Game Theory
Mathematical Prerequisites

The introductory page listed a couple of real-life examples where you can use game theory but did not mention any mathematics. This is because game theory is an *applied* mathematical discipline, and therefore its ***determining side*** is the *real-life phenomena* it tries to model.

The ***secondary***, nonetheless ***essential*** side is of course mathematics. Mathematics serves as a *tool* to build the consistent (abstract) "mental picture" for the understanding of these real life situations. It is an indispensable tool for creating such a mental picture: it forces us to be very clear about what assumptions we are making and it guides us as to the implications of our assumptions. All the mathematical notions and their relationships together form the *mathematical model* of the given class of real-life situations. *Within the mathematical model*, we use mathematical definitions and proofs to further the theory.

Despite the impression you might have gotten from the introduction, this course has a ***strong mathematical side***. Interestingly, "strong" here does *not mean* that you have to know "a lot" of mathematics. Rather, it means that you have to have a ***very good understanding*** of a ***few basic notions*** of few areas (see below) of mathematics. This also implies a certain way thinking, i.e.: "thinking mathematically" (usually acquired through studying mathematics).

Technically, the basic elements the following areas will be used:
Absolutely necessary:

- **Naive Set Theory** (*set* and *set operations*, *Cartesian product*, *relations and functions and their properties*, *inverses*).

The following areas are important, but you might get by if you do not completely recognize everything listed below:

- **Elementary (discrete) Probability Theory** (*event space, probability distribution*, *expected value*, *independence* and *conditional probability* (Bayes's Theorem), *random variable*)
- **Vector Spaces** (finite dimensional, real) (*vector space, linear combination of vectors, convexity, linear and bilinear functions and their representation with numbers* (*matrix, matrix-vector operations*)).
  Note: many of these usually run under the name "Linear Algebra" (for historical reasons).
- **Real Analysis** on (finite dimensional) vector spaces (closed and open sets, compact sets, continuous functions, Extreme Value Theorem).
  Note: if you are familiar with these notions on the real line, that is essentially enough.

If the general background of the class makes it necessary, I *will introduce* these notions in a self-contained format in one (or maximum two) extra class and also during lecture. Nevertheless, I *cannot make up* for a lack of a certain level of "maturity" in mathematical thinking; you should already have at least some of it coming in (it will improve during the class). If the *majority* of the notions listed above sound *completely unfamiliar* to you, you will likely have difficulty following the class in the second half of the semester, even if we have extra classes explaining them.

Overall, this course will *contribute greatly* to your ability to transform "real life" things into mathematical models.