Photo Scavenger Hunt

The goal of this activity is to introduce you to some of the architectural wonders and points of interest Université Laval has to offer whilst testing your general mathematical knowledge. We suggest you to form teams of 4 to attack this challenge. For this Scavenger Hunt, you will only need this instruction sheet, a camera and a cellphone which has access to Internet. You are free to use all the resources available to solve our 10 enigmas (Google, books, call a friend, …). Each enigma will require you to take a picture. The winning team will be determined based on two criterions:

1. The number of good answers, in other words do your pictures show the expected element.
2. The originality of the pictures you have taken. Let your creative spirit flow; photo concepts, funny pictures, and accessories (if you find some!) are more than welcome.

To complete the Scavenger Hunt, you will need to send a picture of your team, the names of all members of your team and the pictures you took for the scavenger hunt to Anthony Doyon on Facebook (https://www.facebook.com/anthony.doyon.31/) before 4:30 PM. We will then compile the results and give the winning team their prize tomorrow. Spoiler: The winning team will be awarded Amazon gift cards.

Good luck!
The CUMC 2022 team

Enigmas

You are free to solve the enigmas in the order you find more efficient. There are no dependencies between the enigmas. A member of your team must appear in every picture you will take.

☐ Visit Université Laval's first rector and take a picture with an octagonal pyramid. Hint: You may find such a pyramid on the rooftop of the building appearing in the banner of the CUMC 2022 (see the home page of our website).

☐ Take a picture with a groundhog's burrow. Bonus points if the groundhog also appears on the picture. Even more bonus points if the groundhog is blonde (Yes, blonde groundhogs do live on Université Laval's campus!). IMPORTANT: Please respect animals and stay at a reasonable distance from them while you take your picture. There is no need to scare the last blonde groundhogs living at Université Laval.

☐ A little bit of mathematical culture. Let 18ZW be the year of publication of Riemann's memoir where Z and W are digits. Set XY to be the two-digit number obtained by adding 10 to ZW (again, ZW are digits and so they should not be multiplied here). For this challenge, go to room 10XY, pick your favorite book in the free books bookshelf near the entrance and take a picture with it.

Riemann's memoir

In a short 8-pages article entitled *Über die Anzahl der Primzahlen unter einer gegebenen Grösse (On the Number of Primes Less Than a Given Magnitude)*, Riemann shook the mathematical community for good. In this article, Riemann studies the analytic properties of the function $\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s}$ for a complex parameter s. This function was already known at the time: Leonhard Euler had already studied it for s a real parameter. It is in this article that Riemann formulated its conjecture now known as Riemann's hypothesis:

If $\zeta(s) = 0$, then $Re(s) = \frac{1}{2}$.

This short article is filled with brilliant ideas: in it, Riemann makes explicit the link between $\zeta(s)$ and the logarithmic integral $Li(x)$, gives a proof of the functional equation satisfied by $\zeta(s)$ and discusses the link between $\zeta(s)$ and the distribution of prime numbers. These incredible ideas later inspired de la Vallée Poussin and Hadamard in the conception of the very first proof of the prime number theorem. This theorem states that the number of primes less than a fixed number x is roughly $\frac{x}{log(x)}$. More precisely, if $\pi(x)$ counts the number of primes less than x, Hadamard and de la Vallée Poussin showed that

$$\pi(x) \sim \frac{x}{log(x)}.$$

The ideas contained in Riemann's memoir still inspire today's generation of mathematicians. An example of this influence can be seen in L-functions, analogues of Riemann's ζ function, whose study occupies a central role in today's algebraic number theory.

*The informations above come from the book *The Life of Primes in 37 Episodes* written by Jean-Marie De Koninck and Nicolas Doyon.

☐ Let X be the 3rd Fermat prime. Take a picture with a university building that has X floors.

Pierre de Fermat
We would have liked to write a historical notice about Pierre de Fermat, but the margin of our document was too narrow to contain it.
*Picture of Pierre de Fermat found on https://en.wikipedia.org/wiki/Pierre_de_Fermat

☐ Your next task will make you rediscover a classical treatise by Archimedes named *Measurement of a ??????*. Go in front of pavilion Jean-Charles Bonenfant and take a picture of yourselves and the most beautiful ?????? you can find.

De A. Theuet, Liure II. 46

ARCHIMEDES PHILOSOPHE Grec. Chap. 23.

CE grãd Geometrien & tref-fubtil inuenteur Archimede, duquel ie reprefente icy le naturel pourtraict, que i'ay apporté de Sicile faict en bronze, cõme vne grande medalle, que l'on trouue au fondemẽt des villes fondées par les Cefars Romains, a efté fi excellent en fon aage, que tous les hiftoriẽs Grecs & Latins ne fe trouuerent iamais las ne ennuyez de fes fubtiles inuentions, fciences & graces. De maniere que quand on vouloit dire anciennement quelque chofe eftre elegam-

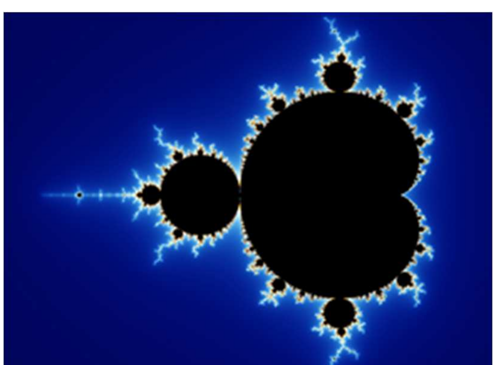
H iiij

*Picture of Archimedes frome the book *Les vrais pourtraits et vies des hommes illustres grecz, latins et payens* written by André Thevet.

☐ Let (r, θ) be the usual basis for polar coordinates and let a,b be real parameters. An equation of the form $r = a + b\theta$ describes a curve called an Archimedean ??????. Take a picture of yourselves and the most beautiful hidden Archimedean ???????? you can find inside pavilion Adrien-Pouliot's cafeteria.

☐ Warning: This enigma requires some thought! Alice and Bob invite 171 couples to a party at their house. Bob, a quite annoying individual who likes maths a bit too much, asks everyone attending to their party with how many people they shook hands with whilst entering their house (Of course, Bob does not ask himself this question.). Curiously, everyone shook hands with a different number of people. If we make the reasonable hypothesis that no one shook hands with his or her partner, how many people did Alice shook hands with? To complete this challenge, take a picture of yourselves in front of room 00X where X is the number of people Alice shook hands with.

☐ Take a picture of yourselves with any fractal you found on campus. It can be a natural fractal, a fractal found on a poster, …



*Picture of the Mandelbrot set from https://fr-academic.com/dic.nsf/frwiki/583957

Mandelbrot set
Here is a picture of the Mandelbrot set, one of the most popular fractals, in mathematics at least. This set was first studied in 1978 by Robert W. Brooks and Peter Maleski. It is named after Benoit Mandelbrot who obtained visual representations of this set that are close to those we have today. Black pixels in the picture represent complex numbers c such that the iterations of the function

$$f_c(z) = z^2 + c$$

Remain bounded, i.e. the sequence $f_c(0), f_c(f_c(0)), \ldots$ is bounded. For those of you who know a bit about fractals, it can be shown that the boundary of the Mandelbrot set has Hausdorff dimension 2.
*The informations above come from the article https://www.futurasciences.com/sciences/dossiers/mathematiques-fractales-curiosite-mathematique234/page/7/

Évariste Galois

Turbulent young man, political revolutionary, misunderstood genius are three qualifiers that describe Évariste Galois well. Galois' mathematical contributions are mainly related to group theory. His theory culminates with the fundamental theorem of Galois theory who describes explicitly a strong correspondence between subextensions in a tower of field extensions and subgroup of certain specific permutation groups, called Galois groups, associated to this tower. The tools of Galois theory led the next generations of mathematicians to the proof of the insolvability (with radicals) of the general quintic and the impossibility of trisecting an angle in Euclidean geometry. Unfortunately, this mathematical genius passed away at a very young age. He died at 20 years old during a duel leaving its peers to decipher the wonders kept in his unpublished hand-written notes.

*The informations above come from the book *Galois Theory* written by Ian Stewart and the portrait comes from https://en.wikipedia.org/wiki/%C3%89variste_Galois.

☐ Let XY be the digits of the 2nd perfect number and let ZW be any digits you like. Go in pavilion Alexandre-Vachon inside room XYZW and draw your most beautiful portrait of Évariste Galois on the blackboard. On this blackboard, write the number of the room and take a picture of yourselves with your masterpiece.

☐ Take a picture of yourselves on the bridge connecting pavilion La Laurentienne to pavilion Palasis-Prince. To make this a bit more challenging, find an original way of including the number of founding members of the Bourbaki group.

Nicolas Bourbaki

Nicolas Bourbaki is a fictional mathematician invented by a small group of real mathematicians around 1935. During the years following the foundation of the group, members would regularly meet to decide on a structure for writing a book that was meant to be a complete summary of mathematics entitled *Éléments de mathématique* published under the name of Nicolas Bourbaki. Bourbaki provided a systematic way of rigorously exposing mathematics. Bourbaki's book had and still has a massive influence on the way mathematics were taught. Traces of this influence can certainly be found in most of your mathematical textbooks. It is interesting to note that Bourbaki "still lives" as of today and organizes weekly seminars.

*The informations above come from https://www.bourbaki.fr/. The picture showing the restaurant la Capoulade where the members of Bourbaki regularly met comes from https://wehadfacesthen.tumblr.com/post/176293332670/cafe-capoulade-paris-1954-photo-by-inge-morath.