

# Traitement de données et modélisation avec


## Devoir N°1

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### Chapitre 1: Principales lois de probabilités

Ci-dessous, les réponses obtenues aux messages envoyés à l'open AI ChatGPT, consulté le 22 octobre 2024.

Calculez, via , les probabilités des événements cités.

**Déposez la grille des réponses sur MOODLE avant le Samedi 9 Novembre 2024, 23h59.**

#### Message 1: Practical examples of binomial distribution.

 The binomial distribution is useful in scenarios where we are dealing with a fixed number of trials, each having two possible outcomes (success or failure). Here are a few **practical examples** of where the binomial distribution can be applied:

##### 1. Quality Control in Manufacturing

- A factory produces lightbulbs, and there's a known defect rate of 5%. If a quality inspector randomly selects 20 lightbulbs from a production batch, the probability of finding exactly 3 defective bulbs can be modeled with a binomial distribution.

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### Section 1: Lois discrètes

- Number of trials: 20 (lightbulbs)
- Probability of success (defective): 5% or 0.05
- Probability of failure (non-defective): 95% or 0.95

*Commande 1:*

```
> dbinom (3, 20, 0.05)
```

### 2. Flipping a Coin

- If you flip a coin 10 times, what is the probability of getting exactly 7 heads? This can be modeled using the binomial distribution:
  - Number of trials: 10 (coin flips)
  - Probability of success (getting heads): 50% or 0.5
  - Probability of failure (getting tails): 50% or 0.5

### 3. Medical Testing

- Suppose 1 in 100 people in a certain population has a rare disease. If you randomly test 50 people from this population, the binomial distribution can help calculate the probability that exactly 2 of them have the disease.
  - Number of trials: 50 (people tested)
  - Probability of success (having the disease): 1% or 0.01

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- Probability of failure (not having the disease): 99% or 0.99

#### 4. Email Marketing Campaign

- An email marketing campaign has a 10% click-through rate (CTR). If the campaign is sent to 100 people, the binomial distribution can be used to calculate the probability that exactly 15 people click the email link.
  - Number of trials: 100 (emails sent)
  - Probability of success (clicking the link): 10% or 0.10
  - Probability of failure (not clicking the link): 90% or 0.90

#### 5. Sports Outcomes

- In basketball, a player has a 75% chance of making a free throw. If the player attempts 8 free throws in a game, the binomial distribution can be used to find the probability of making exactly 6 successful free throws.
  - Number of trials: 8 (free throws)
  - Probability of success (making the shot): 75% or 0.75
  - Probability of failure (missing the shot): 25% or 0.25

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#### 6. Voting Behavior

- In an election, if a pollster knows that 60% of a population supports a particular candidate, and they interview 12 people, the binomial distribution can help estimate the probability that exactly 8 people will say they support the candidate.
  - Number of trials: 12 (people interviewed)
  - Probability of success (supporting the candidate): 60% or 0.60
  - Probability of failure (not supporting the candidate): 40% or 0.40

#### 7. Genetics

- In genetics, suppose the probability of inheriting a particular gene from a parent is 50%. For a family with 3 children, the binomial distribution can calculate the probability that exactly 2 children will inherit the gene.
  - Number of trials: 3 (children)
  - Probability of success (inheriting the gene): 50% or 0.5
  - Probability of failure (not inheriting the gene): 50% or 0.5

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These examples illustrate how the binomial distribution applies to real-world situations where each event has two possible outcomes, and the trials are independent.

**Message 2: More examples of binomial distribution in practical life**



Here are **more practical examples** of the binomial distribution in various real-world scenarios:

### 8. Drug Testing in Pharmaceuticals

- A pharmaceutical company is testing a new drug, and the probability of a patient experiencing a certain side effect is 20%. If 30 patients take the drug, the binomial distribution can help determine the probability that exactly 5 of them will experience the side effect.
  - Number of trials: 30 (patients)
  - Probability of success (experiencing side effect): 20% or 0.20
  - Probability of failure (no side effect): 80% or 0.80

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### 9. Customer Satisfaction Survey

- A company knows that 70% of customers are satisfied with their product. If they randomly select 50 customers for a survey, the binomial distribution can be used to calculate the probability that exactly 40 customers will express satisfaction.
  - Number of trials: 50 (customers surveyed)
  - Probability of success (satisfaction): 70% or 0.70
  - Probability of failure (dissatisfaction): 30% or 0.30

### 10. Defective Products in a Shipment

- A shipment contains 100 items, and there's a 3% defect rate. A retailer selects 10 items at random. The binomial distribution can be used to calculate the probability that 2 items are defective.
  - Number of trials: 10 (items)
  - Probability of success (defective): 3% or 0.03
  - Probability of failure (non-defective): 97% or 0.97

### 11. Online Purchases

- A website has a 15% conversion rate (the percentage of visitors who make a purchase). If 20 people visit the site, the

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binomial distribution can estimate the probability that 5 visitors make a purchase.

- Number of trials: 20 (visitors)
- Probability of success (purchase): 15% or 0.15
- Probability of failure (no purchase): 85% or 0.85

### 12. Phone Survey Response

- A company conducting a phone survey knows that 30% of people will answer their phone. If the company calls 50 people, the binomial distribution can help predict the probability that exactly 20 people will answer.
  - Number of trials: 50 (calls made)
  - Probability of success (answering the phone): 30% or 0.30
  - Probability of failure (not answering): 70% or 0.70

### 13. Social Media Engagement

- A social media post has a 25% engagement rate (people who like, share, or comment). If the post reaches 100 people, the binomial distribution can calculate the probability that exactly 30 people engage with the post.
  - Number of trials: 100 (people reached)

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- Probability of success (engagement): 25% or 0.25
- Probability of failure (no engagement): 75% or 0.75

### 14. Insurance Claims

- An insurance company finds that 2% of its clients file claims each year. If the company has 1,000 clients, the binomial distribution can be used to estimate the probability that exactly 30 clients will file claims.
  - Number of trials: 1,000 (clients)
  - Probability of success (filing a claim): 2% or 0.02
  - Probability of failure (not filing a claim): 98% or 0.98

### 15. College Admission

- A university knows that 40% of applicants are accepted. If 200 students apply, the binomial distribution can estimate the probability that exactly 80 students will be accepted.
  - Number of trials: 200 (applicants)
  - Probability of success (acceptance): 40% or 0.40
  - Probability of failure (rejection): 60% or 0.60

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#### 16. Sports Betting

- In a soccer tournament, a player has a 60% chance of scoring a goal when taking a penalty. If the player takes 5 penalties in a game, the binomial distribution can calculate the probability of scoring exactly 3 goals.
  - Number of trials: 5 (penalties)
  - Probability of success (goal): 60% or 0.60
  - Probability of failure (miss): 40% or 0.40

#### 17. Absenteeism in Schools

- A school has found that, on average, 10% of students are absent on any given day. In a class of 30 students, the binomial distribution can help determine the probability that exactly 3 students will be absent.
  - Number of trials: 30 (students)
  - Probability of success (absent): 10% or 0.10
  - Probability of failure (present): 90% or 0.90

#### 18. Lottery Tickets

- In a lottery where the chance of winning is 1 in 1000, if someone buys 10 tickets, the binomial distribution can calculate the probability of winning exactly once.

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- Number of trials: 10 (tickets purchased)
- Probability of success (winning): 0.1% or 0.001
- Probability of failure (not winning): 99.9% or 0.999

#### 19. Job Interviews

- A job applicant has a 20% chance of getting a positive response from each company they apply to. If they apply to 15 companies, the binomial distribution can be used to find the probability that they will get exactly 4 job offers.
  - Number of trials: 15 (applications)
  - Probability of success (job offer): 20% or 0.20
  - Probability of failure (no job offer): 80% or 0.80

These examples show how the binomial distribution applies in everyday life across different fields, including business, healthcare, education, and more. It is especially useful when the outcome of interest has only two possible outcomes (success or failure) and the probability of success remains constant across all trials.

**Message 3: More examples, in biology, of binomial distribution.**



Binomial **distribution** is widely used in **biology** for modeling experiments and observations involving dichotomous

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outcomes, such as success/failure, presence/absence, or alive/dead. Here are more practical **examples of binomial distribution in biology**:

#### 20. Genetics and Mendelian Inheritance

- In classical genetics, if a gene has two alleles, and the probability of inheriting a dominant allele is 50%, the binomial distribution can be used to predict the probability of different combinations of genotypes in offspring. For example, in a cross between two heterozygous parents (Aa), the probability of each child inheriting a dominant (A) or recessive (a) allele can be modeled as a binomial process.
  - Number of trials: 3 (children)
  - Probability of success (inheriting dominant allele): 50% or 0.5
  - Probability of failure (inheriting recessive allele): 50% or 0.5

#### 21. Survival Rates in Ecology

- In a population of animals where 30% of individuals are expected to survive a particular environmental condition (such as winter), a biologist might use the binomial

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distribution to estimate the probability that, in a group of 100 animals, exactly 40 will survive.

- Number of trials: 100 (animals)
- Probability of success (survival): 30% or 0.30
- Probability of failure (death): 70% or 0.70

#### 22. Hardy-Weinberg Equilibrium

- In population genetics, the Hardy-Weinberg principle is used to model the distribution of alleles in a population under specific conditions. For example, if 20% of a population carries a recessive allele, the probability of randomly selecting individuals who carry this allele can be modeled as a binomial distribution.
  - Number of trials: A given number of individuals sampled
  - Probability of success (carrying the allele): 20% or 0.20
  - Probability of failure (not carrying the allele): 80% or 0.80

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#### 23. Mutation Studies

- In a study of mutations, suppose 1% of bacteria in a culture are resistant to a particular antibiotic. If a biologist samples 500 bacteria, the binomial distribution can be used to predict the probability that exactly 5 of them are resistant to the antibiotic.
  - Number of trials: 500 (bacteria)
  - Probability of success (resistant): 1% or 0.01
  - Probability of failure (non-resistant): 99% or 0.99

#### 24. Plant Reproduction

- In plant biology, if a specific trait (e.g., flower color) is governed by a dominant allele, and there's a 75% chance that an offspring plant will exhibit the dominant trait, the binomial distribution can be used to estimate the number of offspring with the dominant trait in a sample of 50 plants.
  - Number of trials: 50 (offspring plants)
  - Probability of success (dominant trait): 75% or 0.75
  - Probability of failure (recessive trait): 25% or 0.25

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#### 25. Epidemiology: Disease Transmission

- In the study of infectious diseases, if the probability of a person contracting a particular virus is 10%, the binomial distribution can be used to estimate how many people in a population of 200 individuals are likely to become infected.
  - Number of trials: 200 (individuals)
  - Probability of success (infection): 10% or 0.10
  - Probability of failure (no infection): 90% or 0.90

#### 26. Success of Pollination

- A certain type of flower is known to successfully pollinate 40% of the time when visited by a bee. If a biologist observes 25 visits by bees, the binomial distribution can model the probability that exactly 10 visits result in successful pollination.
  - Number of trials: 25 (bee visits)
  - Probability of success (pollination): 40% or 0.40
  - Probability of failure (no pollination): 60% or 0.60

#### 27. Animal Behavior Studies

- In studies of animal behavior, suppose researchers are looking at how often a specific behavior (e.g., hunting

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success in lions) occurs. If the probability of a successful hunt is 20%, and a researcher observes 15 hunting attempts, the binomial distribution can calculate the probability that exactly 5 hunts are successful.

- Number of trials: 15 (hunting attempts)
- Probability of success (successful hunt): 20% or 0.20
- Probability of failure (unsuccessful hunt): 80% or 0.80

#### 28. Population Dynamics and Extinction Risk

- In a small population of endangered animals, if the probability of survival for each individual over a year is 85%, the binomial distribution can estimate the probability that, out of 10 individuals, exactly 8 survive the year.
  - Number of trials: 10 (individuals)
  - Probability of success (survival): 85% or 0.85
  - Probability of failure (death): 15% or 0.15

#### 29. Fertilization Success in Fish

- In fish species that reproduce through external fertilization, if a biologist knows that the probability of an egg being

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successfully fertilized is 60%, the binomial distribution can model how many of 1000 eggs will be fertilized.

- Number of trials: 1000 (eggs)
- Probability of success (fertilization): 60% or 0.60
- Probability of failure (no fertilization): 40% or 0.40

#### 30. Drug Resistance in Bacteria

- In antibiotic resistance studies, if the probability that a bacterium develops resistance to an antibiotic is 5%, a biologist could use the binomial distribution to calculate the probability that out of 200 bacteria, 12 develop resistance.
  - Number of trials: 200 (bacteria)
  - Probability of success (developing resistance): 5% or 0.05
  - Probability of failure (no resistance): 95% or 0.95

#### 31. Mortality Rates in Field Studies

- In field studies of species mortality, if 70% of birds are expected to survive a migration, the binomial distribution can be used to estimate the number of survivors from a group of 50 birds.
  - Number of trials: 50 (birds)



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- Probability of success (surviving the migration): 70% or 0.70
- Probability of failure (not surviving): 30% or 0.30

These examples demonstrate the **binomial distribution's utility in biology** for analyzing events with two possible outcomes, such as survival or death, presence or absence of a trait, success or failure in reproduction, and much more.

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