Introduction
<table>
<thead>
<tr>
<th></th>
<th>Numbers and reality</th>
<th>Course requirements</th>
<th>Calculus prefresher</th>
</tr>
</thead>
</table>

**Applied probability theory**
Reality expressed in **quantitative** terms

Quantitative and mathematical methods are a way to learn about complex phenomena by examining **formal relationships** between **numerical constructs** at several levels of application.

Our goal is to apply these methods to **reality** through **data**.
Reality is measurable

How much does your iPod cost?
Realty is **predictable**

*Stopping crime before it starts*

*Sophisticated analysis of data can sometimes tell police where criminals are headed. It's academic now, but the LAPD plans to get involved.*
Reality is **visualizable**
Reality is **multidimensional**
Reality is **relational**

**Friendship ties on Facebook**

**Sexual ties in high school**

*Fig. 2.*—The direct relationship structure at Jefferson High
Data stand as professional assets

**OECD Health Data 2010: Statistics and Indicators**

**AVAILABLE NOW - October 21st - Internet update for OECD Health Data 2010**

**OECD Health Data 2010**, released on 29 June 2010, offers the most comprehensive source of comparable statistics on health and health systems across OECD countries. It is an essential tool for health researchers and policy advisors in governments, the private sector and the academic community, to carry out comparative analyses and draw lessons from international comparisons of diverse health care systems.

- [What is OECD Health Data 2010](#)
Data stand as **policy expertise**
Interpretation is key to all analysis.
Interpretation is difficult

Figure 2. Social distance and loneliness in the Framingham Social Network. This figure shows for each exam the percentage increase in the likelihood a given focal participant (FP) is lonely if a friend or family member at a certain social distance is lonely (where lonely is defined as feeling lonely more than once a week). The relationship is strongest between individuals who are directly connected, but it remains significantly greater than zero at social distances up to three degrees of separation, meaning that a person’s loneliness is associated with the loneliness of people up to three degrees removed from them in the network. Values are derived by comparing the conditional probability of being lonely in the observed network with an identical network (with topology and incidence of loneliness preserved) in which the same number of lonely participants are randomly distributed. Linked participant (LP) social distance refers to closest social distance between the LP and FP (LP = Distance 1, LP’s LP = Distance 2, etc.). Error bars show 95% confidence intervals.
Internal biases in surveys

- Survey design
- Sample frame
- Question wording
- Measurements
- Cognitive limits
- Interference

![Graph showing Obama Approval Percentage]

- Typically Lower For Gallup
- Data from Other Adult/Live Interviewer Polls
- Comparisons with Gallup data
External biases in society

- Media coverage
- Political spin
- Corporate obfuscation
- Lack of data
The weirdest people in the world?

“The findings suggest that members of Western, Educated, Industrialized, Rich, and Democratic (WEIRD) societies, including young children, are among the least representative populations one could find for generalizing about humans.”

Joseph Henrich
Department of Psychology and Department of Economics, University of British Columbia, Vancouver V6T 1Z4, Canada
joseph.henrich@gmail.com
http://www.psych.ubc.ca/~henrich/home.html

Steven J. Heine
Department of Psychology, University of British Columbia, Vancouver V6T 1Z4, Canada
heine@psych.ubc.ca

Ara Norenzayan
Department of Psychology, University of British Columbia, Vancouver V6T 1Z4, Canada
ara@psych.ubc.ca
Interpretation is what this course is eventually about.

- What is the **measurement** of the axes?
- What is the **probability** of 2am being the “usual” peak point?
- What is the **shape** of the time/productivity relationship?
Course objectives

Course topics

- **Essential mathematics**: elementary *calculus* and *probability*
- **Frequentist statistics**: issues in *measurement* and *estimation*
Course objectives

Course topics

- **Essential mathematics**: elementary calculus and probability
- **Frequentist statistics**: issues in measurement and estimation

Course extensions

- **Economics**: Move to the Level 2 groups for a more advanced introduction with economic applications.
- **Programming**: An introduction to statistical computing will take place during the next semester.
Class rules

Attendance is compulsory.

Other internal regulations also apply to grades, plagiarism etc. Please check these matters ASAP with admin.
Class rules

Attendance is compulsory.

Other internal regulations also apply to grades, plagiarism etc. Please check these matters ASAP with admin.

Laptops are not allowed.

You are not required to compute anything on your own for this course, but are required to write in mathematical notation.
Class rules

Attendance is compulsory.

Other internal regulations also apply to grades, plagiarism etc. Please check these matters ASAP with admin.

Laptops are not allowed.

You are not required to compute anything on your own for this course, but are required to write in mathematical notation.

Regular work is an absolute requirement.

There will be plenty of course material to achieve all requirements and find help, but you will need to read and practice weekly.
Let me stress that:

Methods cannot be learned through overnight sessions or other techniques to catch up with late work. Sorry.

This won’t work.
Class logistics

Elect a student representative!

No course without representation.

Any questions so far?

Do not worry about readings, homework, exams and grades: these will be discussed in class and details will reach you by email.
Calculus prefresher
Real numbers

Real Numbers

Some things can be represented with numbers like $-1, 0, 8.697$ or $10.6$ trillion $(10,600,000,000,000)$. All these numbers belong to the set of real numbers $\mathbb{R}$. Calculus is based on the real number system.

Integers

To explore real numbers, we start with integers, which can be either positive or negative:

$$\ldots \quad -4 \quad -3 \quad -2 \quad -1 \quad 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad \ldots$$
Rational numbers

We complete the set by adding ratios of integers, or fractions, a.k.a. **rational numbers**:

\[ r = \frac{m}{n} \text{ where } m \text{ and } n \text{ are integers and } n \neq 0 \]
Rational numbers

We complete the set by adding ratios of integers, or fractions, a.k.a. **rational numbers**:

\[ r = \frac{m}{n} \] where \( m \) and \( n \) are integers and \( n \neq 0 \)

Irrational numbers

Some numbers like \( \sqrt{2} \) are called irrational numbers because they cannot be expressed as a ratio of integers. Irrational numbers nonetheless belong to the real number line.
Functions

Domain and range

A function $f$ (or $g$, or $h$, or anything...) consists of two things:

- A set $D$ of objects, called the domain of the function;
- A rule which associates to each object $x$ in $D$ another object, called the value of $f$ at $x$. When abstract, this second object will be written $f(x)$.
- The set of all values of the function is called its range.
Functions

Domain and range

A function $f$ (or $g$, or $h$, or anything...) consists of two things:

- A set $D$ of objects, called the domain of the function;
- A rule which associates to each object $x$ in $D$ another object, called the value of $f$ at $x$. When abstract, this second object will be written $f(x)$.
- The set of all values of the function is called its range.

Real-valued functions

- When the domain is the set $\mathbb{R}$ of real numbers, we call $f$ a real-valued function.
- A real-valued function can be represented by its curve.
Functions

- Affine functions $f : x \rightarrow ax + b$
Functions

- Affine functions $f : x \rightarrow ax + b$
- Power functions $g : y \rightarrow y^n$
Functions

- Affine functions $f : x \rightarrow ax + b$
- Power functions $g : y \rightarrow y^n$
- Inverse power functions $h : z \rightarrow \frac{1}{z^n} = z^{-n}$
Functions

- Affine functions $f : x \rightarrow ax + b$
- Power functions $g : y \rightarrow y^n$
- Inverse power functions $h : z \rightarrow \frac{1}{z^n} = z^{-n}$
- The square-root function $h : t \rightarrow \sqrt{t}$, which is only defined on the set of nonnegative real numbers, $\mathbb{R}^+$. 

And of course, sums, products and compositions exist for all these functions: $1 + \sqrt{x}$, $t^2 + 12t^4$, etc. We’ll be using such notation to translate real-world problems into mathematical language.
Functions

- Affine functions $f : x \rightarrow ax + b$
- Power functions $g : y \rightarrow y^n$
- Inverse power functions $h : z \rightarrow \frac{1}{z^n} = z^{-n}$
- The square-root function $h : t \rightarrow \sqrt{t}$, which is only defined on the set of nonnegative real numbers, $\mathbb{R}^+$. 

And of course, sums, products and compositions exist for all these functions: $1 + \sqrt{x}$, $\frac{t^2}{7+12t^4}$, etc.

We’ll be using such notation to translate real-world problems into mathematical language.
Thank you for your attention and welcome to the course!

francois.briatte@sciences-po.org