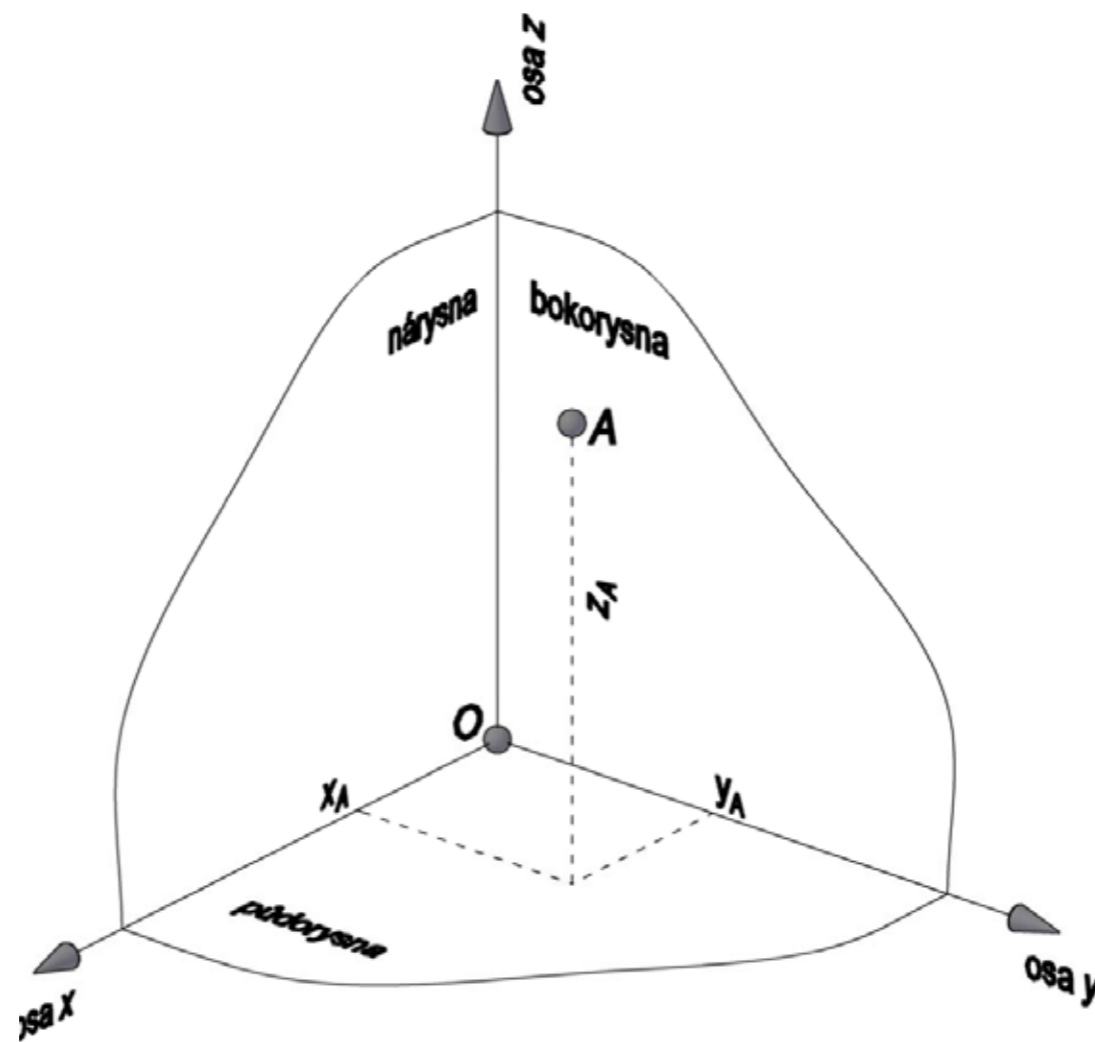
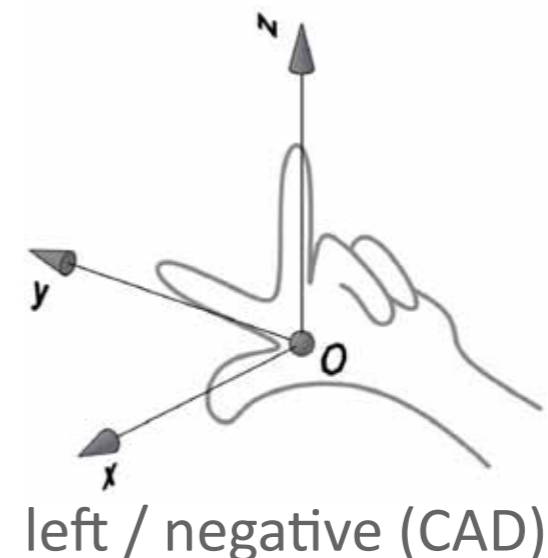
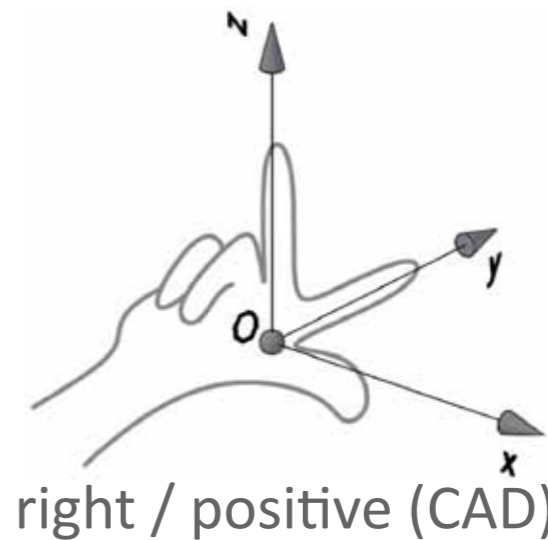


- point is a geometric element that has no dimensions
- all geometric objects are sets of points
- in Cartesian coordinate system (and CAD) is every point given by three real numbers



Cartesian coordinate system



- point objects in CAD are used as helpers
- AutoCAD: object *point*, command POINT
- Rhino: object *point*, command Point
- DIVIDE/Divide, MEASURE or ClosestPt also create points
- entering points:
 - by coordinates x, y, z (2, 3, 1)
 - by distances $\Delta x, \Delta y, \Delta z$ relative to previous entered point (@2, 3, 1)
 - by pointing device ($z = 0!$)
 - by pointing device with object snap (end, mid, cen, int...)
 - by pointing device with object *snap tracking, polar tracking, ortho, smarttrack*
 - by pointing device with *coordinate filter* (.x, .y, .z; .xy, .yz, .zx)
- getting coordinates of point: command ID/EvaluatePt
- getting distance of the points: DIST / Distance

-
- curve is a continuous one-dimensional object (with measurable length, not area nor volume); can be described as a path of a point moving in the space
- **parametric equations** of a curve:
- $x=x(t)$
 - $y=y(t)$
 - $z=z(t)$
 - or shortened as $B(t)=(x(t),y(t),z(t))$,
 - where $t \in (-\infty, \infty)$ is a parameter
 - usually a curve is limited by parameter $t \in (t_1, t_2)$, most often $t \in (0, 1)$

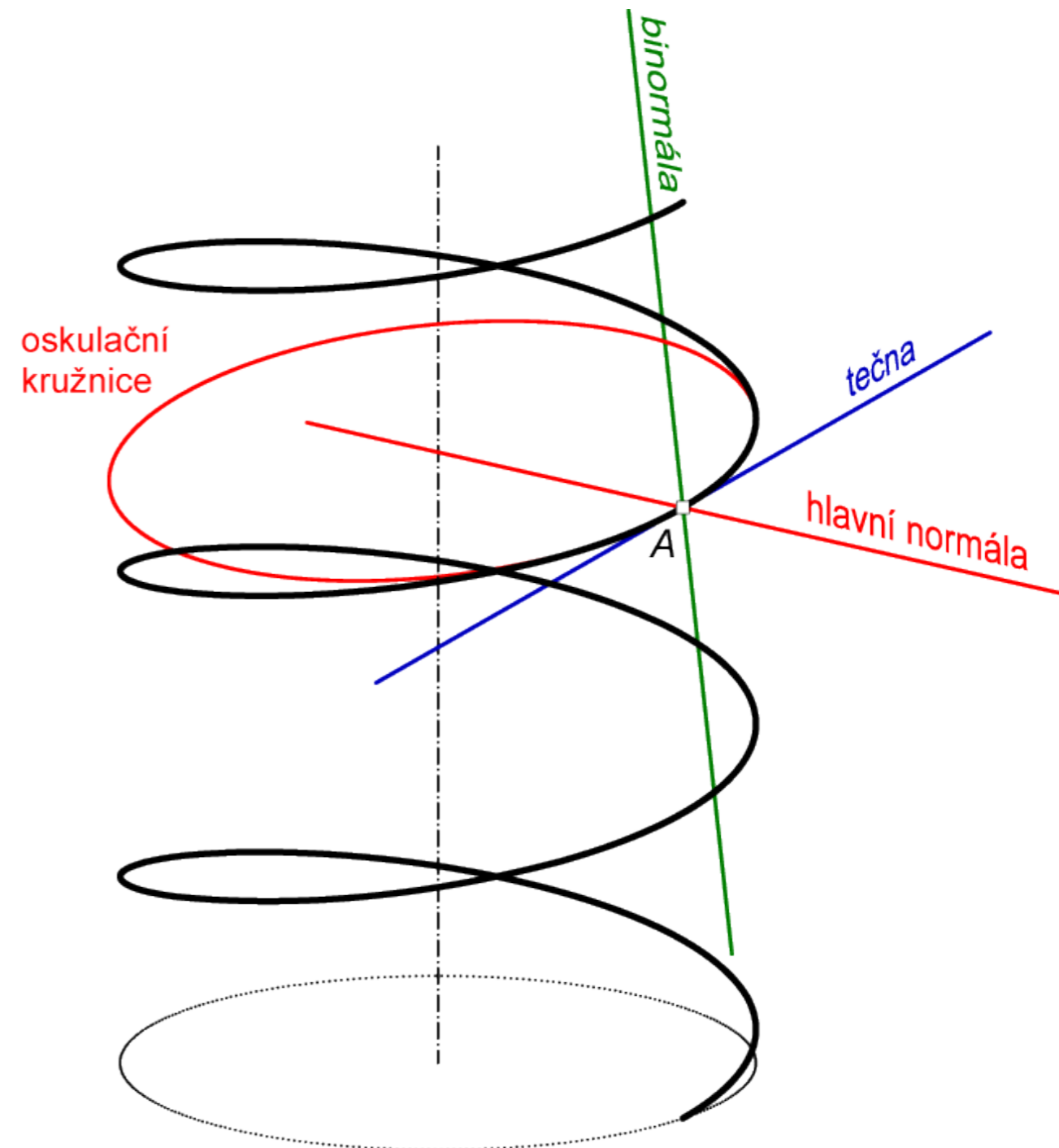
→ **types of curves:**

- *algebraic* – curves with known analytic equations
- *geometric* – curves with known geometric definition
- *empiric* – other curves, hand drawn curves

→ **orientation of a curve:**

- a curve is orientated in direction of increasing parameter t
- orientation is used in orientation of surface and in modeling some more complex surfaces

- *tangent* is a line through two adjacent (indefinitely close) points; geometrically it is touching the curve at one point [blue]
- *osculating circle* is a circle through three adjacent points. It is laying in *osculating plane* [red]
- *normal* is a line perpendicular to the tangent in the touching point; *main normal* is in the osculating plane, *bi-normal* is perpendicular [green]



- *curvature* is rate of change of tangent's direction in adjacent surrounding of a point; it is equal to reciprocal value of osculating circle's radius (e.g. line has a zero curvature and infinite osculating circle's radius)
- *torsion* is rate of change of bi-normal's direction; curves with zero torsion are planar

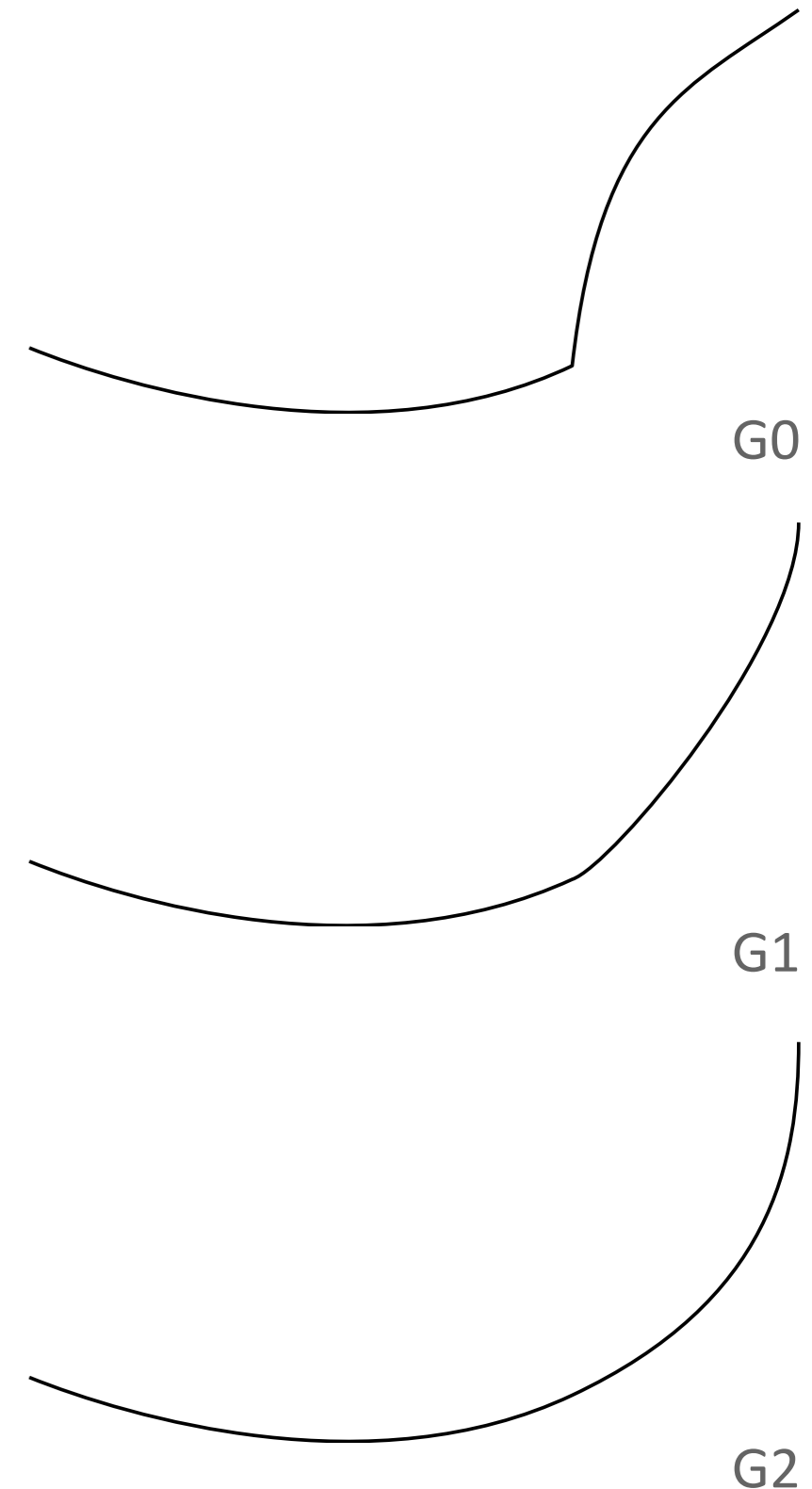
→ **geometric continuity:**

- *G0 continuity in point* – the point has adjacent points from both sides – middle point of a curve
- *G1 continuity in point* – the change of tangent's direction is fluent
- *G2 continuity in point* – the change of curvature is fluent

→ **parametric continuity** adds a “speed” of point related to t :

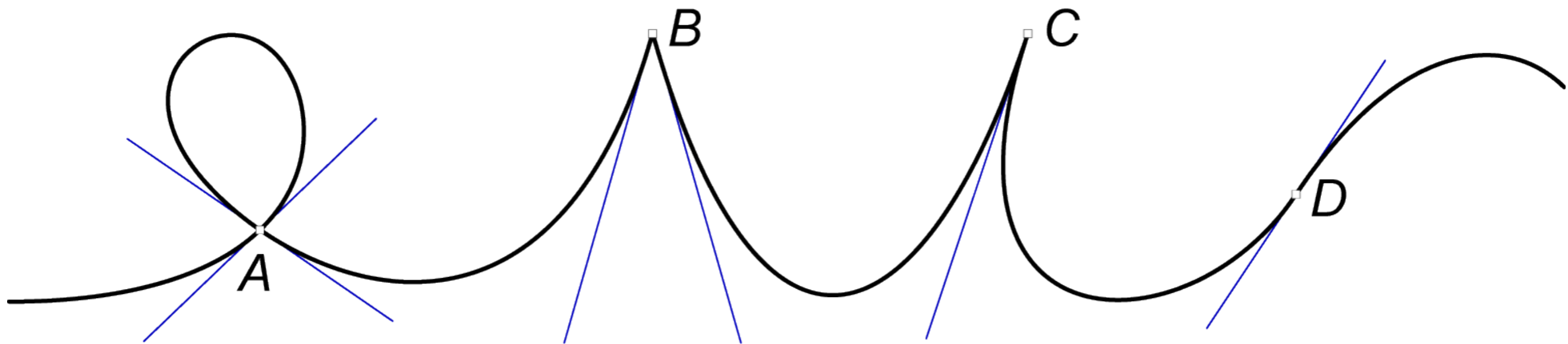
- *C0 continuity* – same as G0
- *C1 continuity* – speed change is fluent
- *C2 continuity* – acceleration change is fluent

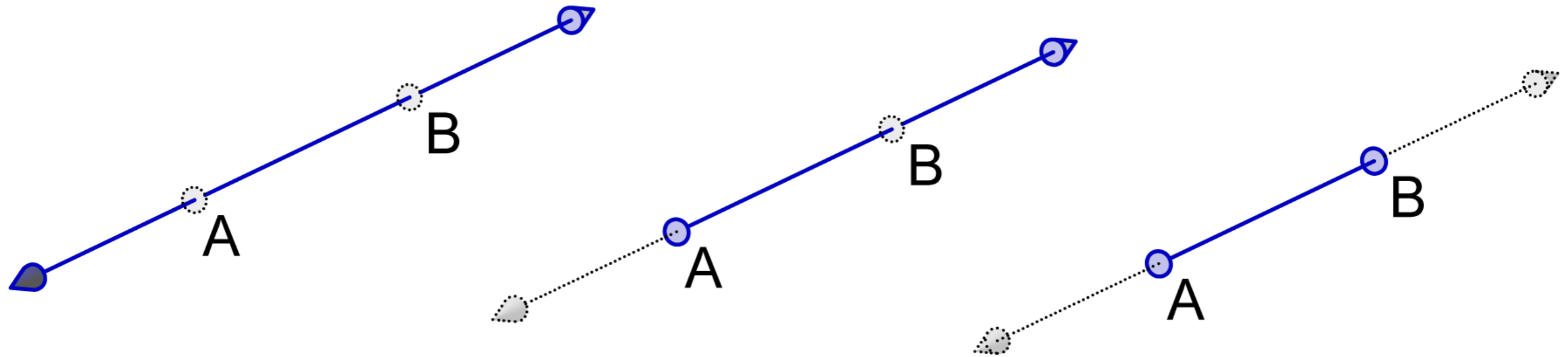
→ a curve is continuous when it is continuous in all its points



→ **special points** of a curve:

- multiple point [*A*]
- isolated point
- refraction point [*B*]
- reversion point [*C*]
- inflection point [*D*]





- straight curve; is given by two points A and B
- *bisector* expands indefinitely in both directions
 - *half-line* expands from point A indefinitely in direction of B
 - *line segment* lays between points A and B

→ parametric equation of line:

$$B(t) = P_0 + mt, \text{ where}$$

P_0 is a point of line for $t=0$, m is a direction vector and t is parameter

→ **line segment:**

- length of line segment is the same as the distance between points
- points C lays on the line segment AB , if $|AC| + |CB| = |AB|$
- middle point M is a point of line segment, $|AM| = |MB|$

- by joining the segments in its end points, we get a polyline, or (regular) polygon

→ AutoCAD

- objects: *line, xline, ray, polyline, 2D polyline, 3D polyline*
- creating commands: LINE, XLINE, RAY, PLINE, 3DPOLY, RECTANG, POLYGON
- editing commands: PEDIT, EXPLODE and JOIN

→ Rhinoceros

- objects: *curve* (all curves, 3D)
- creating commands: Line, Polyline, Rectangle, Polygon
- editing commands: Join, Explode, CloseCrv, InsertLineIntoCrv and other



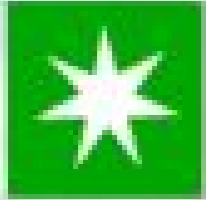
Gizah Pyramids, Egypt, ca. 2500 BC [photo by Ricardo Liberato, 2006, commons.wikimedia.org]



Spittelau Viadukt, Wien, Zaha M. Hadid, 2005 [photo by Petr Šmídek, 2005, www.archiweb.cz]



Holocaust-Mahnmal, Berlin, Peter Eisenman, 2005 [photo by Jan Foretník, 2007]



Superharbour, Baltic Sea, BIG, proposal, 2003 [picture by BIG]