The Laws of Distribution

The Common Root of the Leonardo Rule, the Pareto Principle, and the Dunbar Number

Content

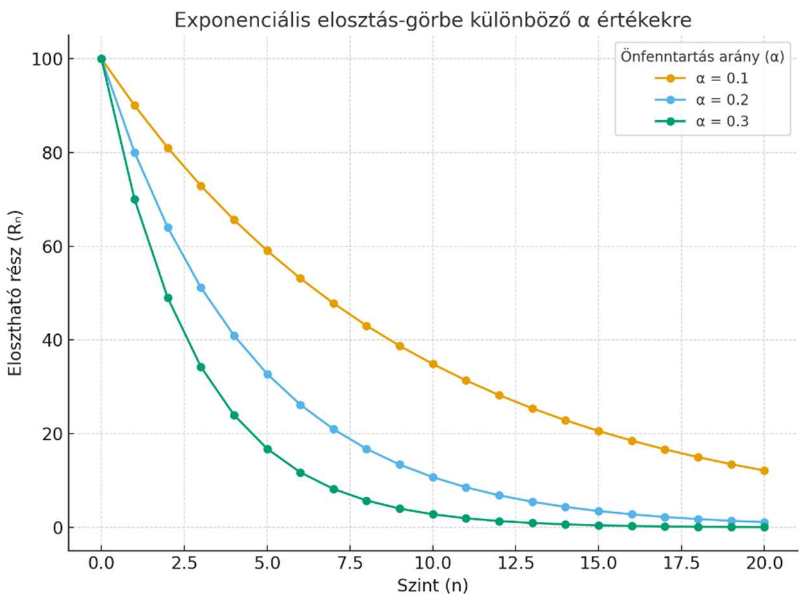
The Laws of Distribution

One of the oldest questions in living and human systems is how to distribute finite resources in a way that ensures the system's survival and keeps every endpoint functional. At first glance, trees, economies, and human social networks seem to have nothing in common. However, upon closer inspection, a shared logic emerges—one that enforces the same law: distribution is finite, fractal, and always organizes itself into structure.

The Formula of Distribution

Let us imagine that we have a given amount of resources X. At each branching point, a portion α must be retained for self-maintenance, and the remainder can be passed on. The energy or attention distributed in this way becomes smaller at each subsequent level: by the time it reaches the endpoints, only what has filtered through the entire network remains. This process can be described with a simple formula: the distributable portion at level nn is $(1-\alpha)^n$, which defines a finite domain for the system.

$$R_n = X \cdot (1-\alpha)^n$$

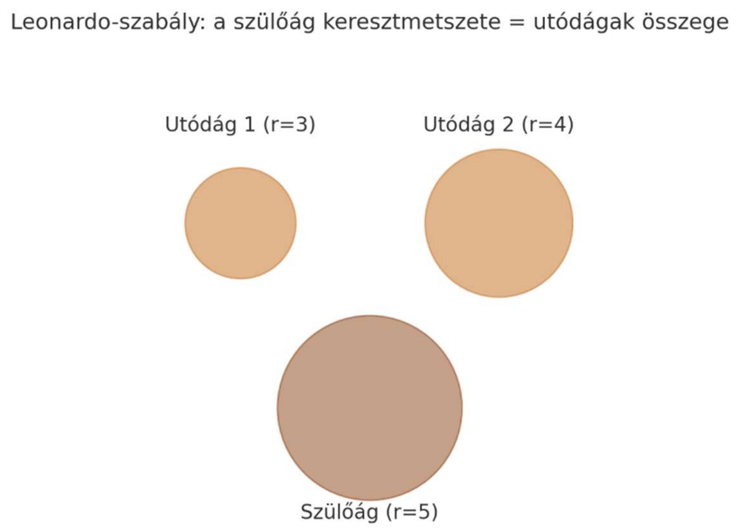


1. Ábra: Exponenciális eloszlás-görbe különböző α értékekre

The Leonardo Rule

Nature follows the same geometric law in trees, blood vessels, and neurons: the cross-sectional area of the parent branch equals the sum of the cross-sectional areas of its child branches. This ensures that the system neither thins out excessively nor becomes unstable. The branching number $\boldsymbol{k}$ is typically 2–3, which profoundly determines the structure of the entire network.

$$r^2 = r_1^2 + r_2^2$$



2. Ábra: Leonardo-szabály: a szülőág keresztmetszete = utódágak összege

The Combination of the Two

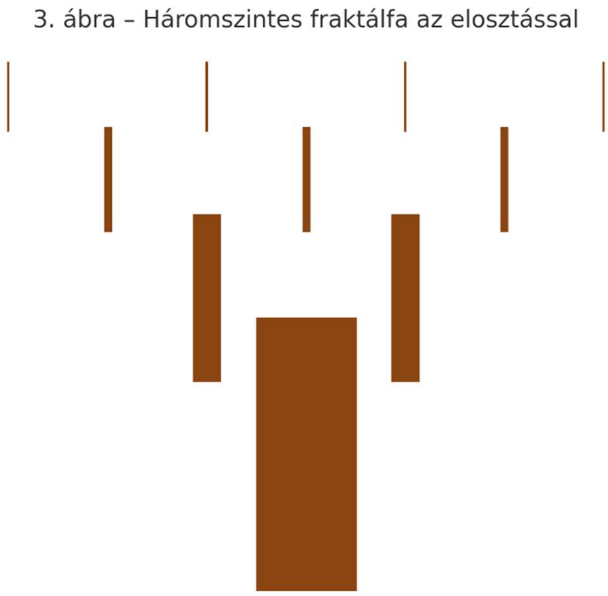
When we compare the distribution formula with the Leonardo Rule, it becomes clear: the portion reaching the endpoints always follows the form

$$\frac{X \cdot (1-\alpha)^L}{k^L}$$

where LL is the number of levels. From this, it directly follows that every system has a maximum number of endpoints. Not because it “doesn’t want” more, but because physics and geometry do not allow it.

Formula:

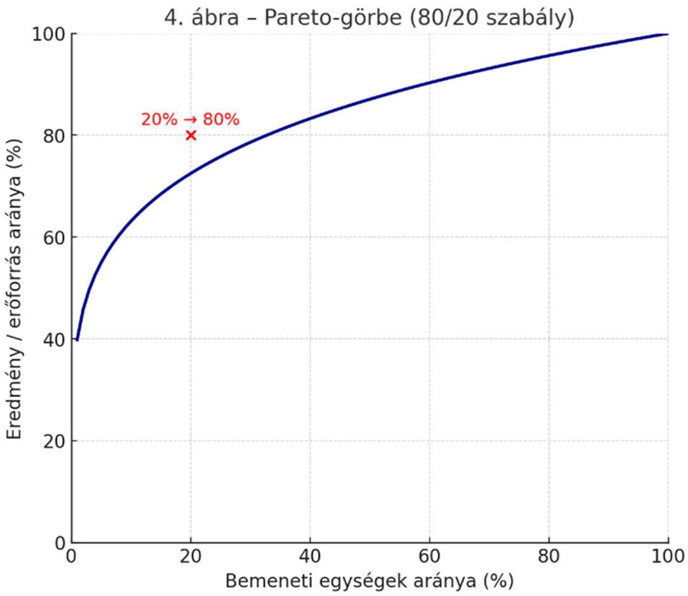
$$Endpointshare = X \cdot \frac{(1-\alpha)^L}{k^L}$$



3. Ábra: Háromszintes fraktálfa az elosztással

The Pareto Principle as a Consequence

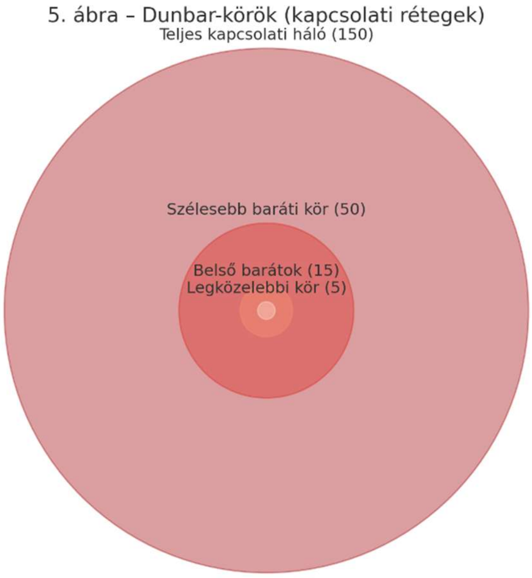
The Pareto Principle is not an empirical rule, but the natural outcome of combining the distribution formula with the Leonardo Rule. The system becomes top-heavy: at the upper levels, a few nodes receive a large share of resources, while at the lower levels, many endpoints share very little. This gives rise to the familiar 80/20 ratio of the Pareto Principle: a small number of units carry most of the system's total value. It is not an exception—it is a necessary consequence. (Note: the ratio observed by Pareto does not align perfectly with the curve; I will elaborate on the reasons for this later.)



4. Ábra: Az elosztás normalizált százalékos reprezentációja

The Dunbar Number as a Consequence

Human relationships are no exception. Attention, time, and energy are also divisible quantities. If every relationship requires a minimum amount of attention **ε**, and each person retains a portion **α** for themselves, then a limit eventually emerges: the maximum number of relationships that can be stably maintained. This is the Dunbar threshold (~150), which has been empirically confirmed by numerous studies.

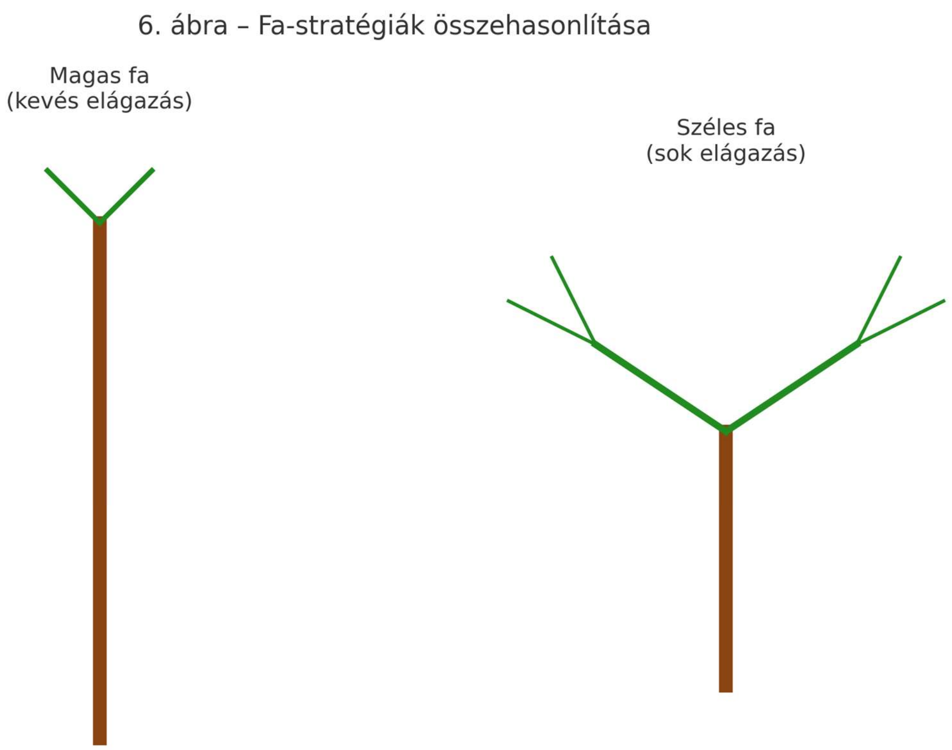


5. Ábra: Dunbar-körök (kapcsolati rétegek)

Consequences

It is worth recognizing that every system also chooses a strategy:

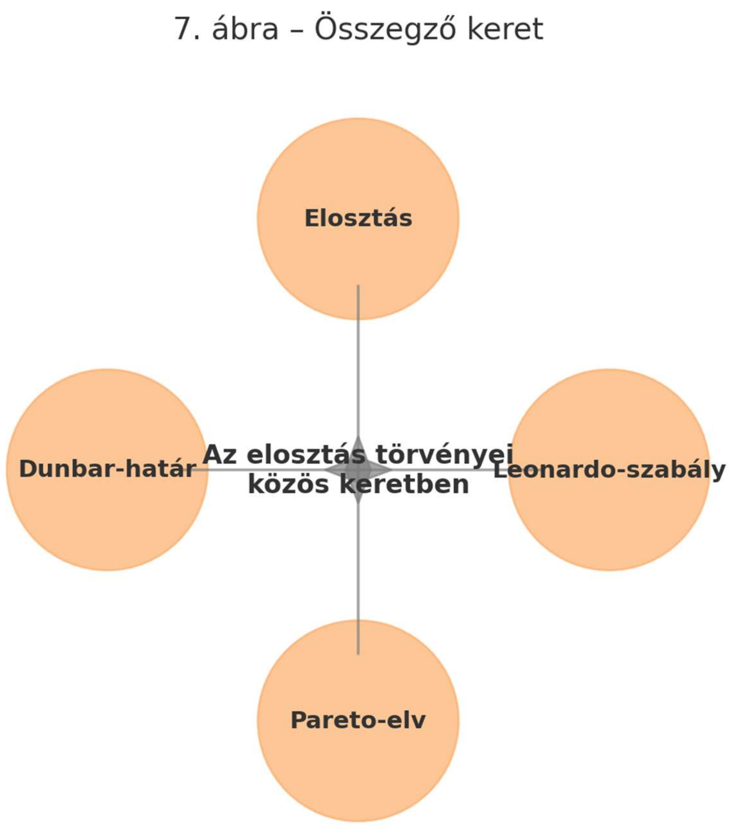
- **Tall trees** with few branches (small $\boldsymbol{k}$) build long trunks and only unfold their canopy at the top. That's why they can reach heights of up to a hundred meters.
- **Wide trees** with more branches (larger $\boldsymbol{k}$) spread broadly but reach lower heights.
- Human networks follow a similar pattern: the inner circle is narrow with strong connections, while the outer circle is wide but consists of looser ties.



6. Ábra: Fa-stratégiák összehasonlítása

Summary

The distribution formula, Leonardo's rule, the Pareto principle, and the Dunbar number are not four separate worlds, but different expressions of the same deeper law. A single logic describes how a system can survive, how far resources can be distributed, and why the same patterns repeat in nature and society. This shared interpretive framework is not just an explanation—it is a bridge: the branching of a tree, economic distribution, and human relationships all answer the same question: **how can the whole be sustained when resources are finite?**



7. Ábra: Összegző keret: Az elosztás tőrvényei közös keretben