary operations might be done at each step , the third and fourth matrices are the ones in row echelon form, and the final matrix is the unique reduced row echelon form. In linear algebra , a minor of a matrix A is the determinant of some smaller square matrix , cut down from A by removing one or more of its rows or columns. Minors obtained by removing just one row and one column from square matrices first minors are required for calculating matrix cofactors, which in turn are useful for computing both the determinant and inverse of square matrices. In mathematics , a bivector or 2-vector is a quantity in exterior algebra or geometric algebra that extends the idea of scalars and vectors. If a scalar is considered an order zero quantity, and a vector is an order one quantity, then a bivector can be thought of as being of order two. Bivectors have applications in many areas of mathematics and physics. They are related to complex numbers in two dimensions and to both pseudovectors and quaternions in three dimensions. They can be used to generate rotations in any number of dimensions, and are a useful tool for classifying such rotations. They also are used in physics , tying together a number of otherwise unrelated quantities. Bivectors are generated by the exterior product on vectors: Not all bivectors can be generated as a single exterior product. More precisely, a bivector that can be expressed as an exterior product is called simple; in up to three dimensions all bivectors are simple, but in higher dimensions this is not the case. The geometric algebra GA of a vector space is an algebra over a field , noted for its multiplication operation called the geometric product on a space of elements called multivectors , which is a superset of both the scalars F.

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Chapter 2 : Elements of Vector Algebra

Elements of Algebra Translated From the French, With the Notes of Bernoulli, and the Additions of M. De La Grange by Leonhard Euler The Elements of Algebra by George Lilley Elementary Vector Analysis With Application to Geometry and Physics by C. E. Weatherburn.

Once defined, we study its most basic properties. Now, there are several important observations to make. Many of these will be easier to understand on a second or third reading, and especially after carefully studying the examples in Subsection VS. Something so fundamental that we all agree it is true and accept it without proof. Typically, it would be the logical underpinning that we would begin to build theorems upon. Some might refer to the ten properties of Definition VS as axioms, implying that a vector space is a very natural object and the ten properties are the essence of a vector space. We will instead emphasize that we will begin with a definition of a vector space. After studying the remainder of this chapter, you might return here and remind yourself how all our forthcoming theorems and definitions rest on this foundation. We have been working with vectors frequently, but we should stress here that these have so far just been column vectors â€” scalars arranged in a columnar list of fixed length. We have extended its use to the addition of column vectors and to the addition of matrices, and now we are going to recycle it even further and let it denote vector addition in any possible vector space. Similar comments apply to scalar multiplication. Conversely, we can define our operations any way we like, so long as the ten properties are fulfilled see Example CVS. In Definition VS , the scalars do not have to be complex numbers. There are many, many others. A vector space is composed of three objects, a set and two operations. Also, we usually use the same symbol for both the set and the vector space itself. Do not let this convenience fool you into thinking the operations are secondary! This discussion has either convinced you that we are really embarking on a new level of abstraction, or it has seemed cryptic, mysterious or nonsensical. You might want to return to this section in a few days and give it another read then. In any case, let us look at some concrete examples now. Subsection EVS Examples of Vector Spaces Our aim in this subsection is to give you a storehouse of examples to work with, to become comfortable with the ten vector space properties and to convince you that the multitude of examples justifies at least initially making such a broad definition as Definition VS. Some of our claims will be justified by reference to previous theorems, we will prove some facts from scratch, and we will do one nontrivial example completely. In other places, our usual thoroughness will be neglected, so grab paper and pencil and play along. That entitles us to call a matrix a vector, since a matrix is an element of a vector space. But it is worth comment. The previous two examples may be less than satisfying. We made all the relevant definitions long ago. And the required verifications were all handled by quoting old theorems. However, it is important to consider these two examples first. Indeed, it is these two theorems that motivate us to formulate the abstract definition of a vector space, Definition VS. Now, if we prove some general theorems about vector spaces as we will shortly in Subsection VS. Notice too, how we have taken six definitions and two theorems and reduced them down to two examples. With greater generalization and abstraction our old ideas get downgraded in stature. Let us look at some more examples, now considering some new vector spaces. Example VSS The singleton vector space Perhaps some of the above definitions and verifications seem obvious or like splitting hairs, but the next example should convince you that they are necessary. We will study this one carefully. Check your preconceptions at the door. EVS has provided us with an abundance of examples of vector spaces, most of them containing useful and interesting mathematical objects along with natural operations. In this subsection we will prove some general properties of vector spaces. Some of these results will again seem obvious, but it is important to understand why it is necessary to state and prove them. It is like starting over, as we learn about what can happen in this new algebra we are learning. But the power of this careful approach is that we can apply these theorems to any vector space we encounter â€” those in the previous examples, or new ones we have not yet contemplated. Or perhaps new ones that nobody has ever contemplated. We will illustrate some of these results with examples from the crazy vector space Example CVS , but mostly we are stating theorems and doing proofs. These proofs do not get too involved, but are not trivial either, so these are good theorems to try proving yourself before you study the proof given here. See Proof Technique P. First we show that there is just one zero vector. Notice that the properties only require there to be at least one, and say nothing about there possibly being more. That is because we can use the ten properties of a vector space Definition VS to learn that there can never be more than one. To require that this extra condition be stated as an eleventh property would make the definition of a vector space more complicated than it needs to be. As obvious as the next three theorems appear, nowhere have we guaranteed that the zero scalar, scalar multiplication and the zero vector all interact this way. Until we have proved it, anyway. Here is another theorem that looks like it should be obvious, but is still in need of a proof. Proof Here is another one that sure looks obvious. The theorem is not true because the notation looks so good; it still needs a proof. Not really quite as pretty, is it? Our next theorem is a bit different from several of the others in the list. It should remind you of the situation for complex numbers. This critical property is the driving force behind using a factorization to solve a polynomial equation. One combines two vectors and produces a vector, the other takes a scalar and a vector, producing a vector as the result. And the resulting object would be another vector in the vector space. If you were tempted to call the above expression a linear combination, you would be right. Four of the definitions that were central to our discussions in Chapter V were stated in the context of vectors being column vectors, but were purposely kept broad enough that they could be applied in the context of any vector space. They only rely on the presence of scalars, vectors, vector addition and scalar multiplication to make sense. We will restate them shortly, unchanged, except that their titles and acronyms no longer refer to column vectors, and the hypothesis of being in a vector space has been added. Take the time now to look forward and review each one, and begin to form some connections to what we have done earlier and what we will be doing in subsequent sections and chapters. Specifically, compare the following pairs of definitions:

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Thus, if C be a third vector, (AB)C or C(AB) will simply mean the vector C magnified (stretched) AB times, assuming, that is, that AB is a dimensionless or pure number ; if AB is an area and C, say, a displacement, then (AB) C, the tensor u ELEMENTS OF VECTOR ALGEBRA of fAB)C, is a volume, of course, and so on.

Chapter 5 : Full text of "Elements of vector algebra"

A.I Elements of Vector Algebra Fig. A caused by a force P). In the attached coordinate system, the displacement vector u (see Fig. A.3) can be expressed as follows.

Chapter 6 : Linear Algebra: Vectors - IMTI - Craig Johnston

The geometric algebra (GA) of a vector space is an algebra over a field, noted for its multiplication operation called the geometric product on a space of elements called multivectors, which is a superset of both the scalars and the vector space.

Chapter 7 : Algebra Icon Images, Stock Photos & Vectors | Shutterstock

Generically, a pseudo-vector is the Hodge dual of a vector, but an axial vector is a product of a vector by a vector. In field theory, since there 4 dimensions, pseudo-vectors will also be axial. share | cite | improve this answer.

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Chapter 8 : Geometric algebra - Wikipedia

Elements of vector algebra. by Silberstein, Ludwik, Publication date Topics Vector analysis. Publisher London, New York [etc.] Longmans, Green and co.