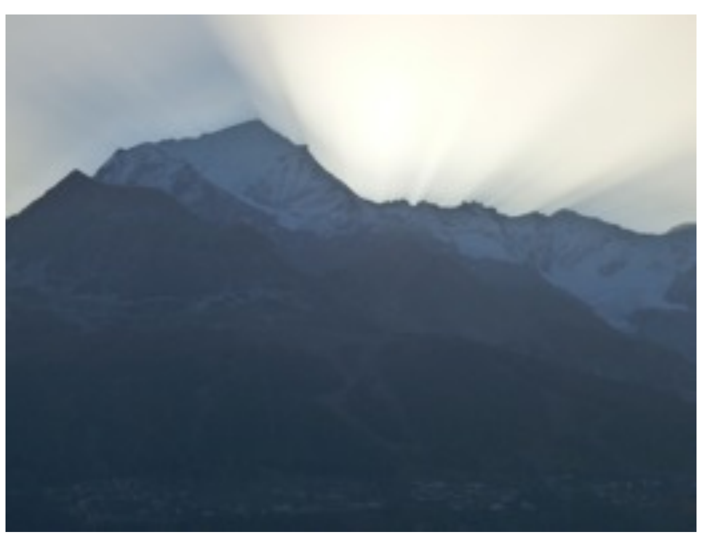
MATHEMATICS FOR THE WORKING ARTIST PART II

An introduction to the qualitative theory of cones



- V main vertex, apex

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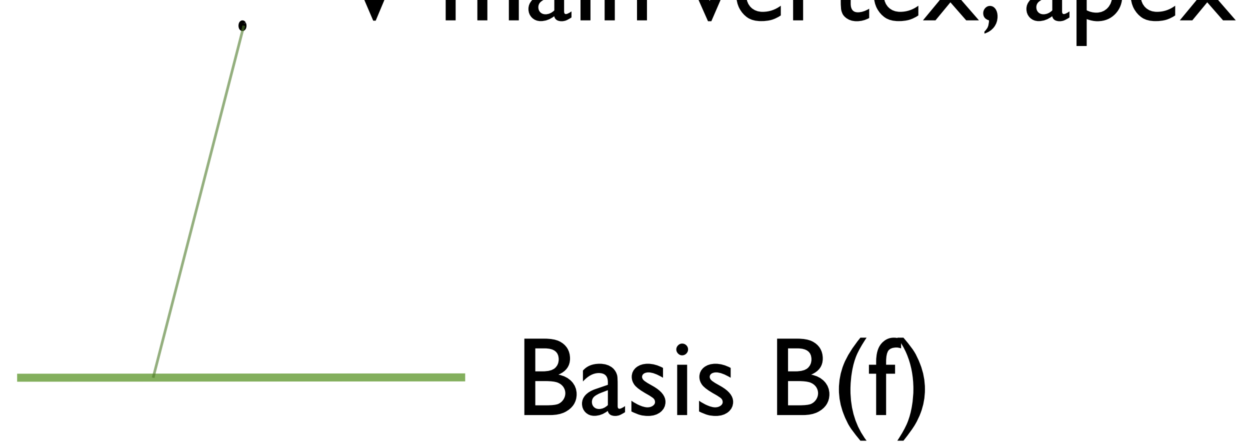
V main vertex, apex

Basis B(f)


V main vertex, apex
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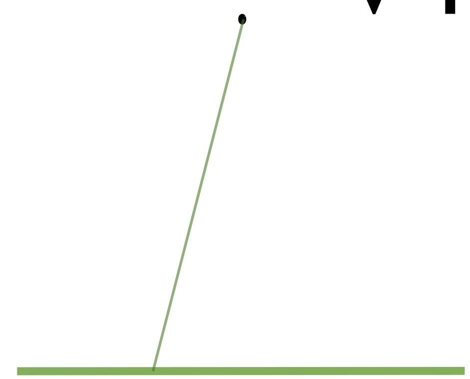

V main vertex, apex

a fiber

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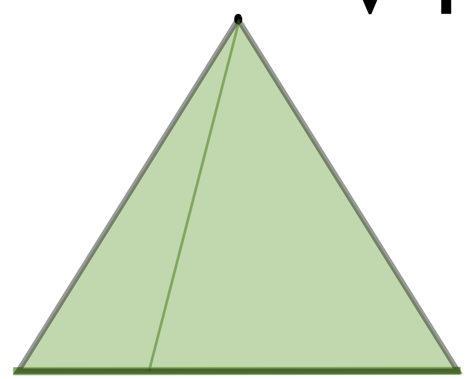

V main vertex, apex

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Basis B(f)

V main vertex, apex

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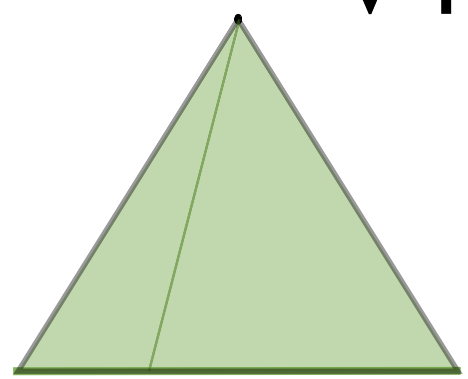

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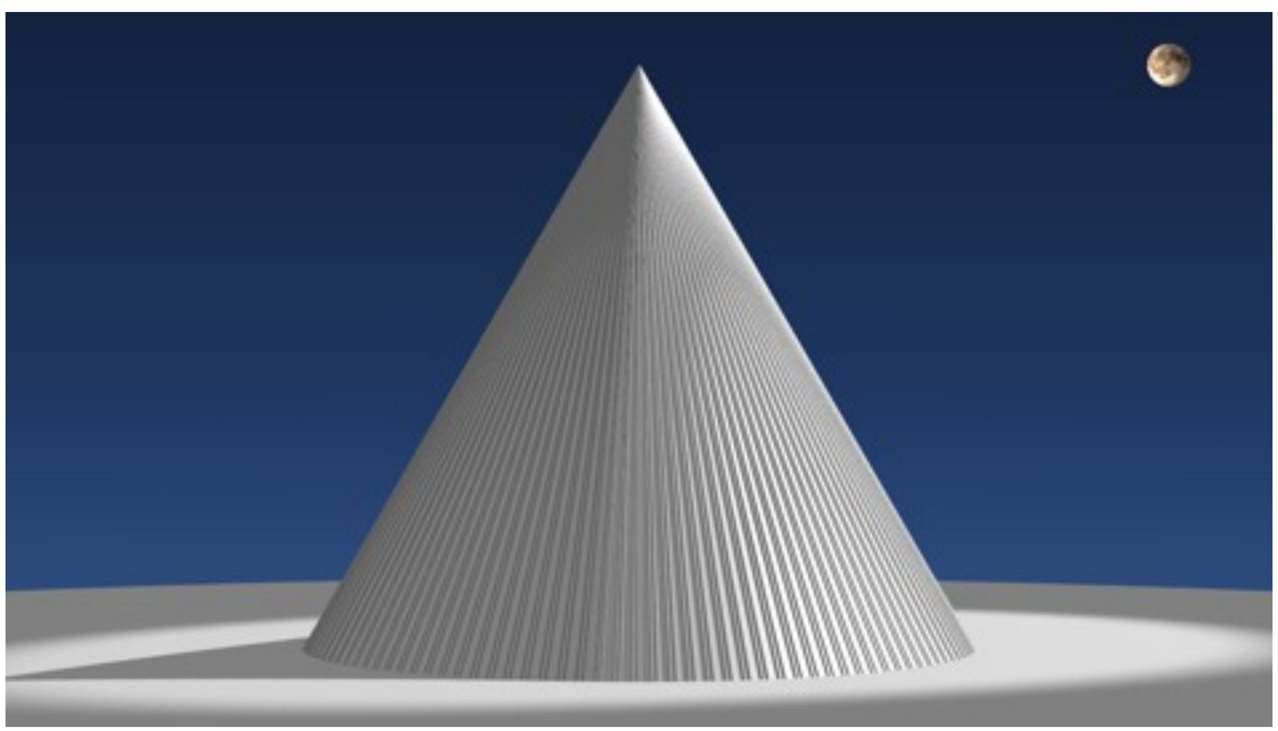
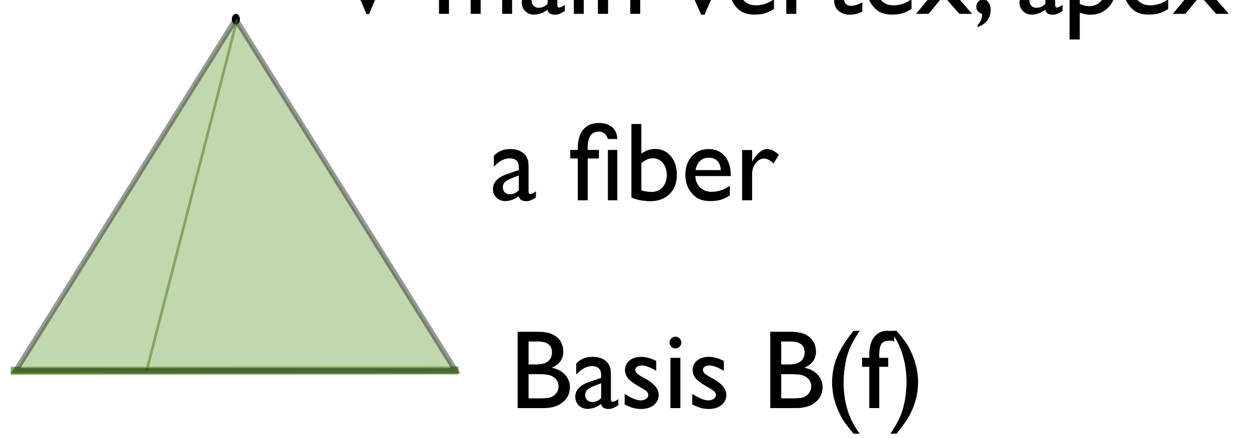
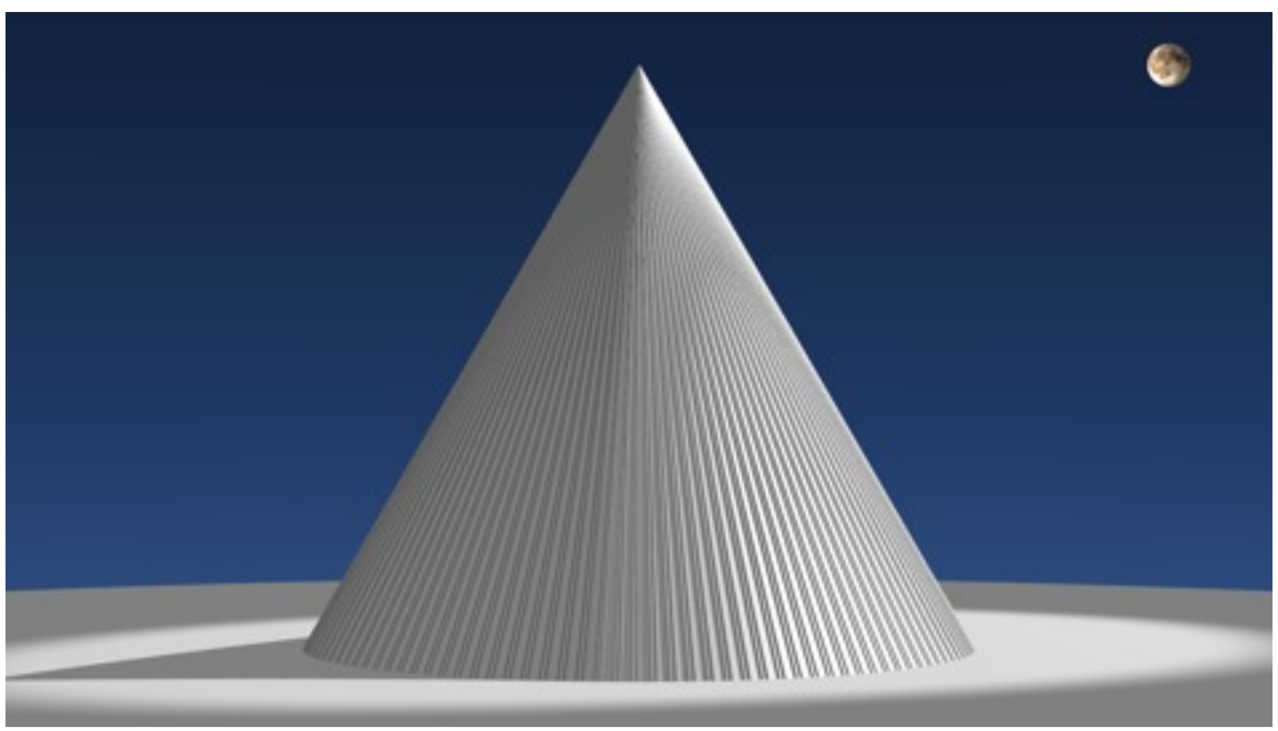
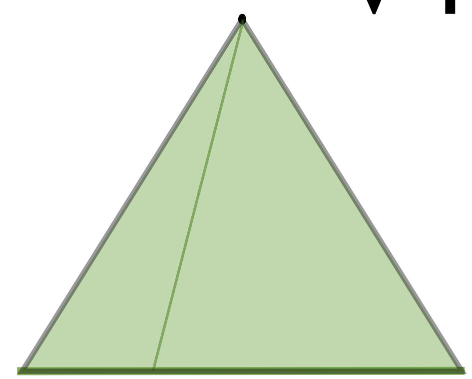
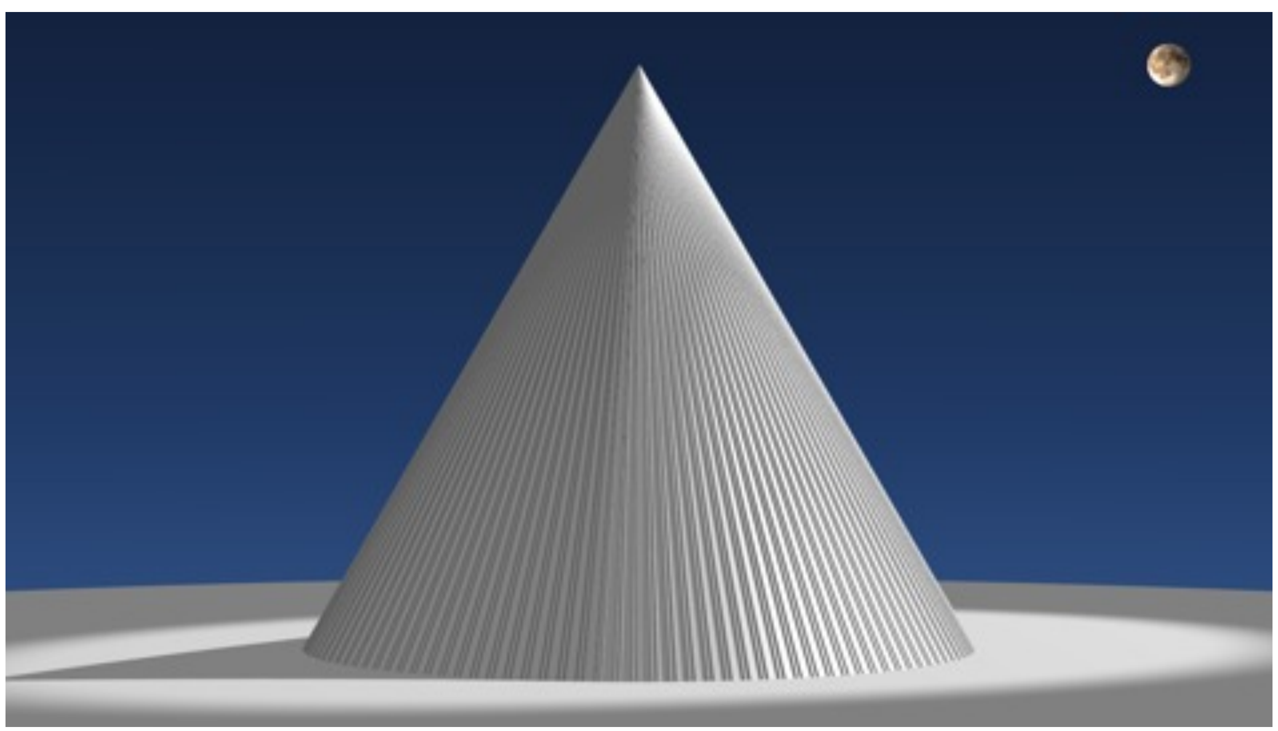






The quasi standard cone, a view by Jos Leys





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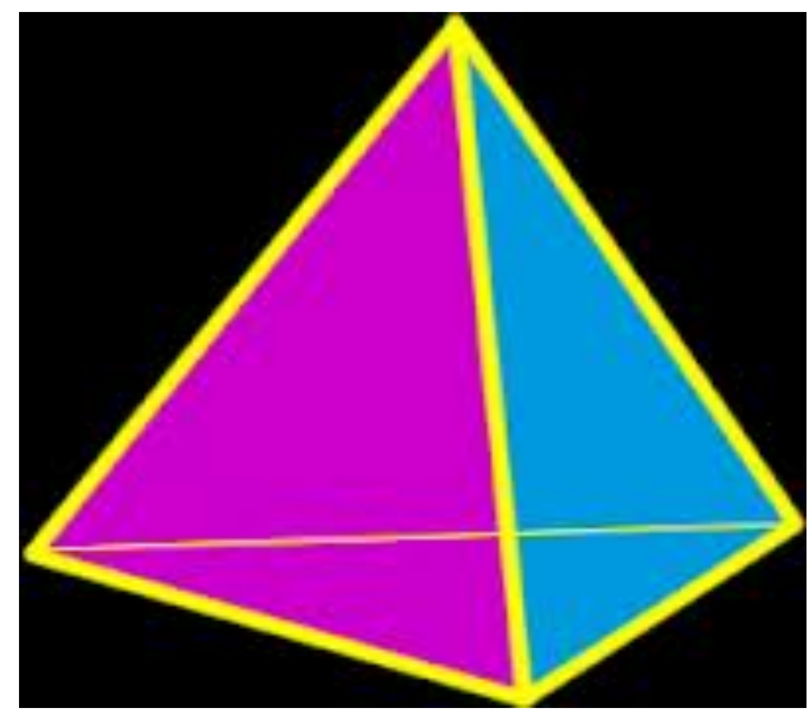

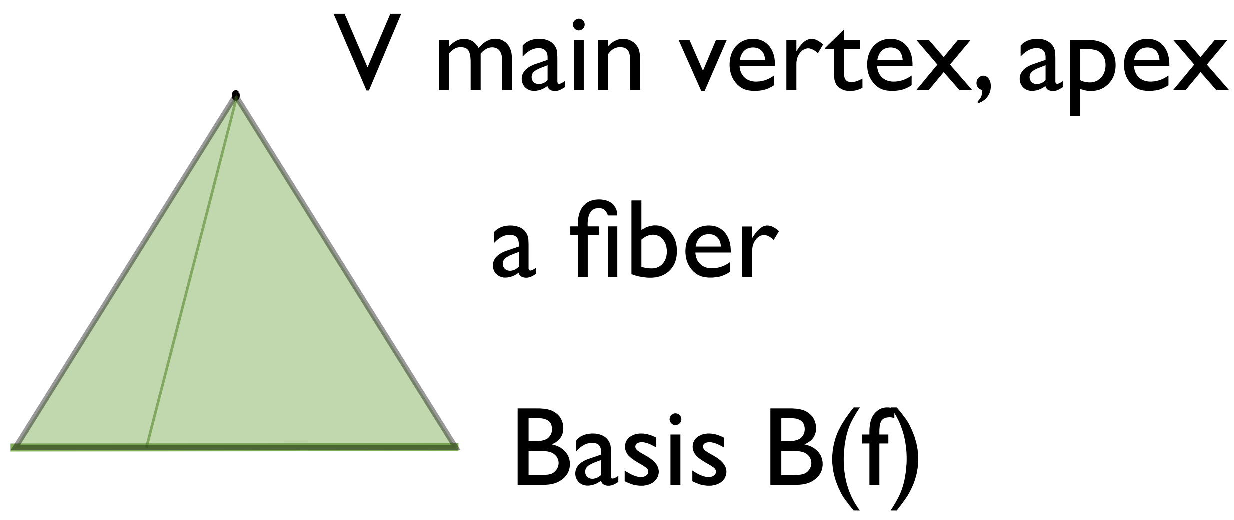

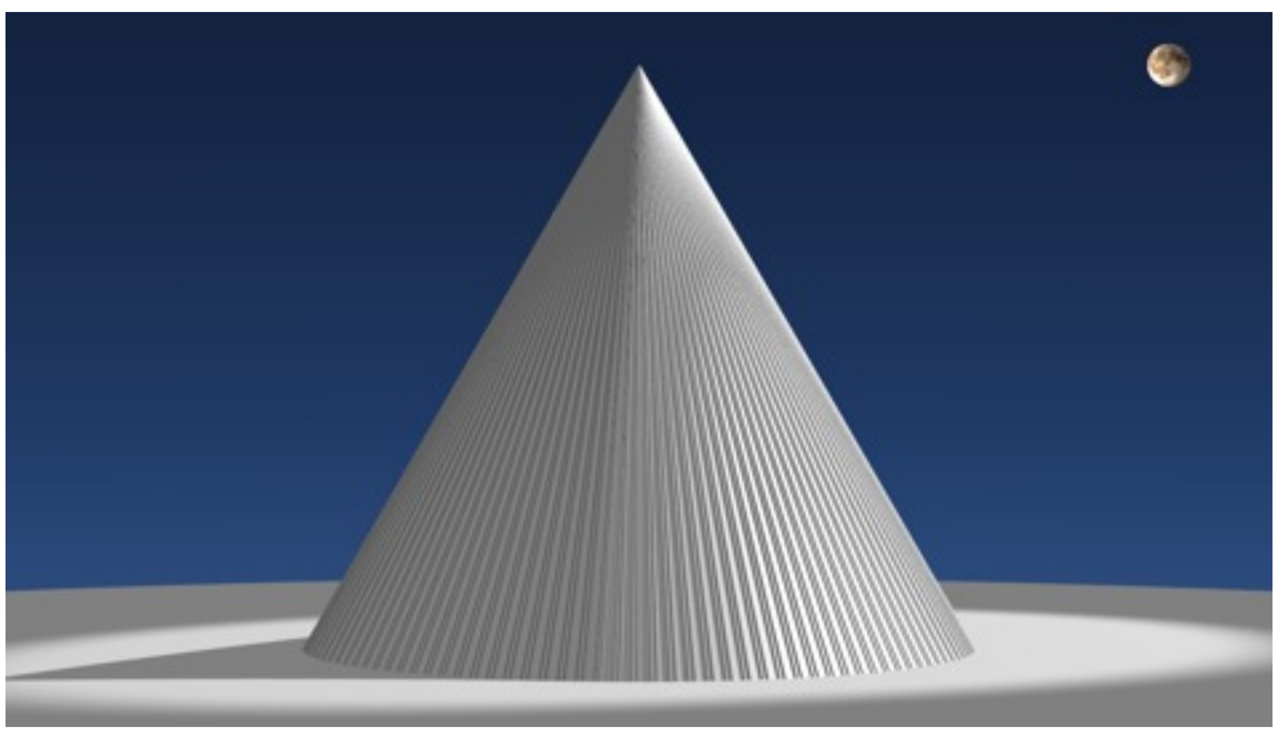

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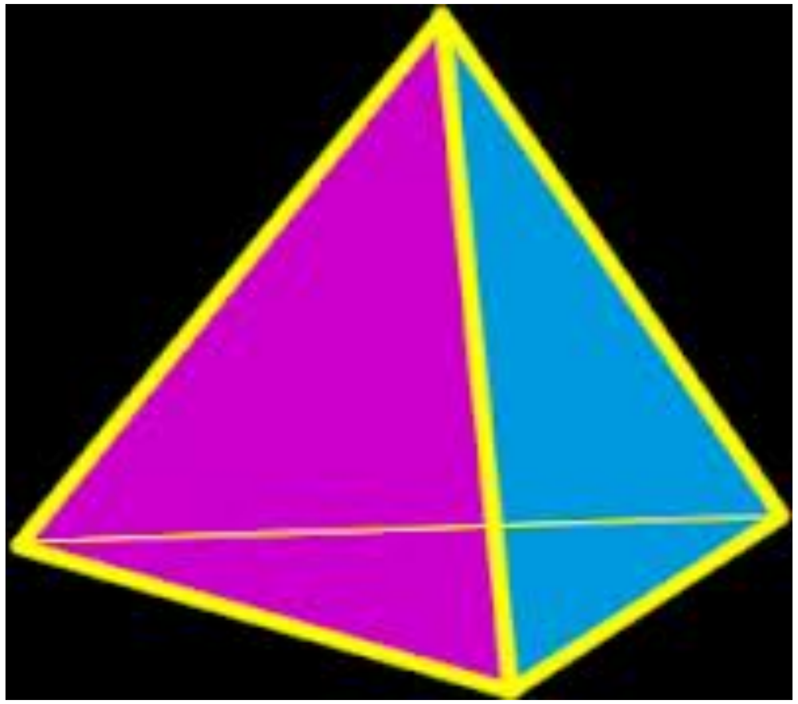
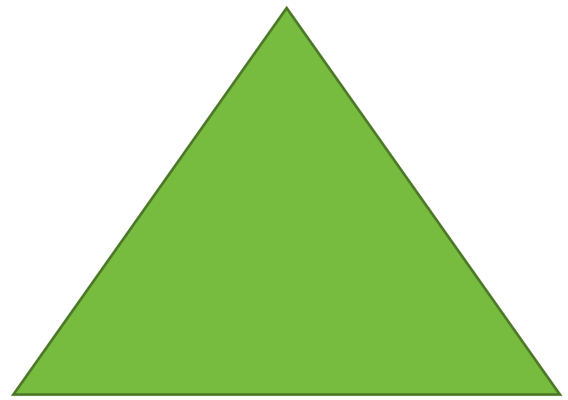
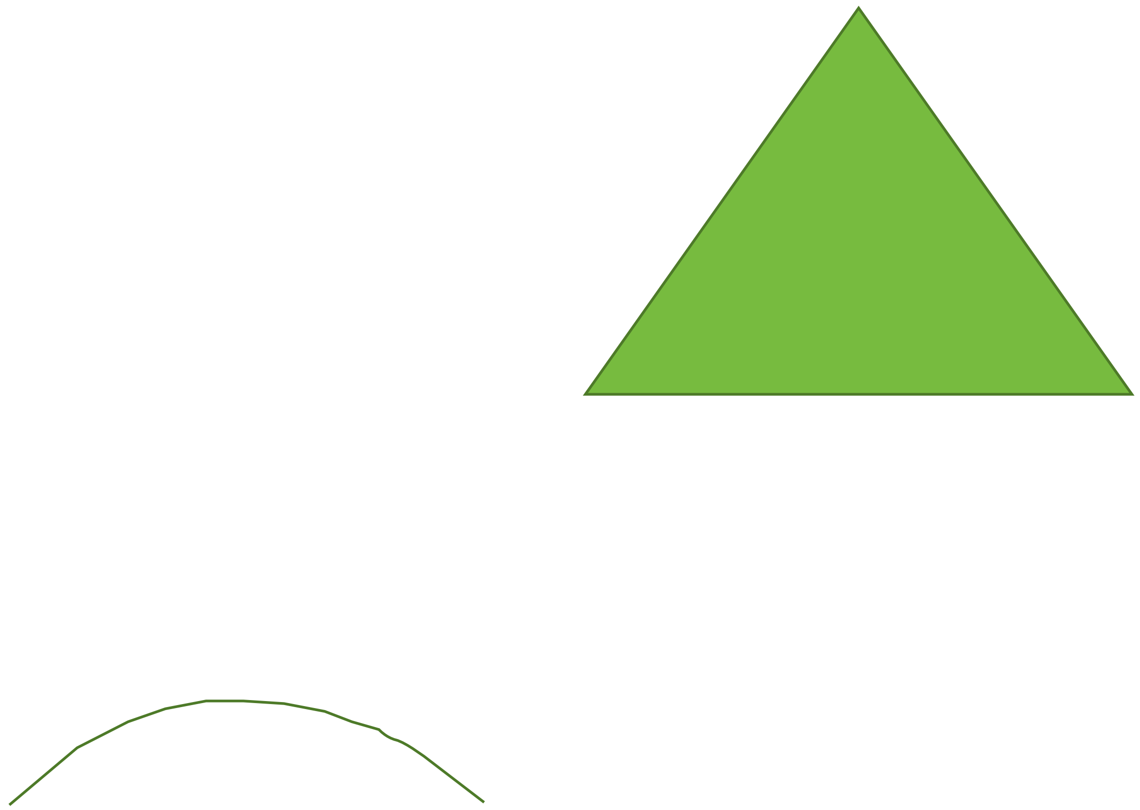
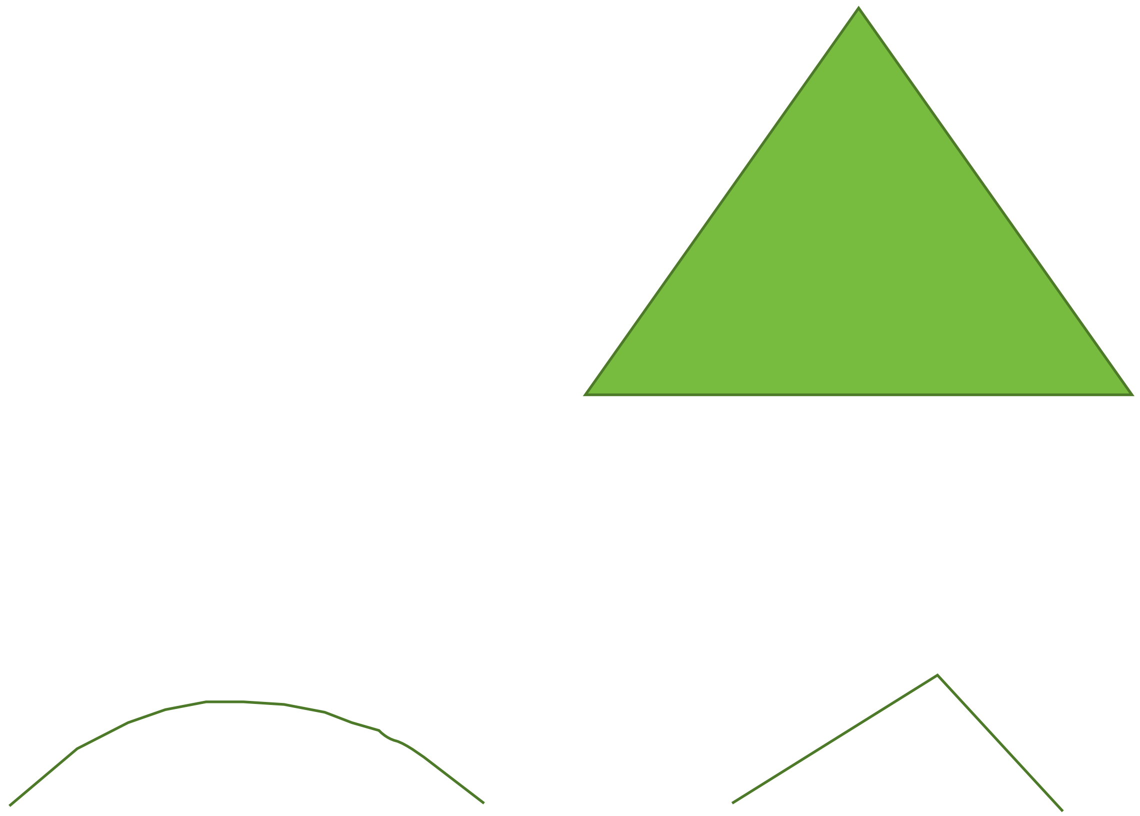
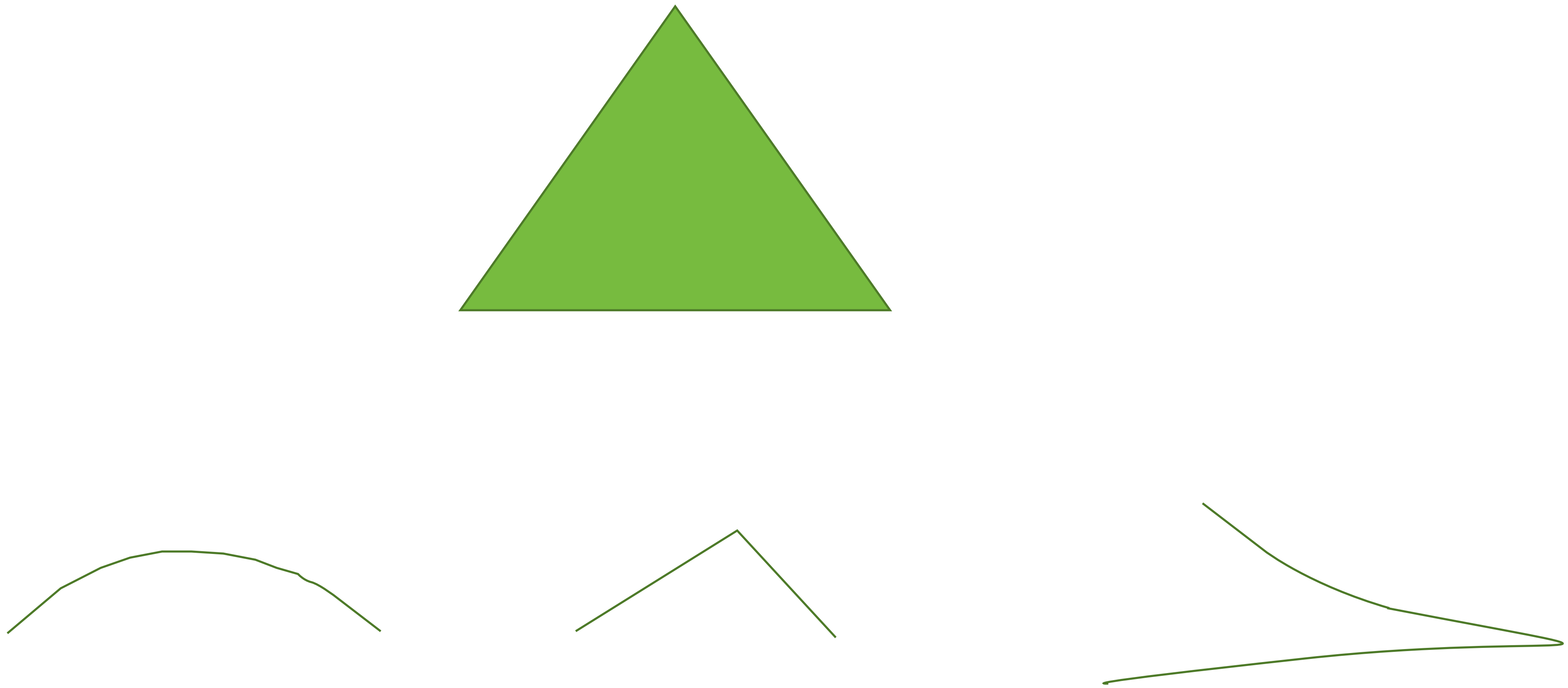


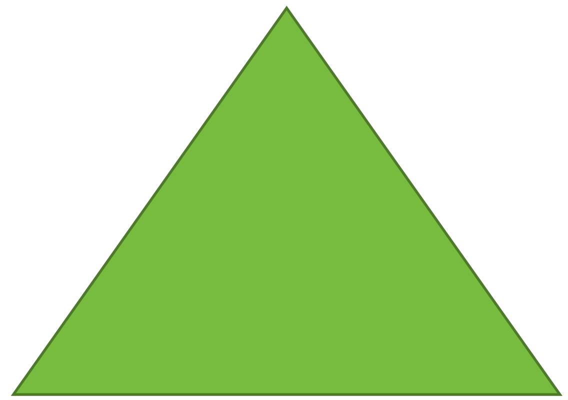
The standard tetrahedron

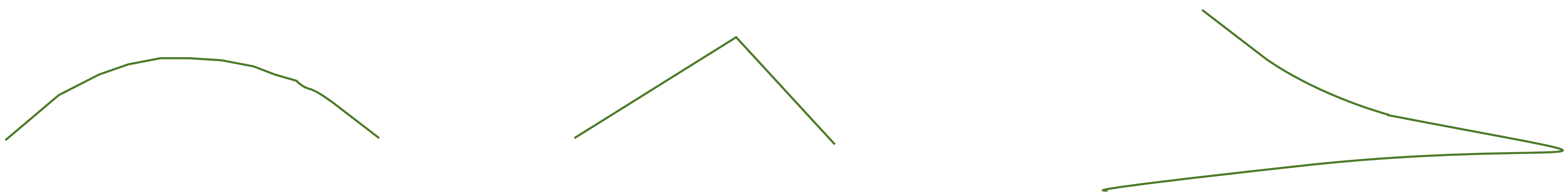












Basis B(f) (dimension p)
here p = 1

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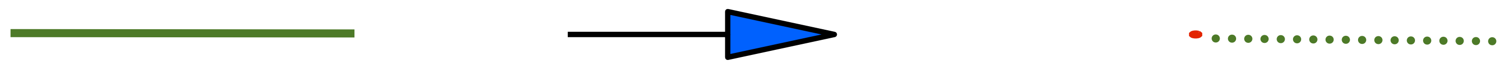

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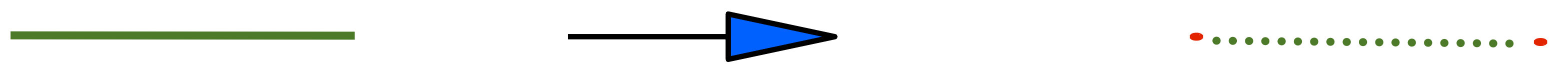

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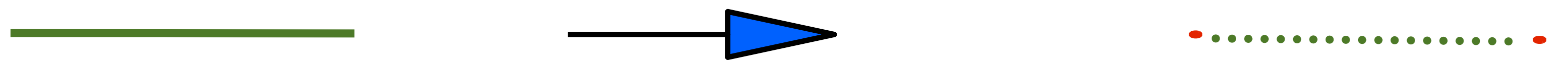

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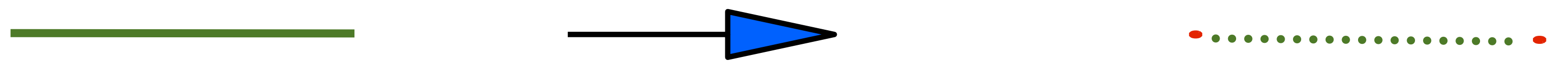

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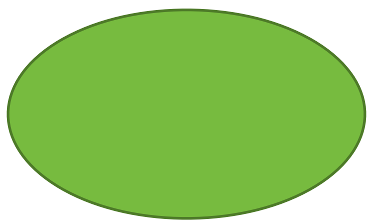

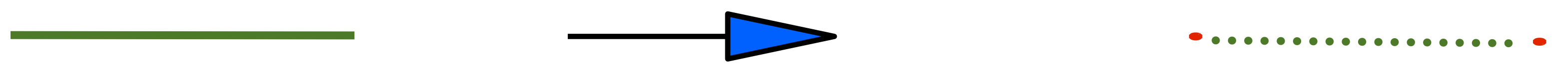

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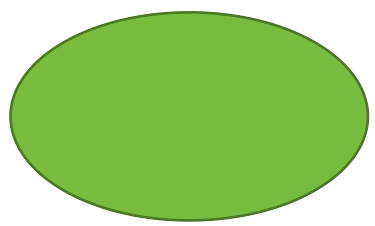
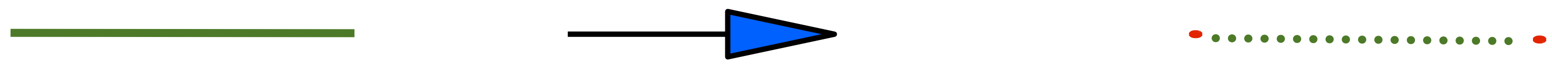


B(f) is a topological 2-disk



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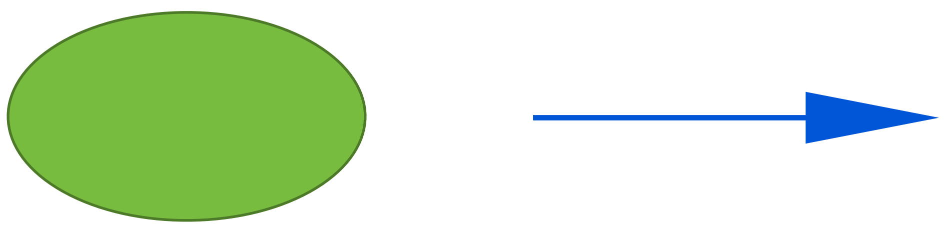

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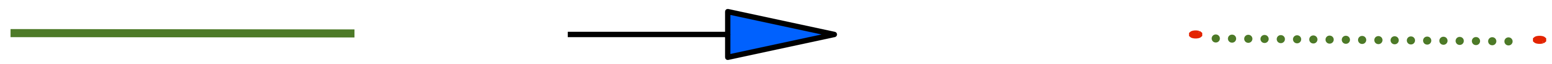

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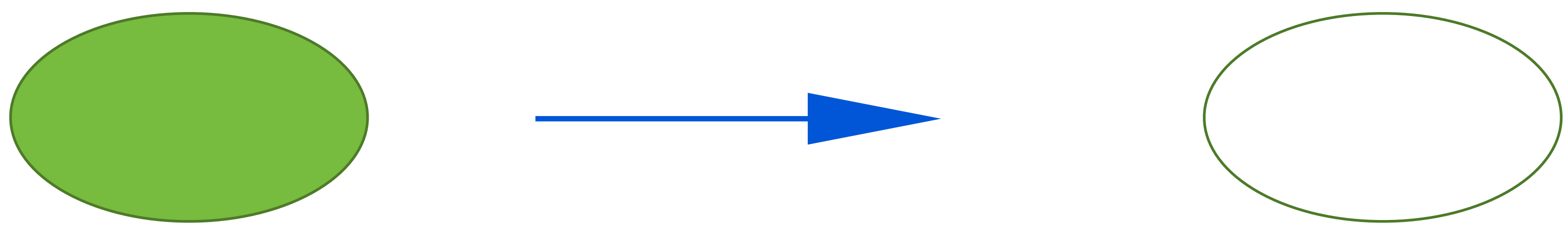

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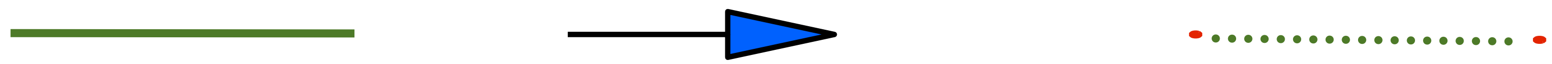

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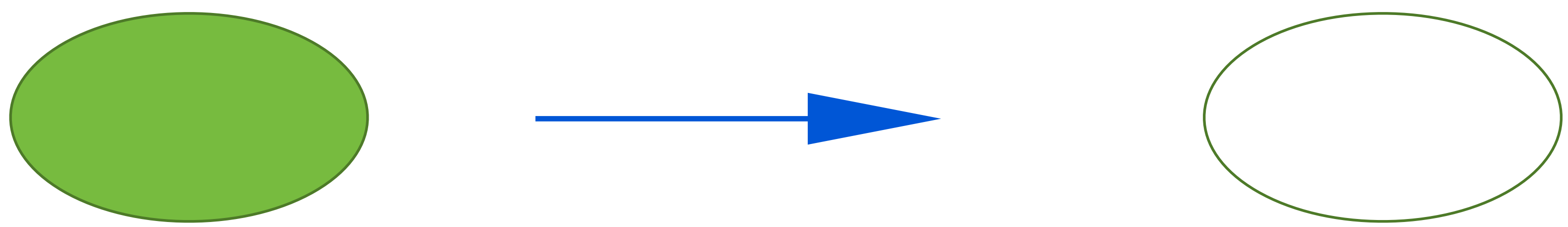

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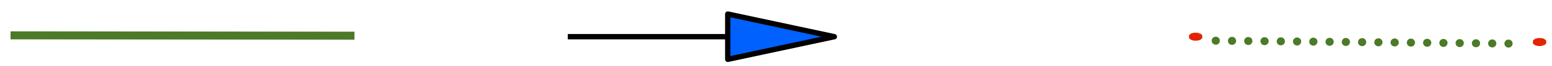
B(h), boundary of B(f) is a topological 1-sphere
more generally a knot



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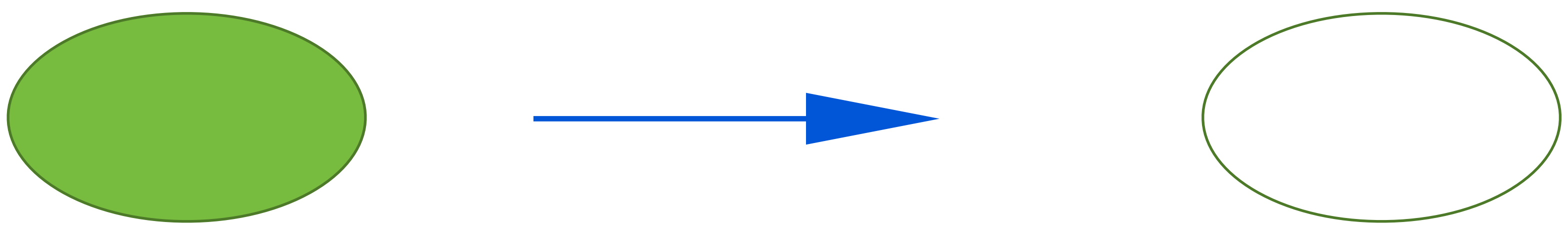

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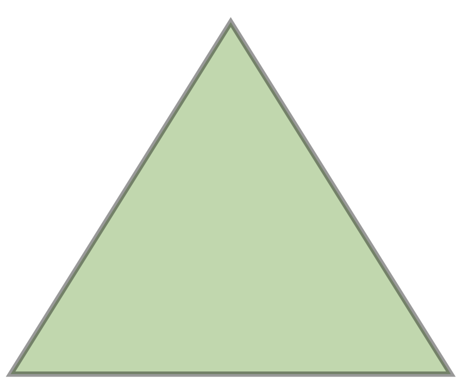

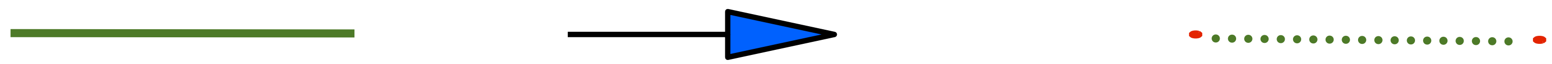

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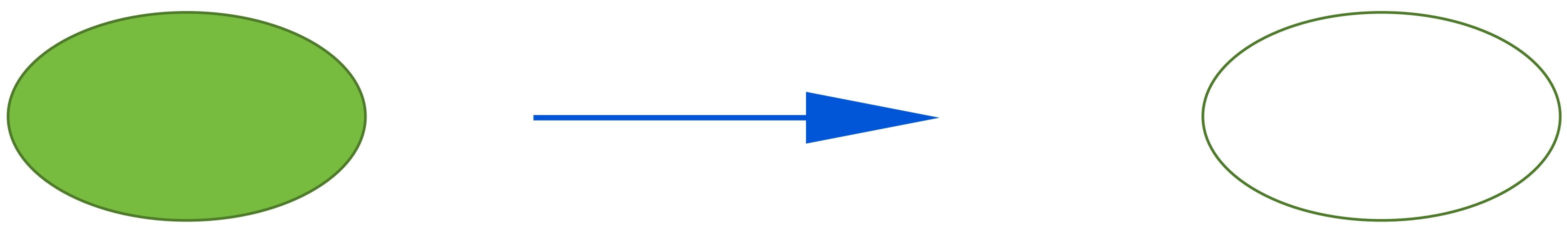

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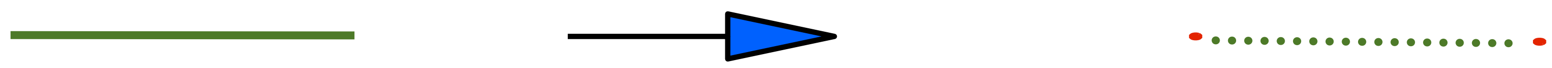
The **full cone C** over B(f)
a n (here = 2)-dimensional cone
in an n-dimensional space gives rise to the



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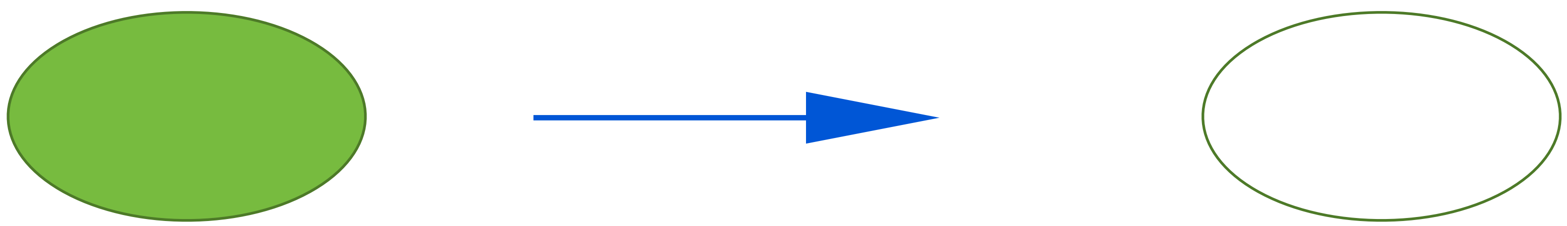

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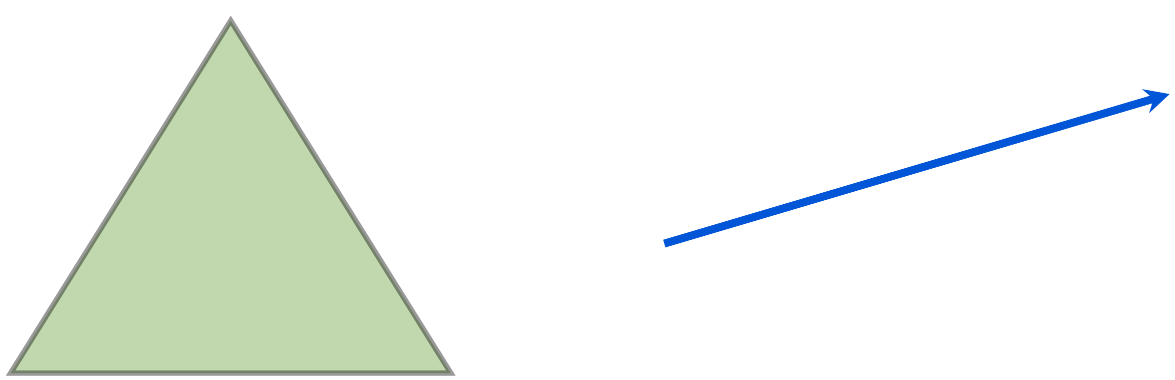

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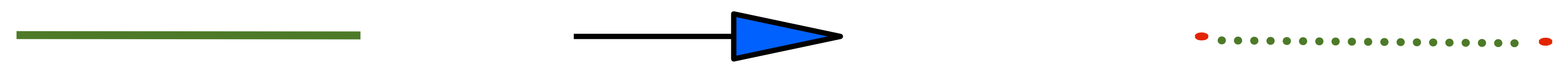

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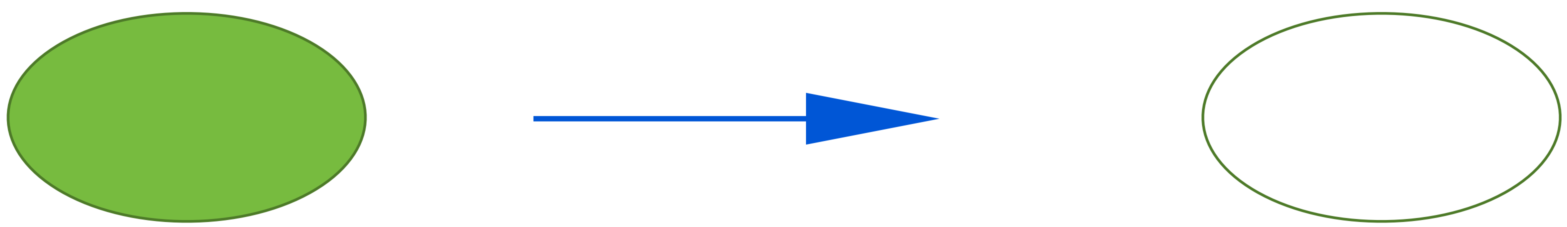

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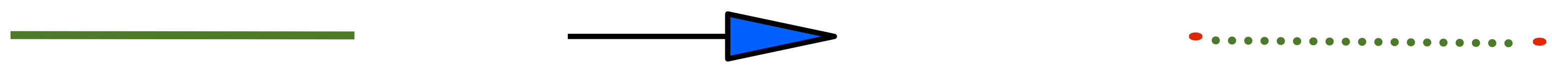

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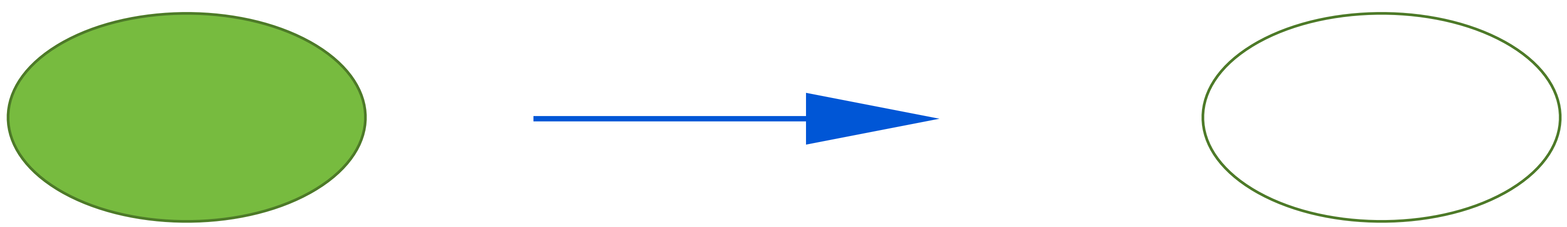

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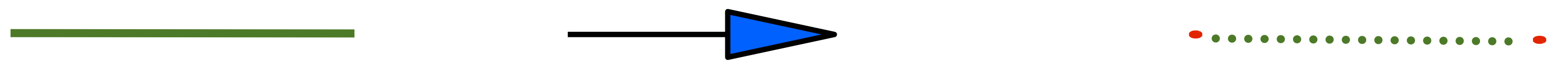

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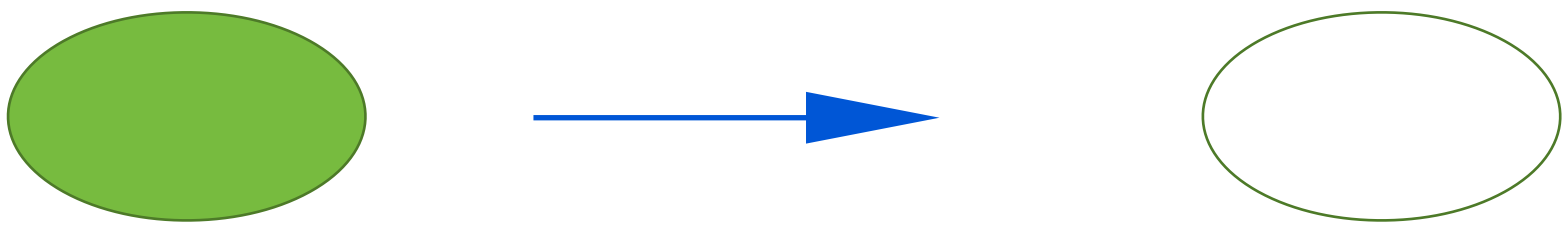

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a n (here = 2)-dimensional cone
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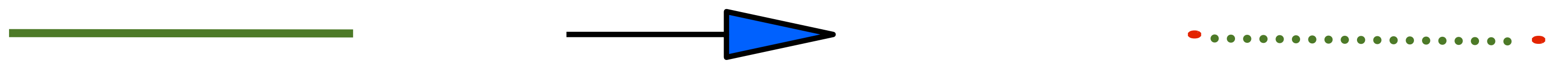
the **complete hollow cone** over B(f)
(a (n-1)-dimensional cone)
the boundary of the full cone



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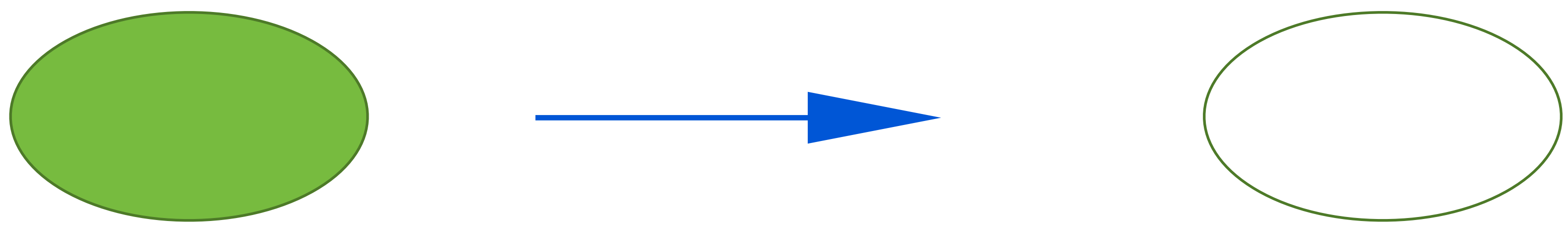

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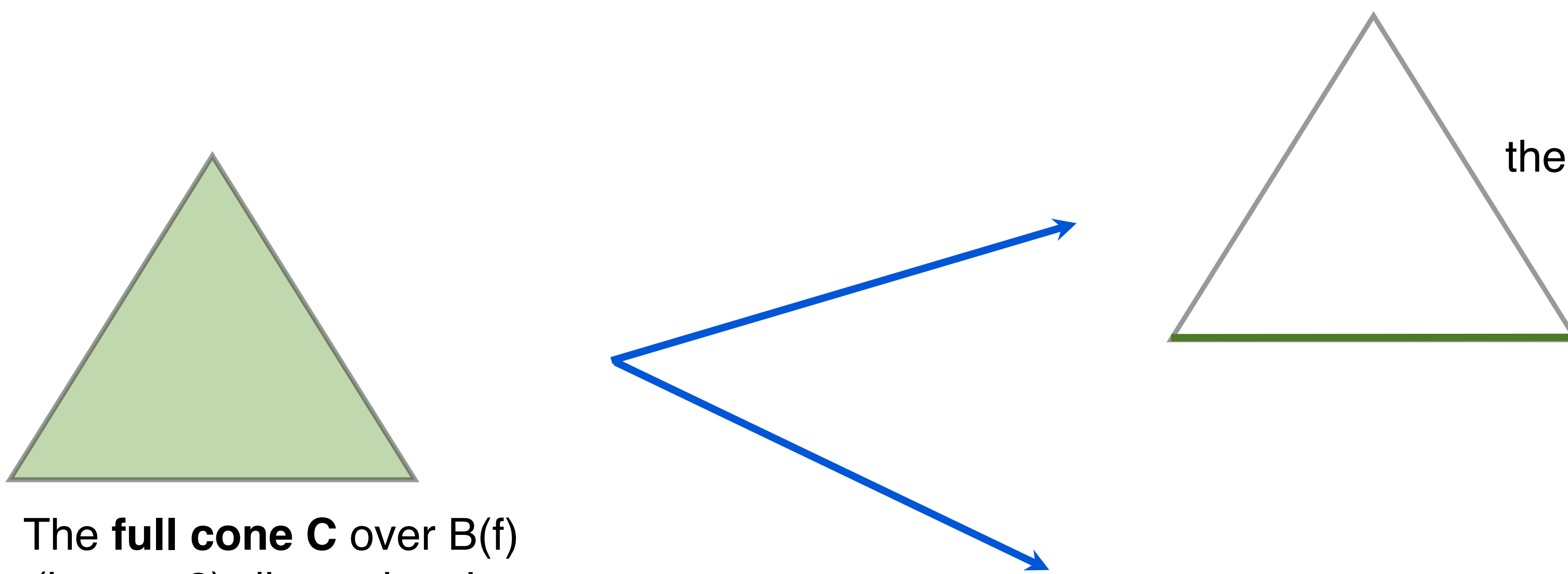

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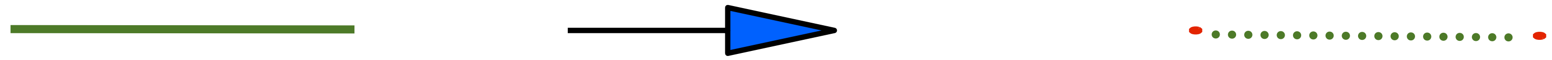

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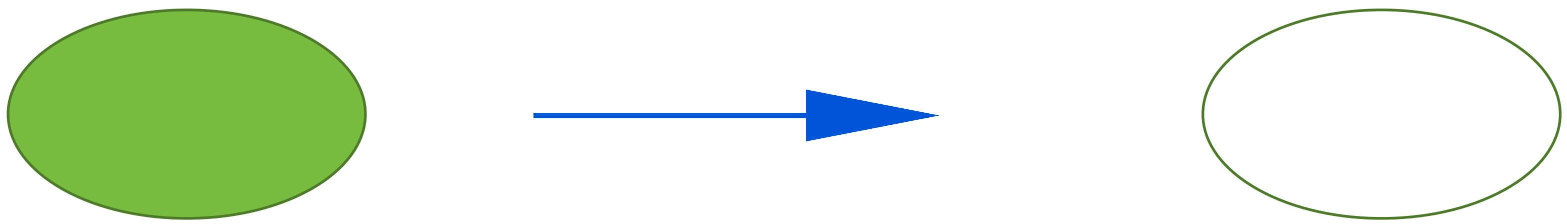

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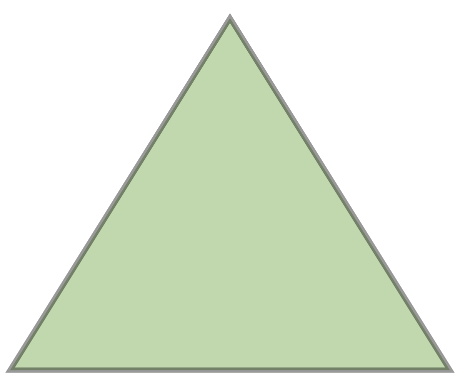

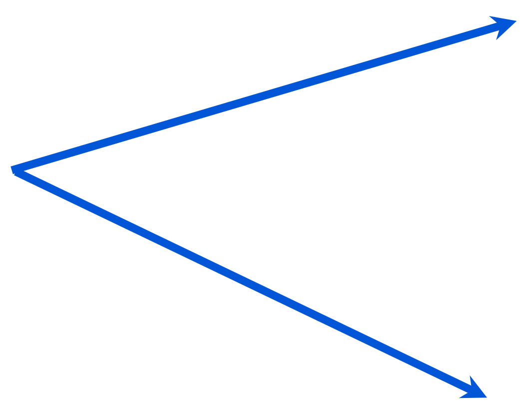

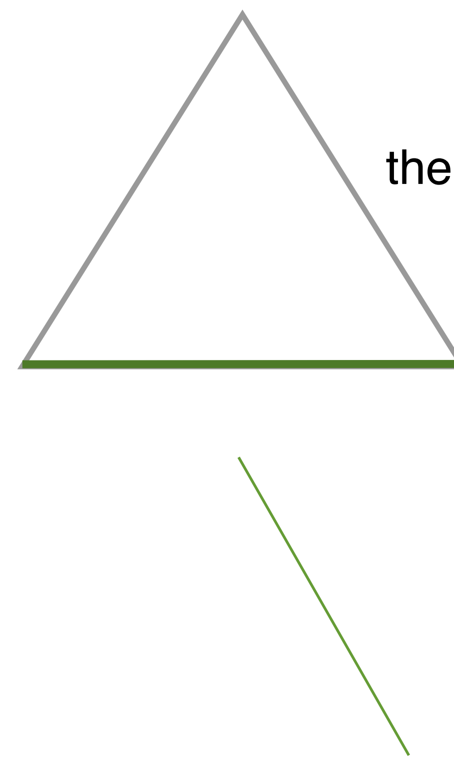

the **complete hollow cone** over B(f)
(a (n-1)-dimensional cone)
the boundary of the full cone

The **full cone C** over B(f)
a n (here = 2)-dimensional cone
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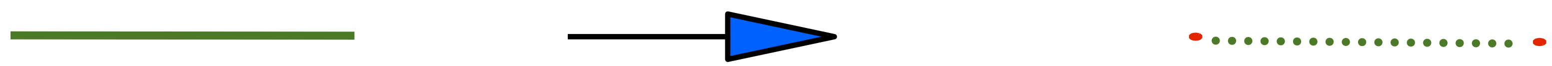

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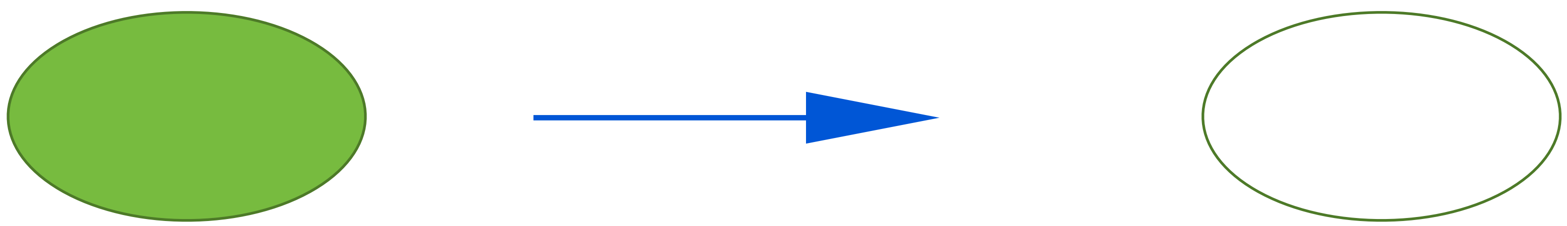

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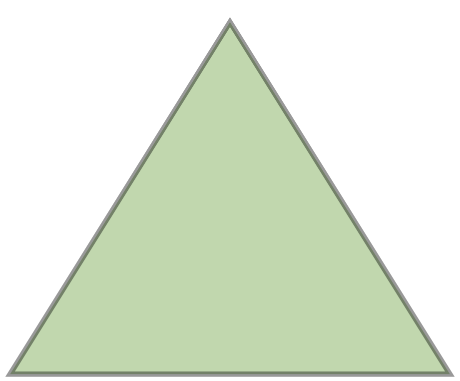

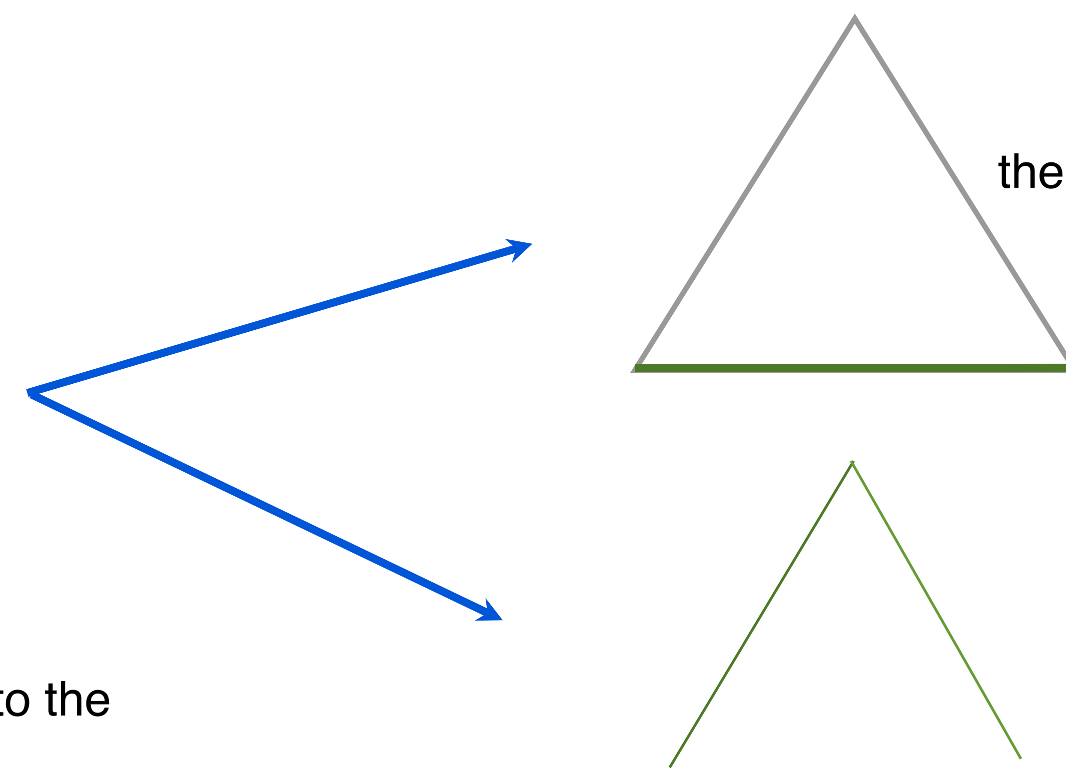

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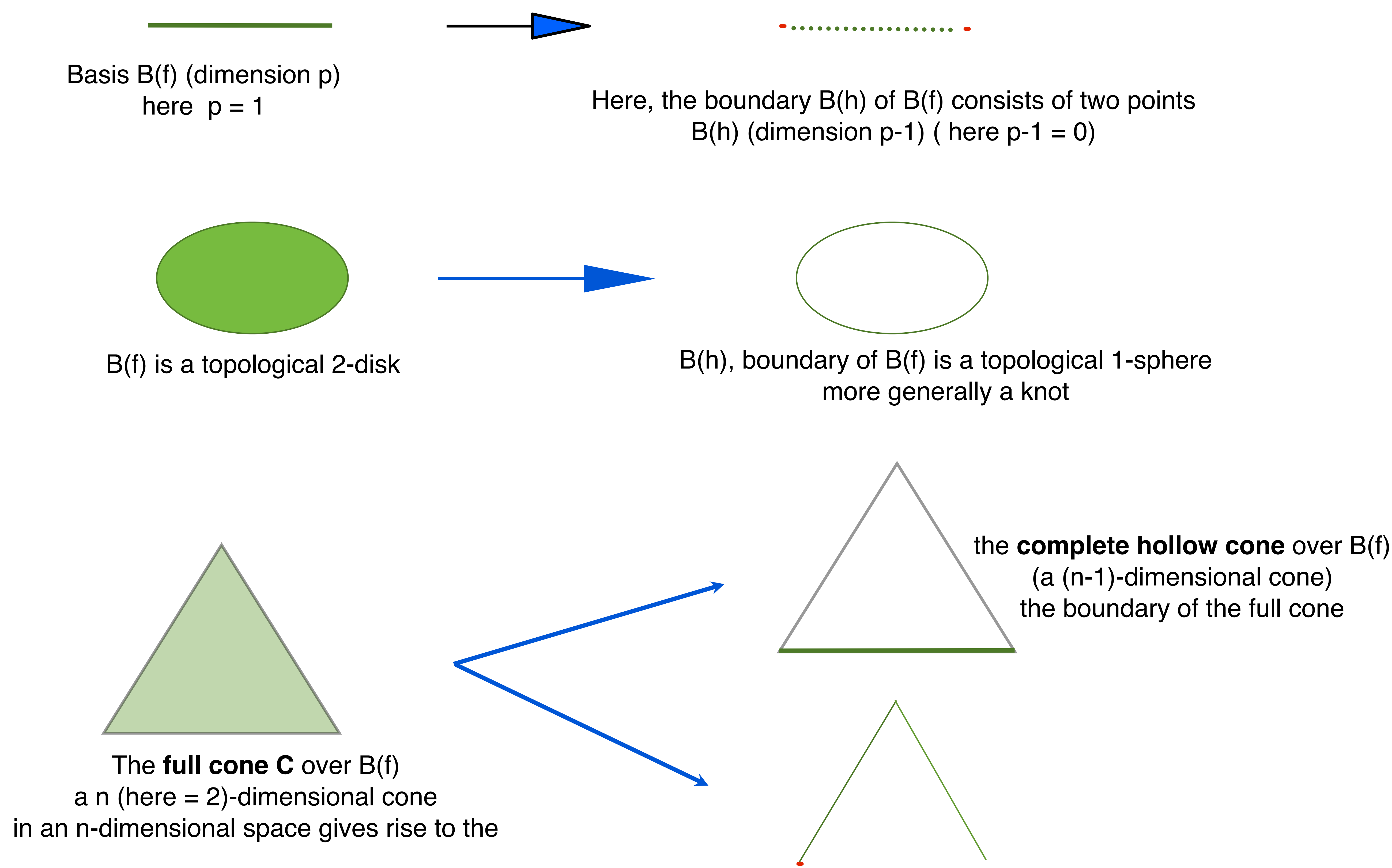
Basis B(f) (dimension p)
here p = 1
Here, the boundary B(h) of B(f) consists of two points
B(h) (dimension p-1) (here p-1 = 0)
B(f) is a topological 2-disk
B(h), boundary of B(f) is a topological 1-sphere
more generally a knot
the **complete hollow cone** over B(f)
(a (n-1)-dimensional cone)
the boundary of the full cone
The **full cone C** over B(f)
a n (here = 2)-dimensional cone
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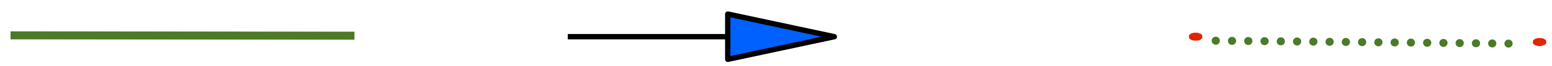

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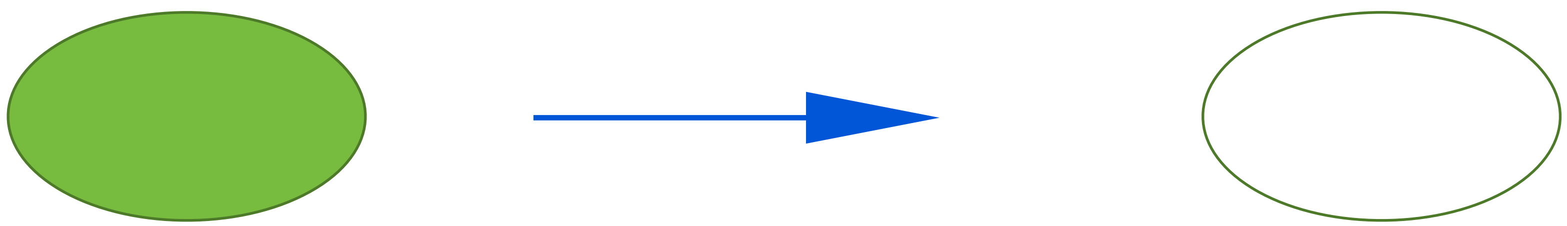

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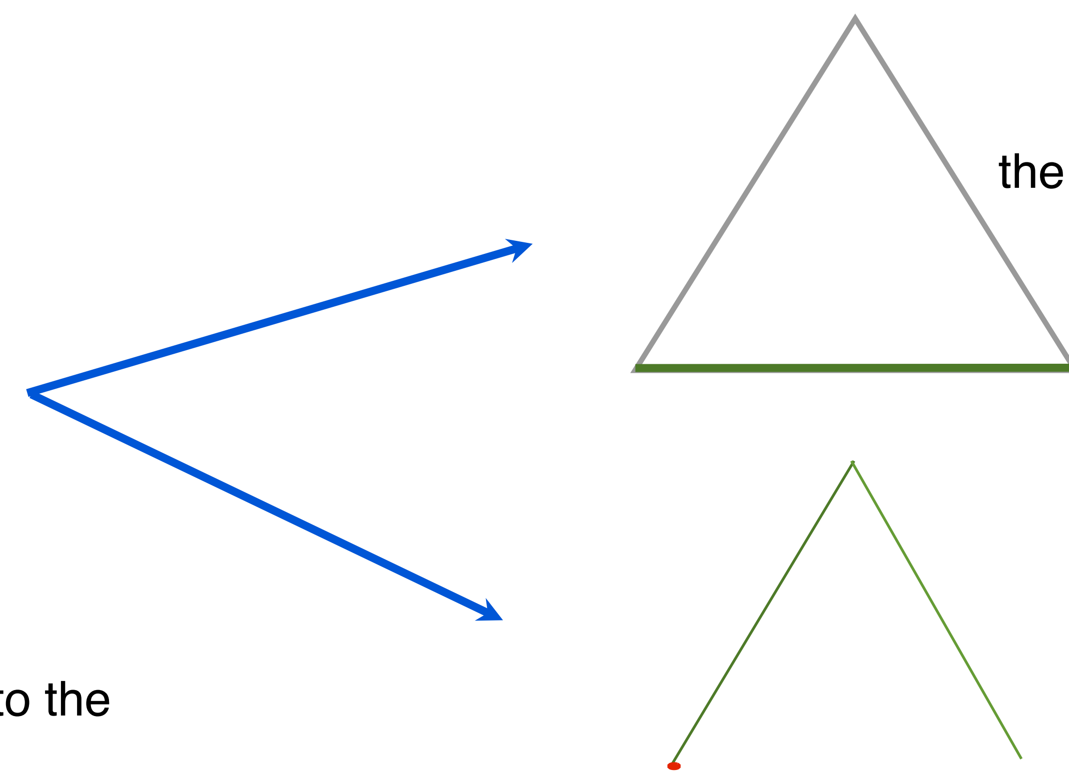

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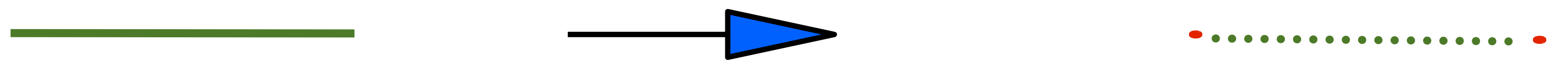

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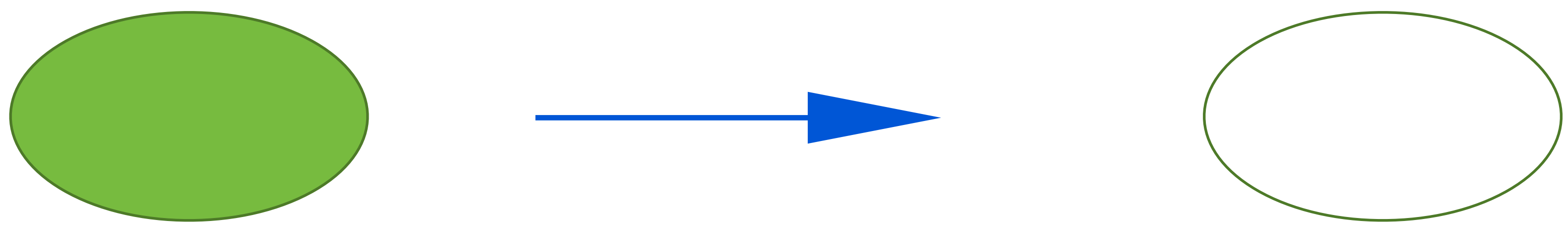

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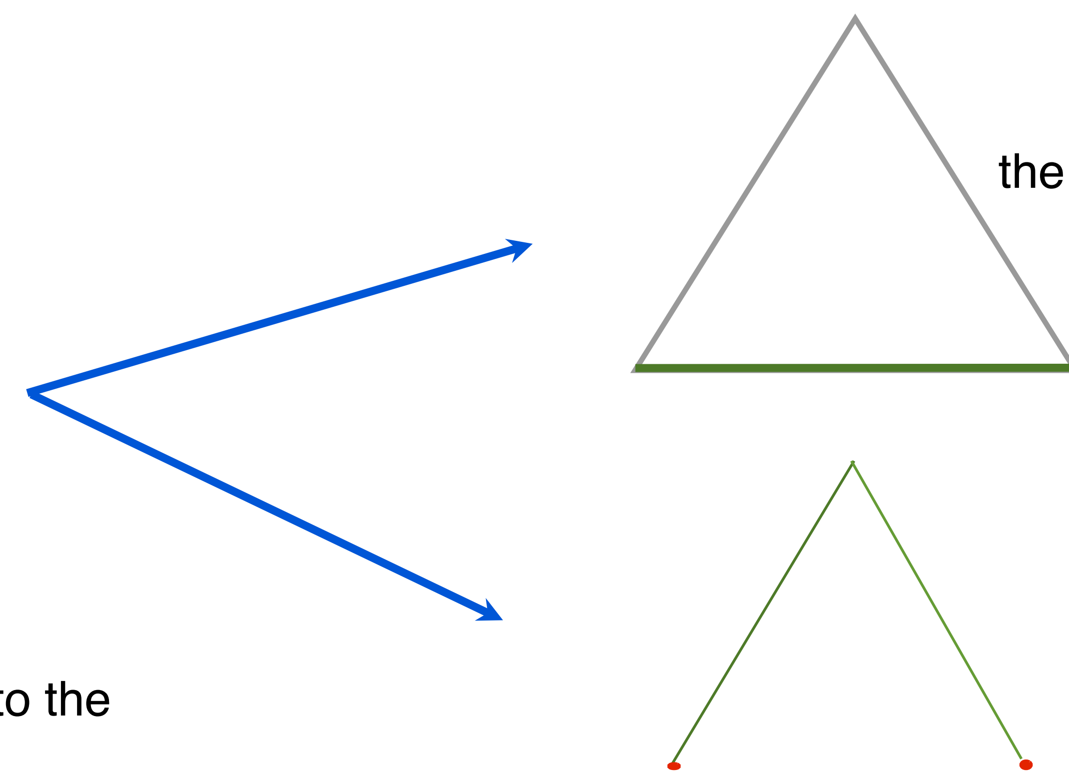

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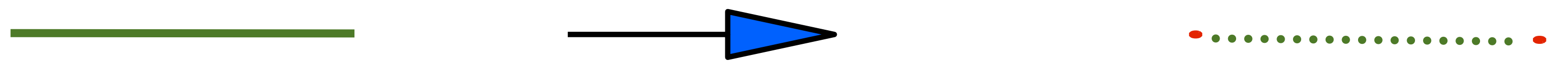

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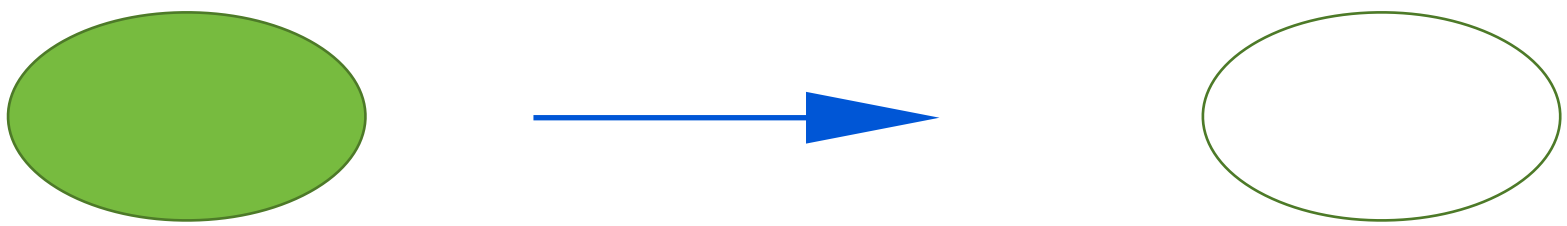

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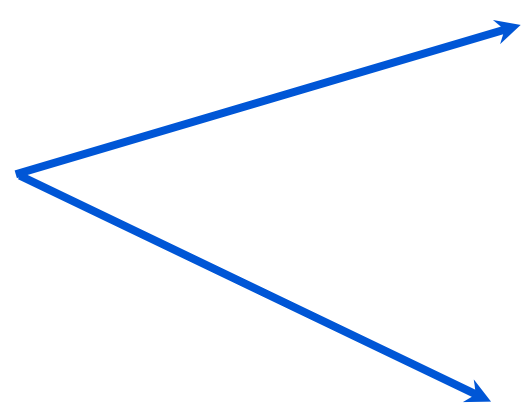

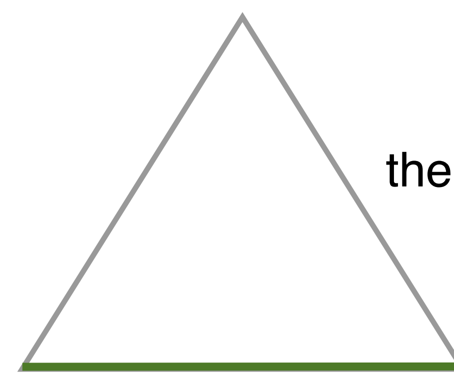

the **complete hollow cone** over B(f)
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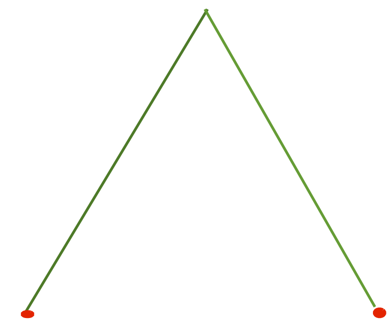


the **cone C**^{c} over B(h) is
a (n-1)-dimensional cone
the **coat** of the full cone **C**
which is the **wearer** of **C**^{c}
C^{c} is also an hollow cone

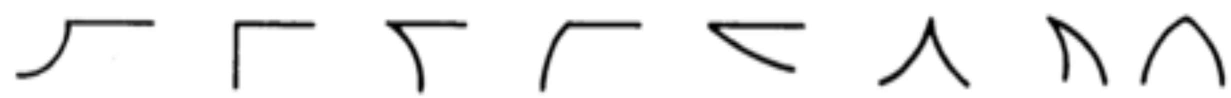
Examples of Cones in the Plane

Examples of Cones in the Plane

Rough Cones

Examples of Cones in the Plane

Rough Cones



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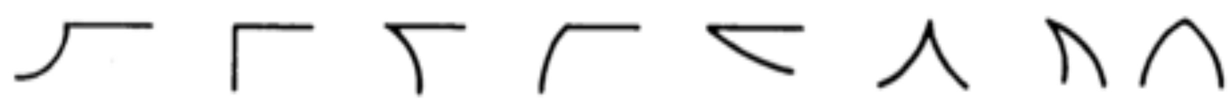

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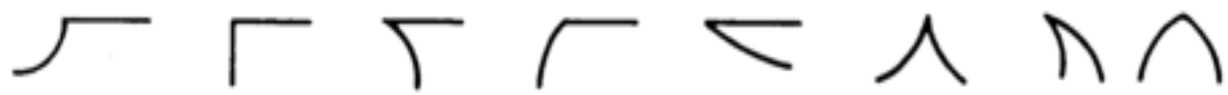
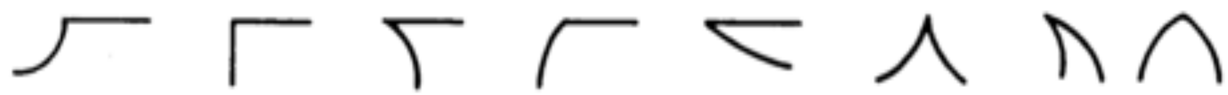


Durer’s

Examples of Cones in the Plane

Rough Cones



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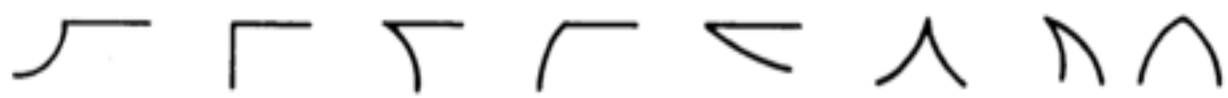
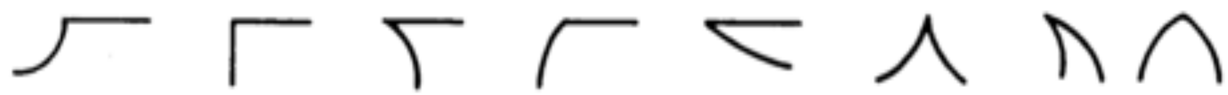


Durer's

Chinese hat

Examples of Cones in the Plane

Rough Cones



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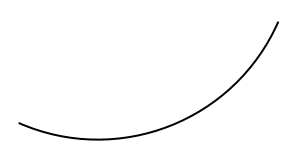

Chinese hat

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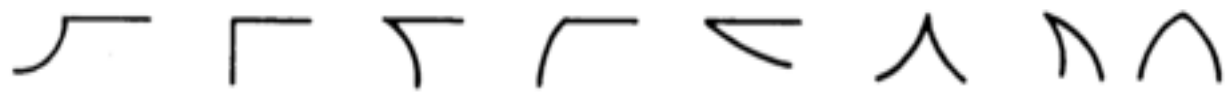

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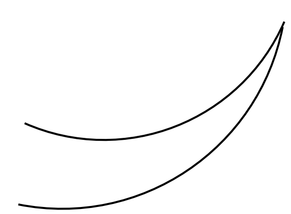

Chinese hat

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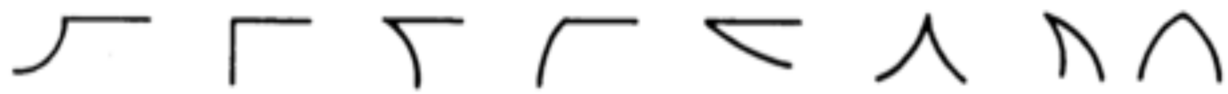
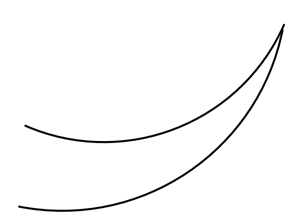


Durer's

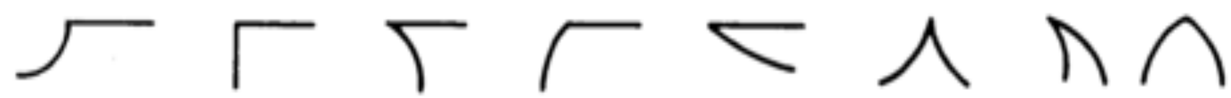
Chinese hat



half smiling cone

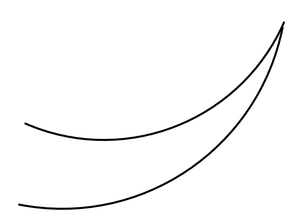
Examples of Cones in the Plane

Rough Cones



V

Durer's



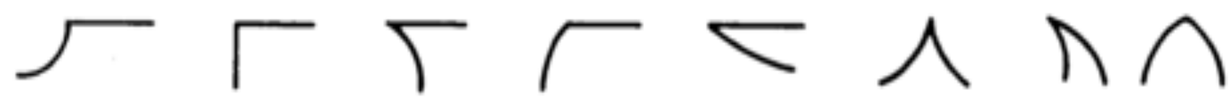
b b'

Chinese hat

half smiling cone

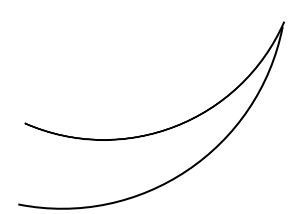
Examples of Cones in the Plane

Rough Cones



Durer's

Chinese hat



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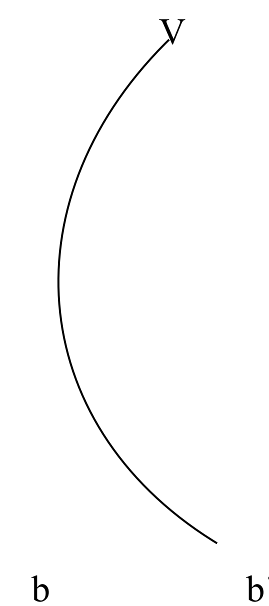

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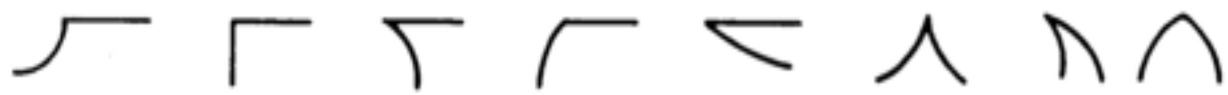

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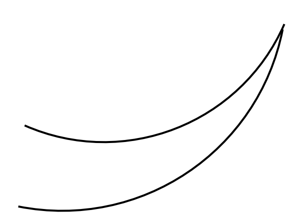

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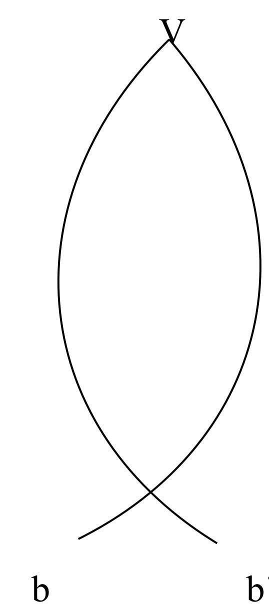

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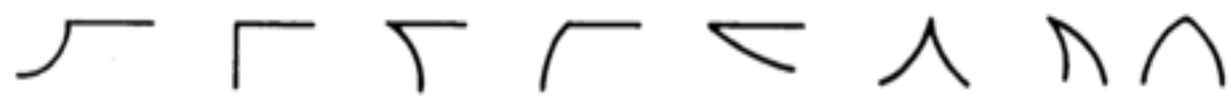

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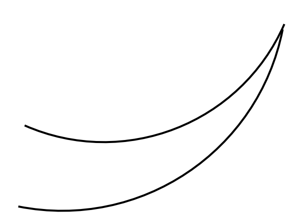

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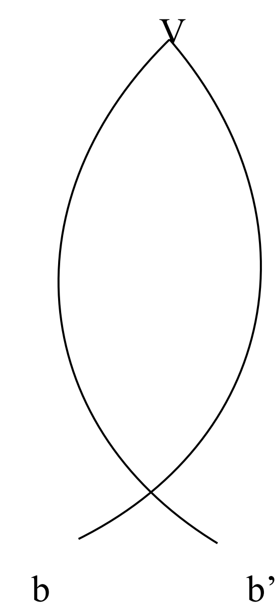
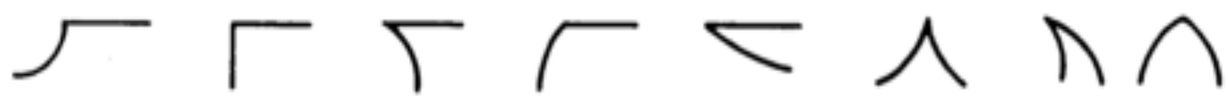


Folded arms

Examples of Cones in the Plane

Rough Cones



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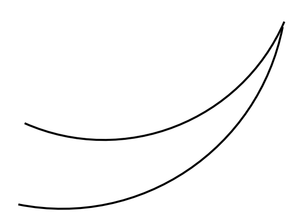

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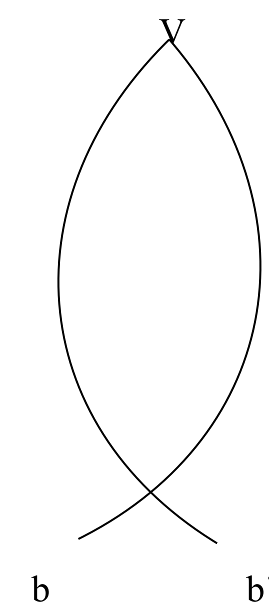


Folded arms

These 1-cones have only two fibers, named its **arms**

Special rough cone

Special rough cone

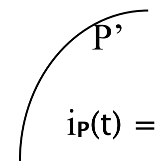
P　　　　　　　　P'

$i_{P'}(t) = \{-t^3, t\}$　　　　$i_P(t) = \{t^3, t\}$

Special rough cone

P

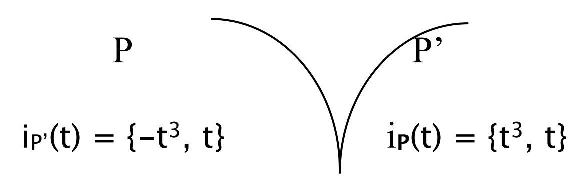
$i_{P'}(t) = \{-t^3, t\}$



P'

$i_{P}(t) = \{t^3, t\}$

Special rough cone



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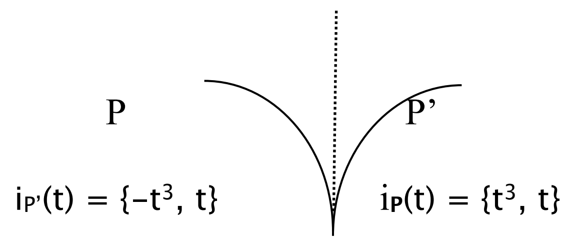

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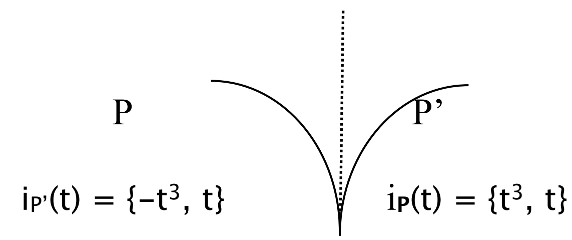
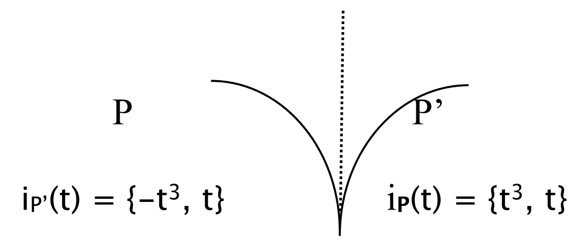


Penetrating cone or spine

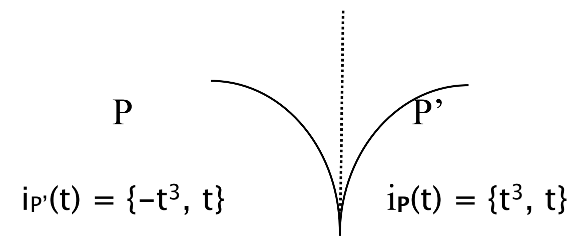
Special rough cone



Penetrating cone or spine

Soft Cones

Special rough cone



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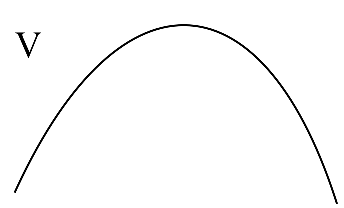

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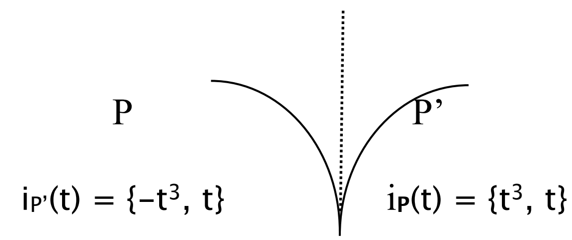

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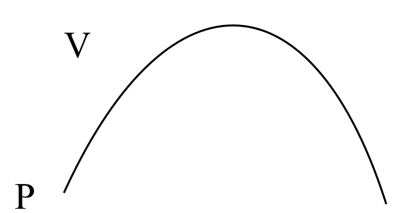
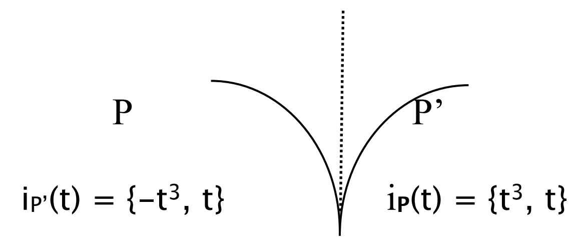


Special rough cone



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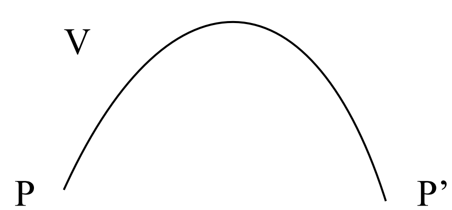

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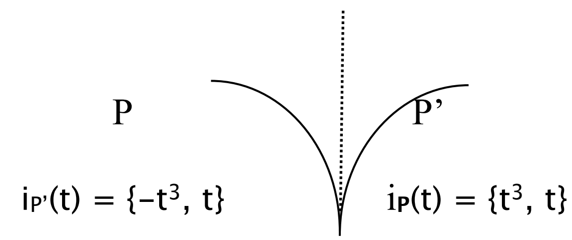

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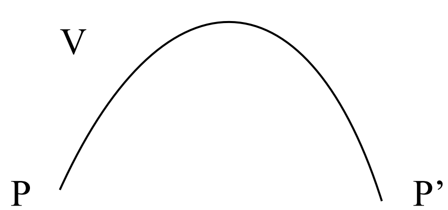
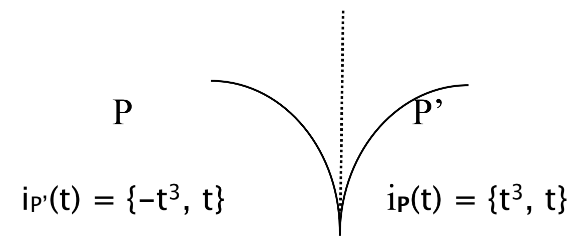


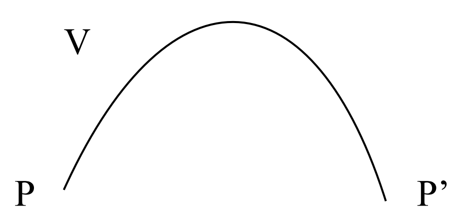
Arc of circle as a soft 1-cone : an edge

Special rough cone



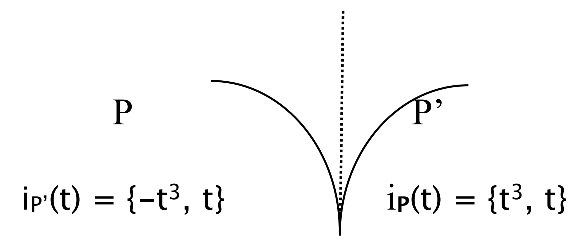
Penetrating cone or spine

Soft Cones



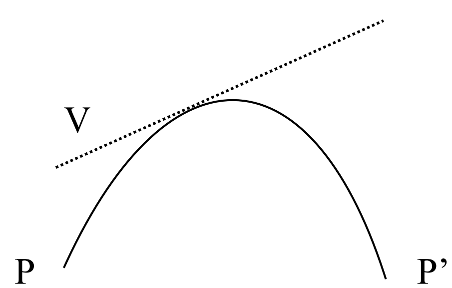
Arc of circle as a soft 1-cone : an edge joining its basis B(h) = {P, P’}

Special rough cone



Penetrating cone or spine

Soft Cones



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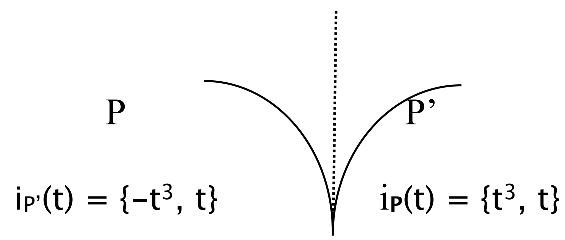

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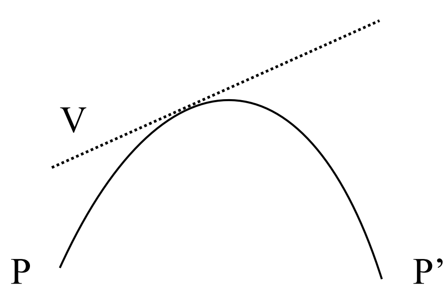

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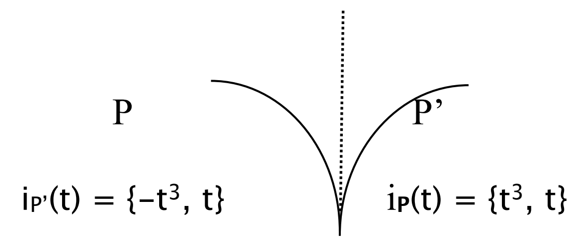
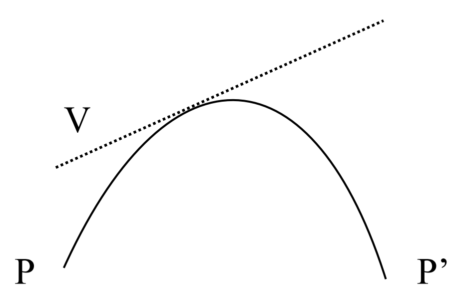
Special rough cone



Penetrating cone or spine

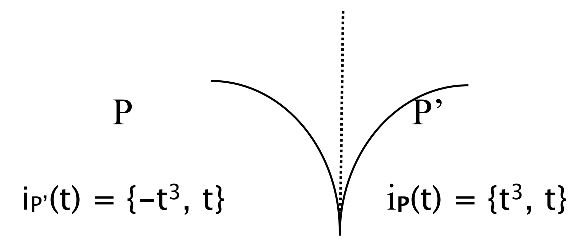
Soft Cones



Arc of circle as a soft 1-cone : an edge joining its basis B(h) = {P, P'}

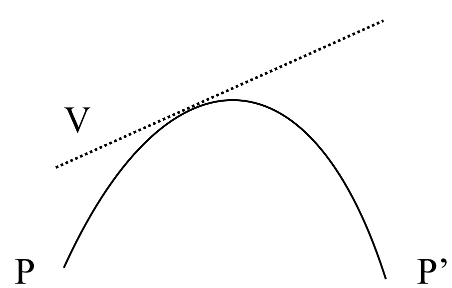
Half sphere as a soft 2-cone in the 3D space: its basis is a circle

Special rough cone



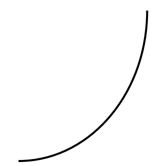
Penetrating cone or spine

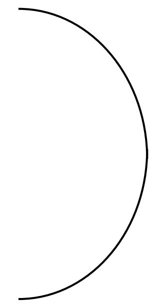
Soft Cones

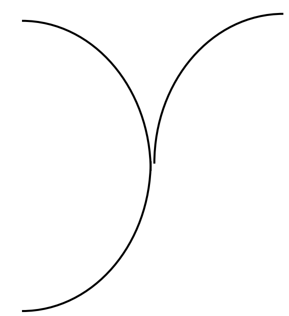


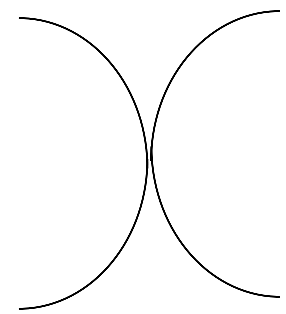
Arc of circle as a soft 1-cone : an edge joining its basis B(h) = {P, P'}

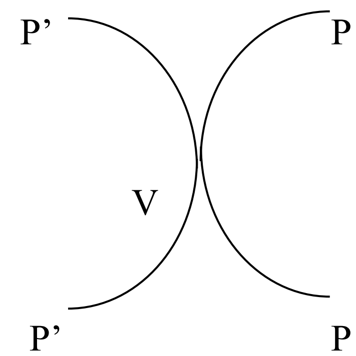
Half sphere as a soft 2-cone in the 3D space: its basis is a circle
A view by Jos Leys







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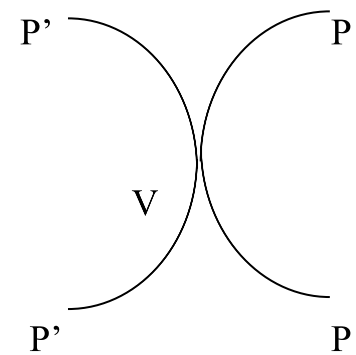
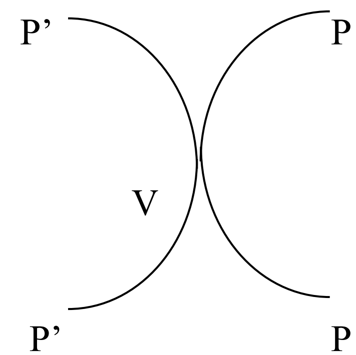


Symmetry



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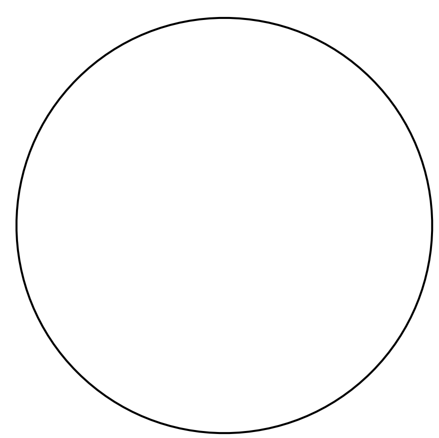

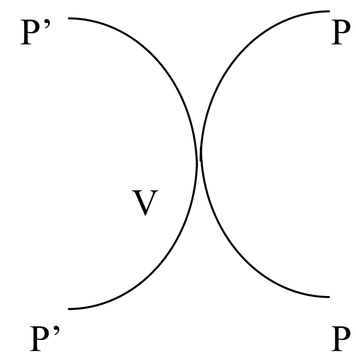

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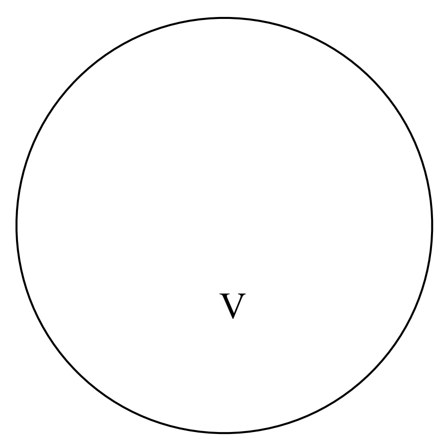

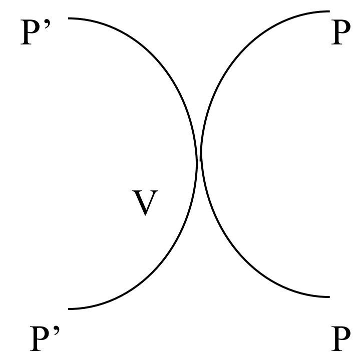

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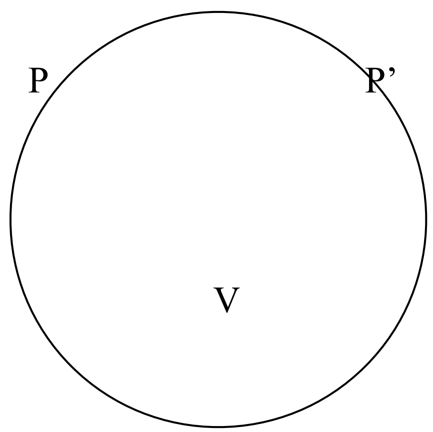

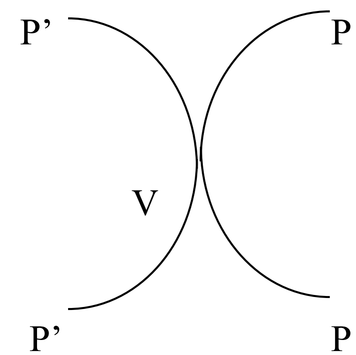

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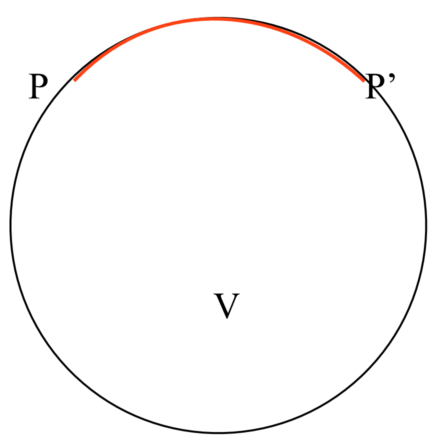

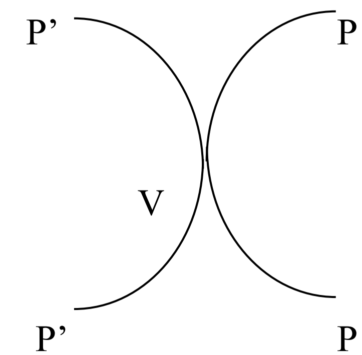

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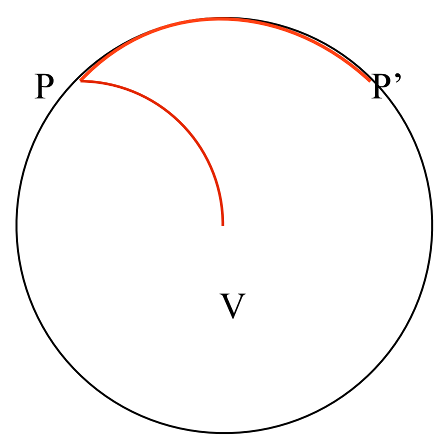

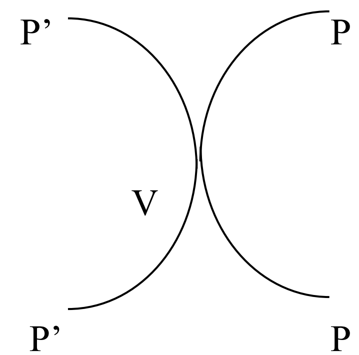

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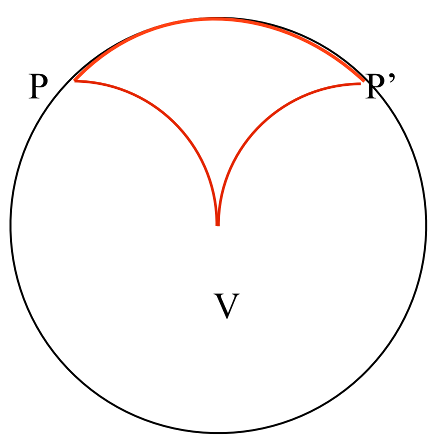

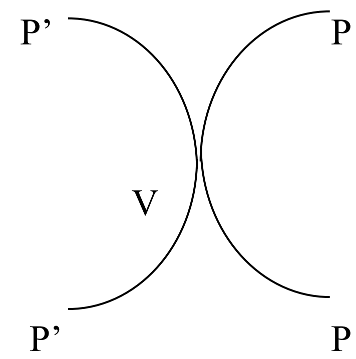

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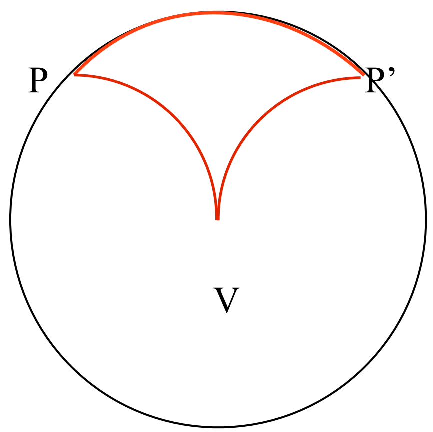


The complement in the neighbourhood of V of the **male cone** is ...

a **female cone**

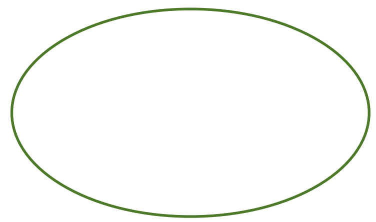
Exemples of simple topological operations with 1-cones

Exemples of simple topological operations with 1-cones

1) ***Self-attachment***

Exemples of simple topological operations with 1-cones

1) ***Self-attachment***



Exemples of simple topological operations with 1-cones

1) ***Self-attachment***

Exemples of simple topological operations with 1-cones

1) ***Self-attachment***

2) ***Attachment of cones by identification of their apex***

Exemples of simple topological operations with 1-cones

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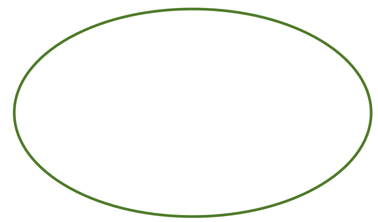
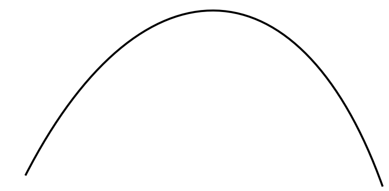
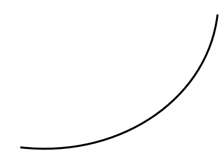




2) ***Attachment of cones by identification of their apex***



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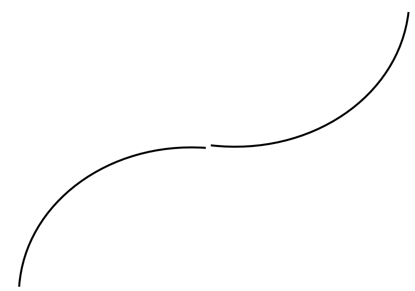

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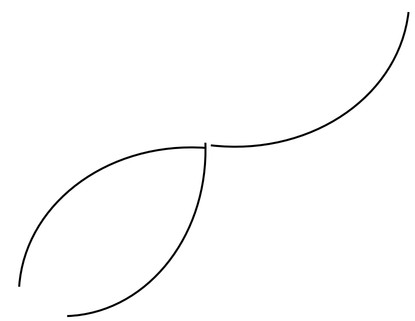

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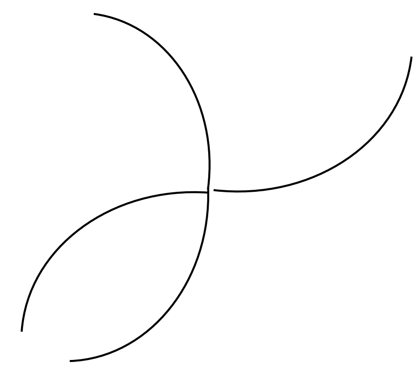

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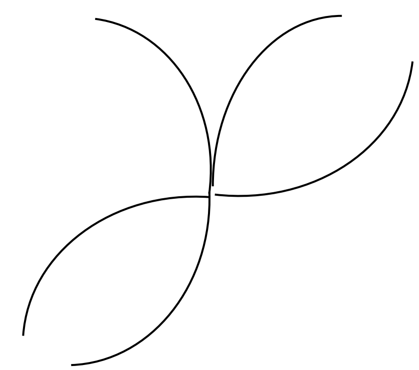

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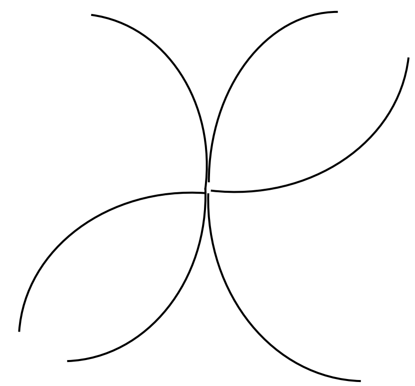

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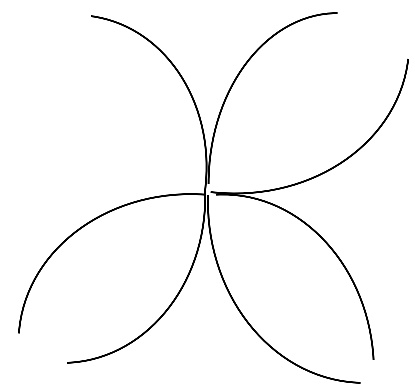

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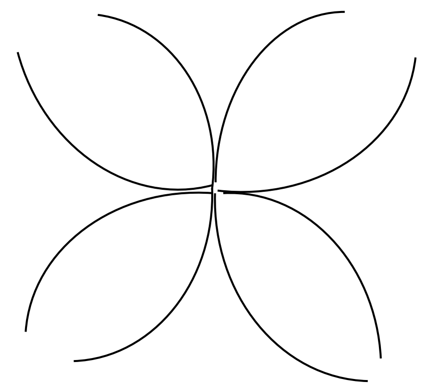

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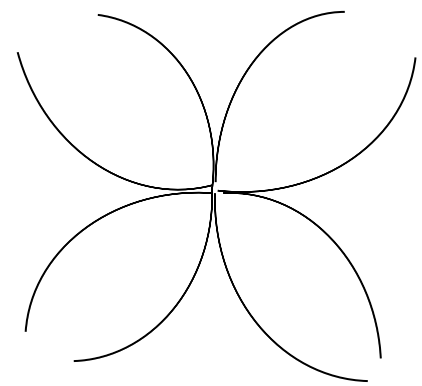

Spider or Flower or Bouquet

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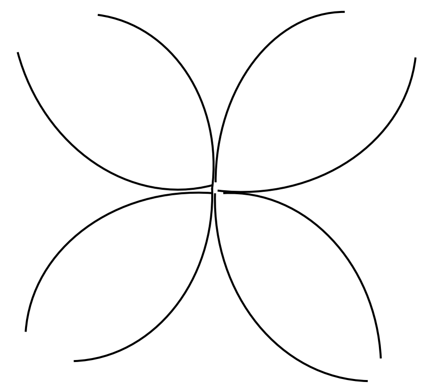

Spider or Flower or Bouquet

3) ***Attachment by identification of a unique point of their basis,***
(giving rise to garlands and flags)

Exemples of simple topological operations with 1-cones

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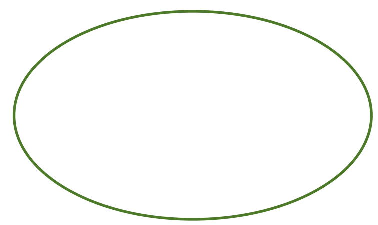

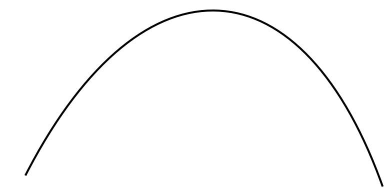

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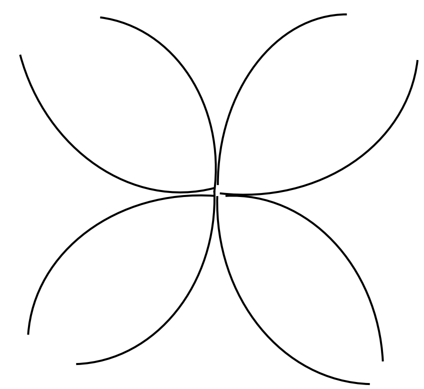

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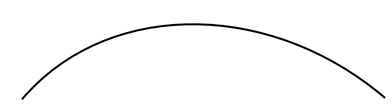

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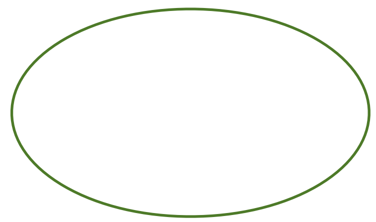

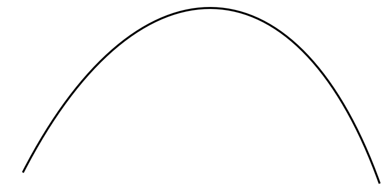

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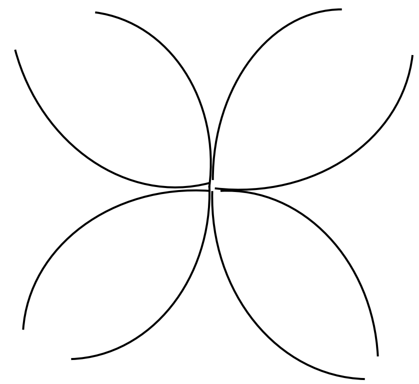

Spider or Flower or Bouquet

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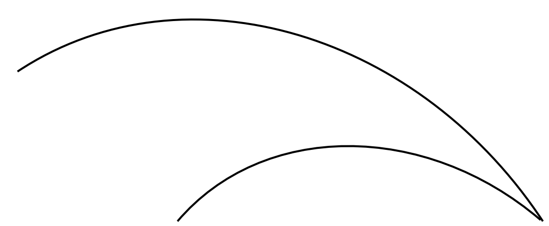

Exemples of simple topological operations with 1-cones

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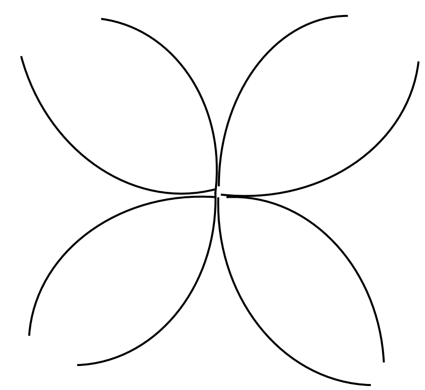

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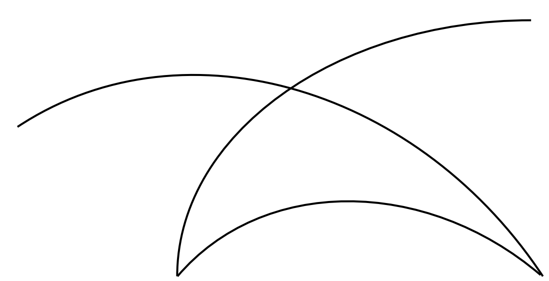

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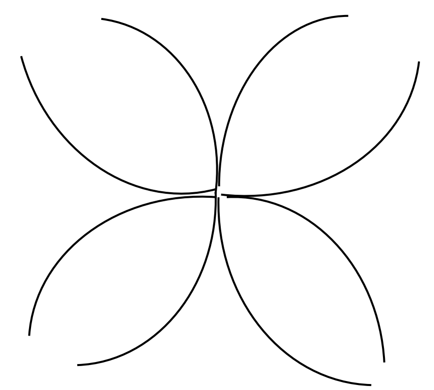

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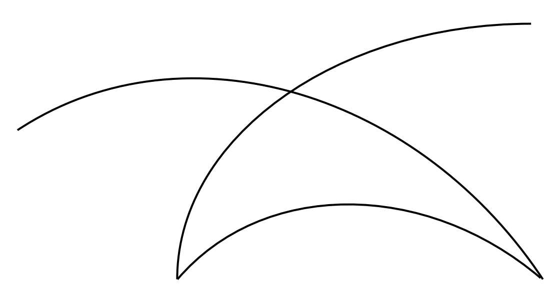

The Bird, the Swallow Tail

Exemples of simple topological operations with 1-cones

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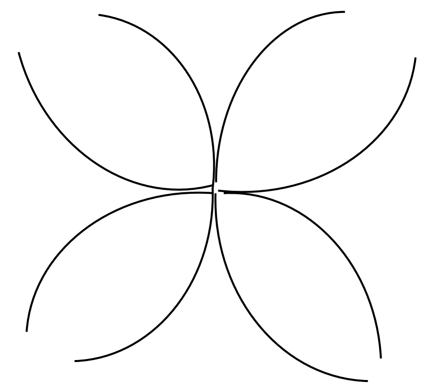

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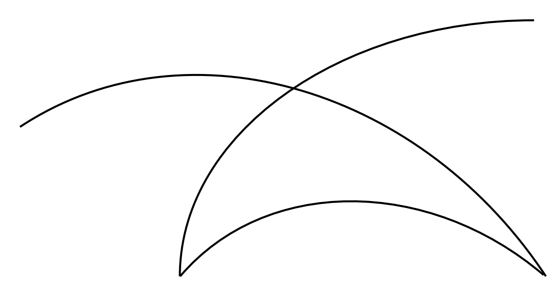

The Bird, the Swallow Tail

4) ***Attachment by identification of the two singular points of their basis***

Exemples of simple topological operations with 1-cones

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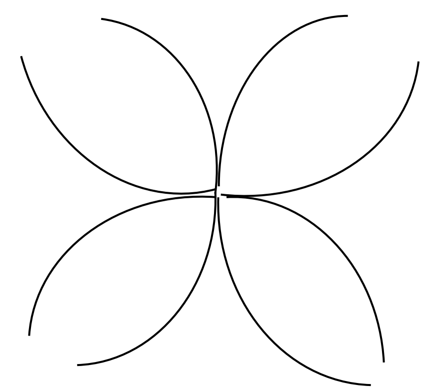
2) ***Attachment of cones by identification of their apex***



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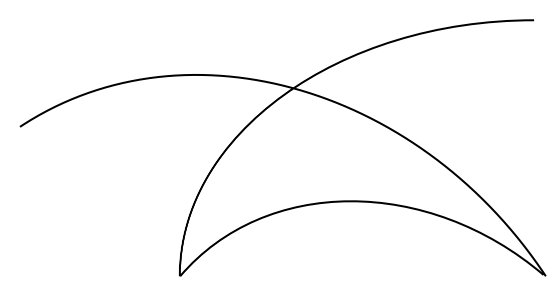

The Bird, the Swallow Tail

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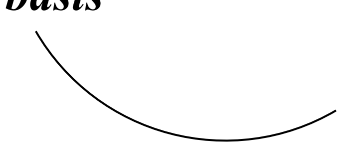

Exemples of simple topological operations with 1-cones

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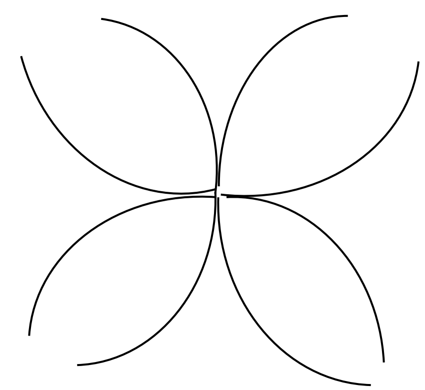

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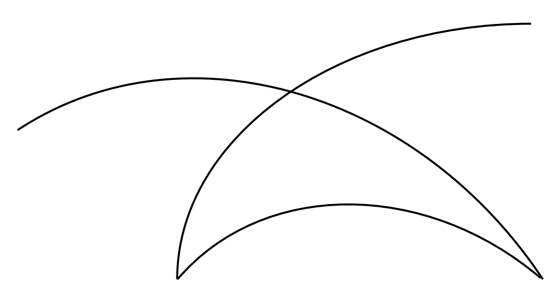

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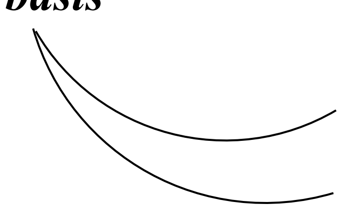

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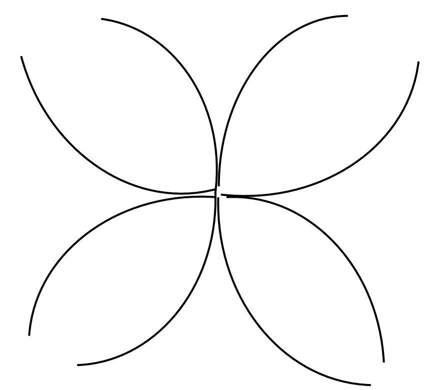

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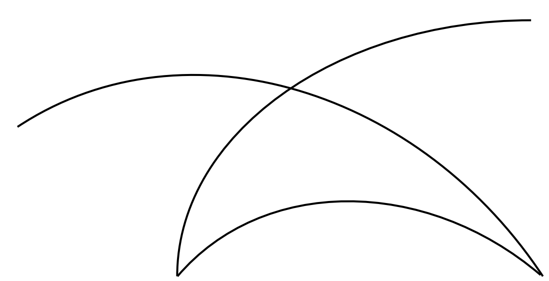

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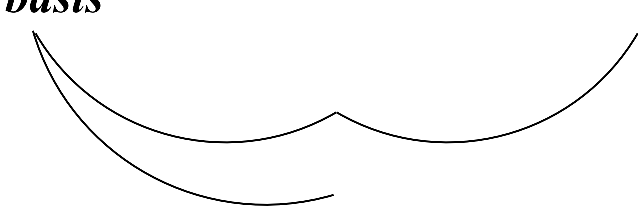

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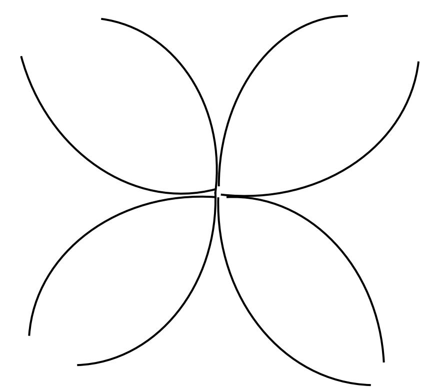

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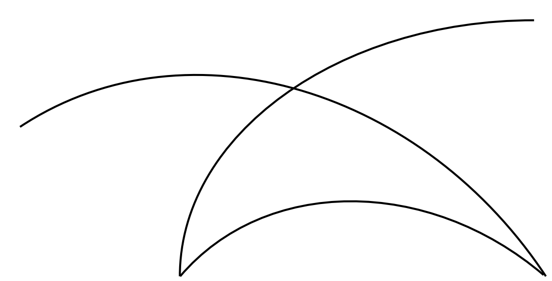

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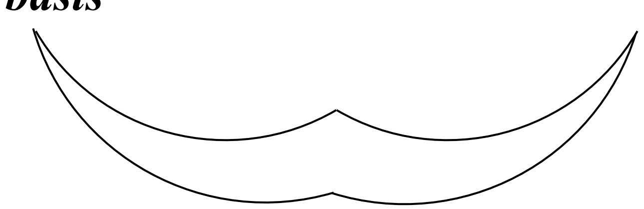

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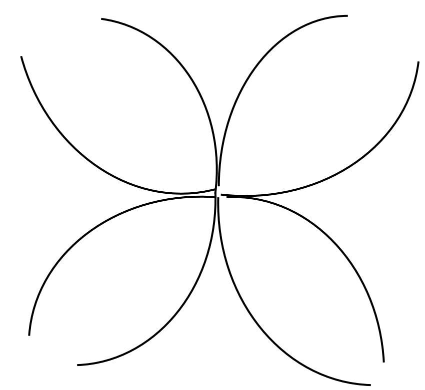

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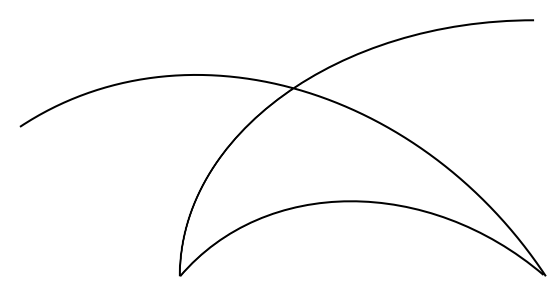

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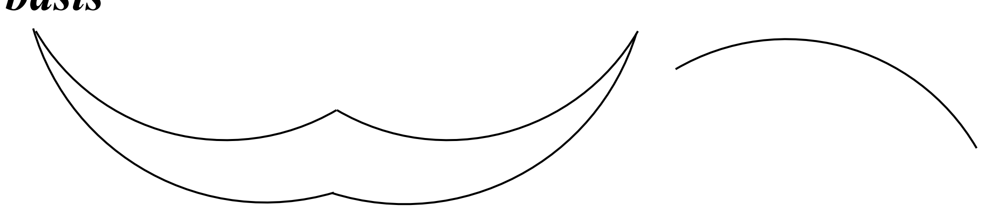

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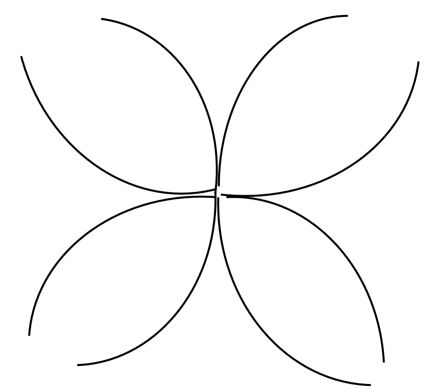

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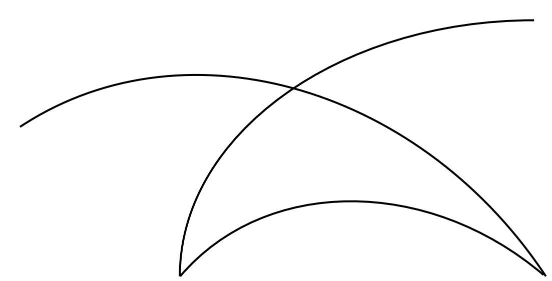
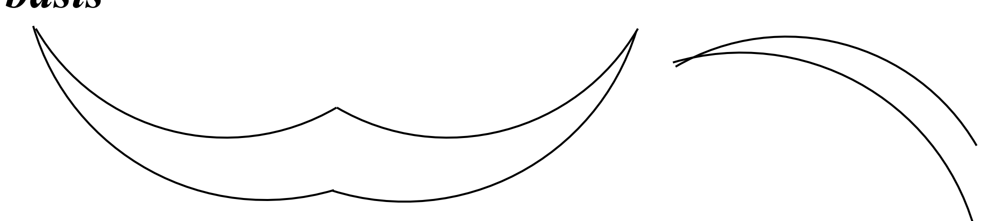
3) ***Attachment by identification of a unique point of their basis,***
(giving rise to garlands and flags)



The Bird, the Swallow Tail

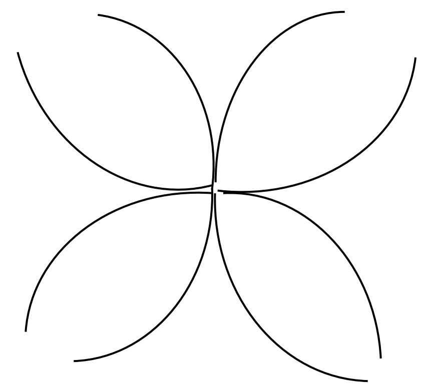
4) ***Attachment by identification of the two singular points of their basis***



Exemples of simple topological operations with 1-cones

1) ***Self-attachment***

2) ***Attachment of cones by identification of their apex***



Spider or Flower or Bouquet

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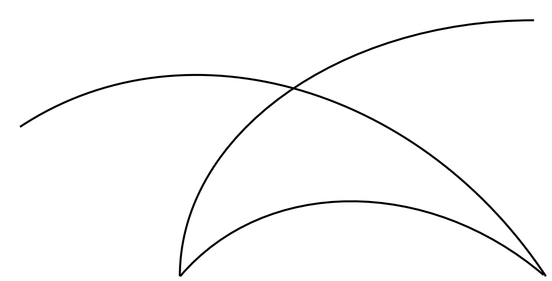

The Bird, the Swallow Tail

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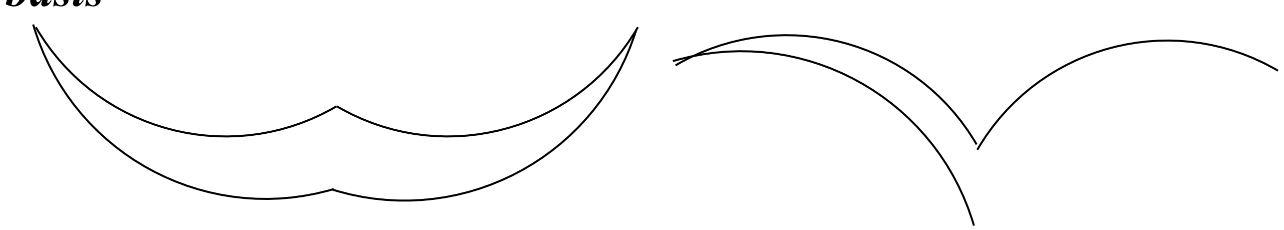

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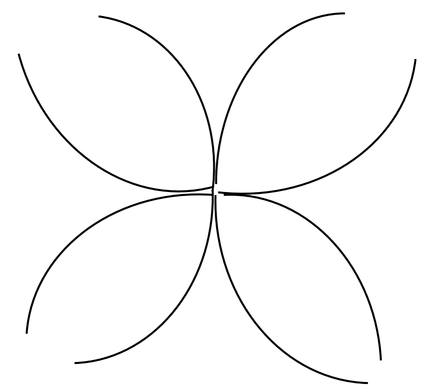

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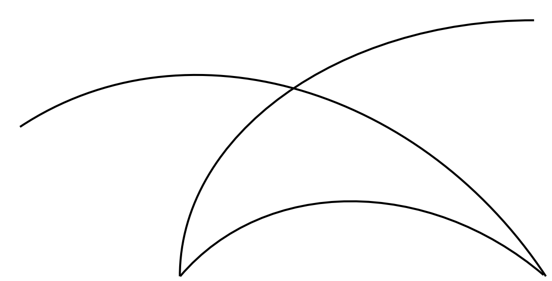

The Bird, the Swallow Tail

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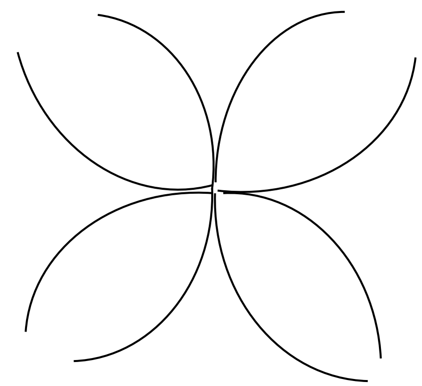

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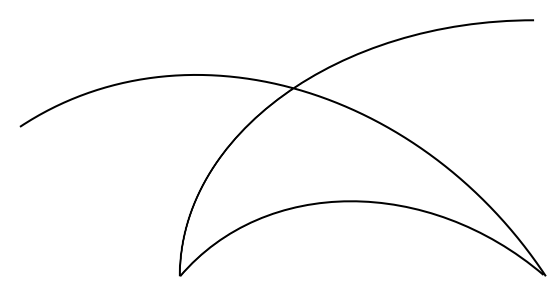

The Bird, the Swallow Tail

4) ***Attachment by identification of the two singular points of their basis***

Smile and Moustache

Exemples of simple topological operations with 1-cones

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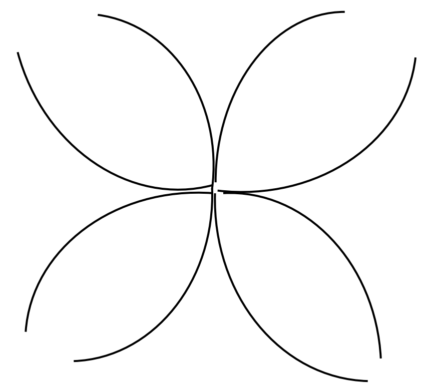
2) ***Attachment of cones by identification of their apex***



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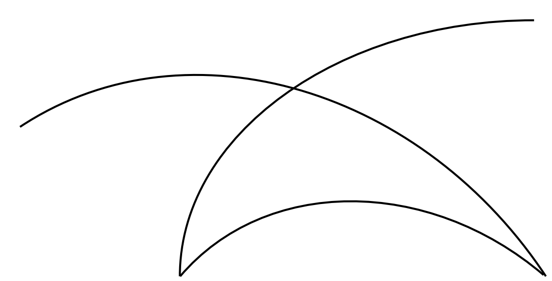

The Bird, the Swallow Tail

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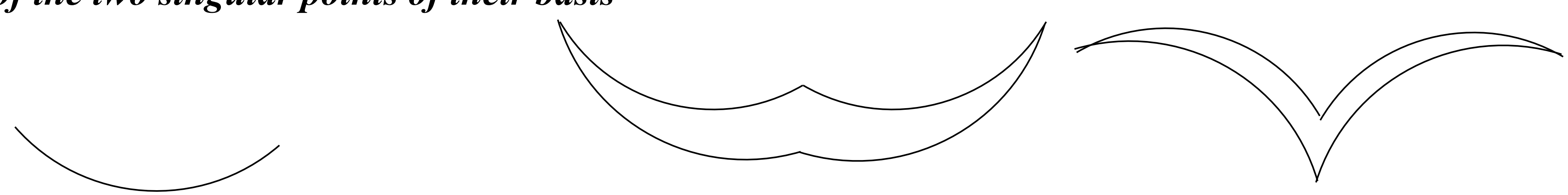

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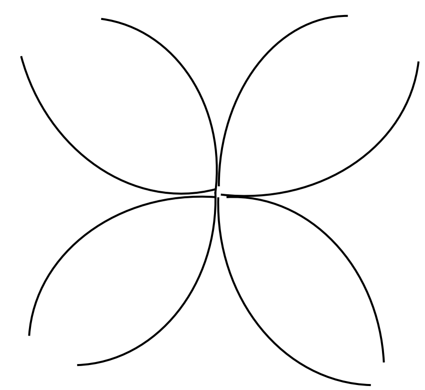

Spider or Flower or Bouquet

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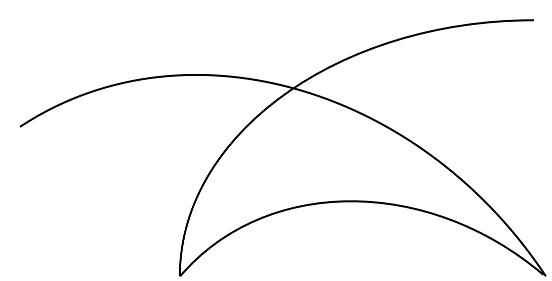

The Bird, the Swallow Tail

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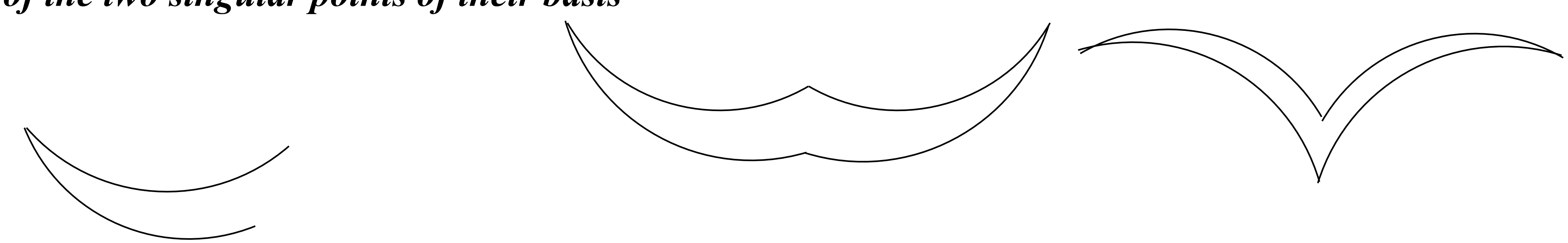

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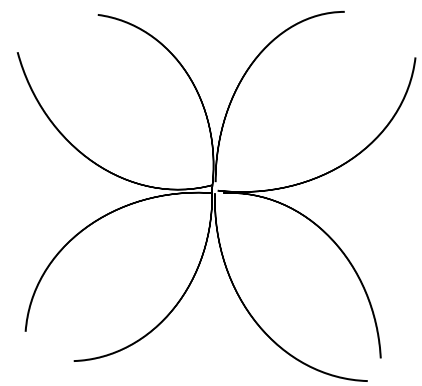

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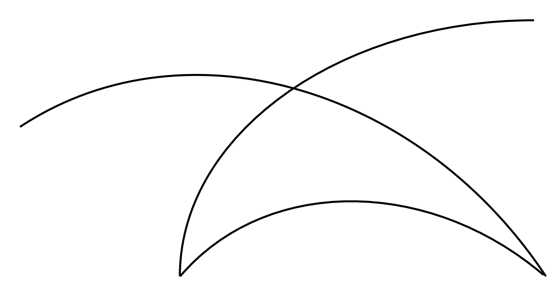

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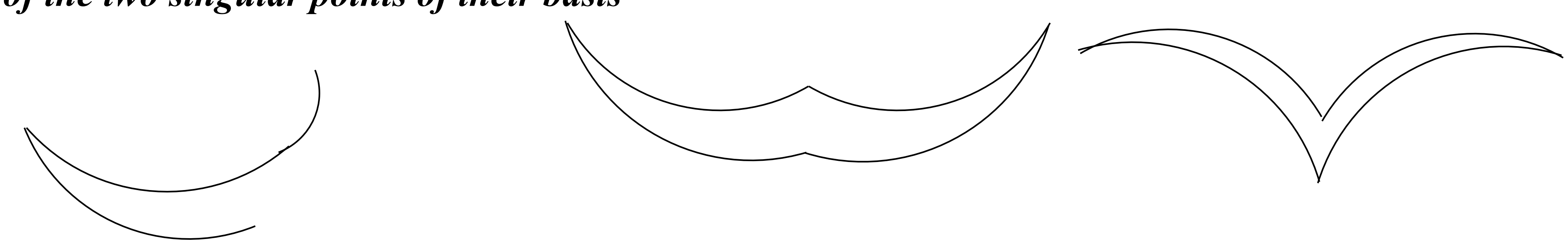

Smile and Moustache

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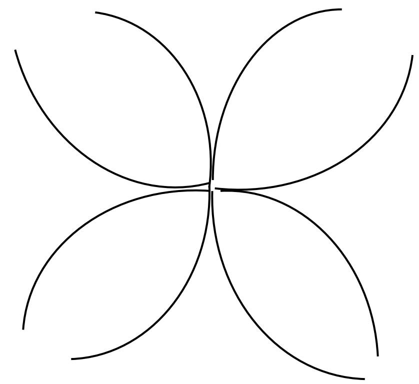

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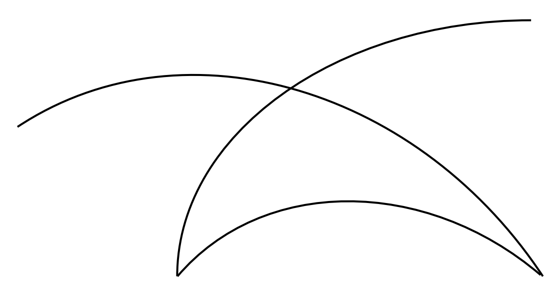

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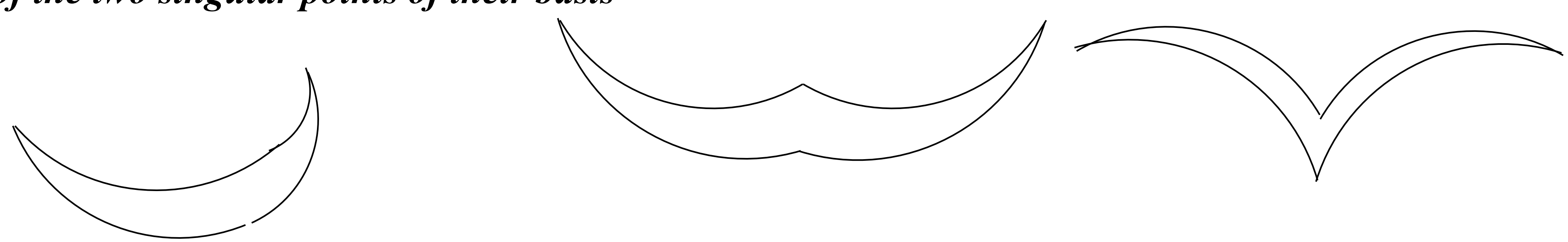
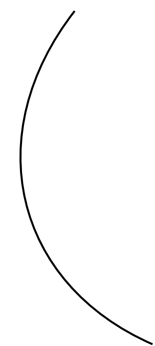


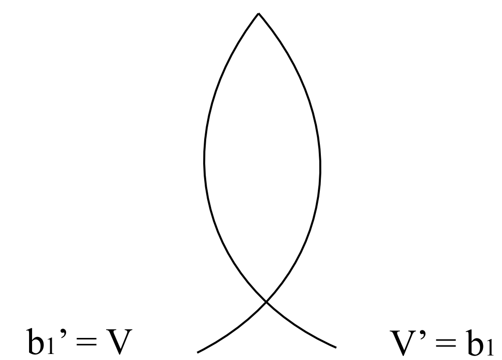
Smile and Moustache

$b_1' = V$

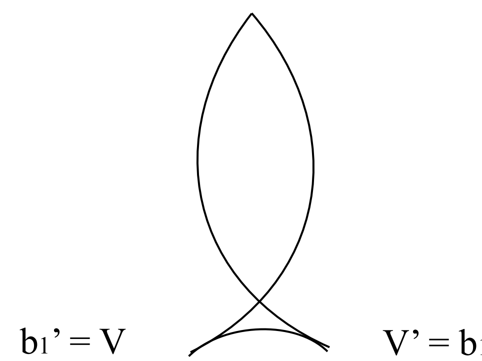
$b_1' = V$ $V' = b_1$



$b_1' = V$ $V' = b_1$



$b_1' = V$
$V' = b_1$



$b_1' = V$
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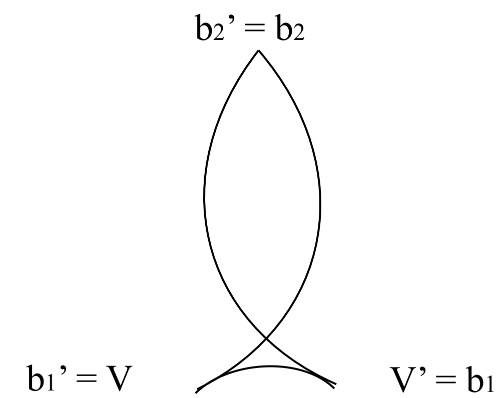
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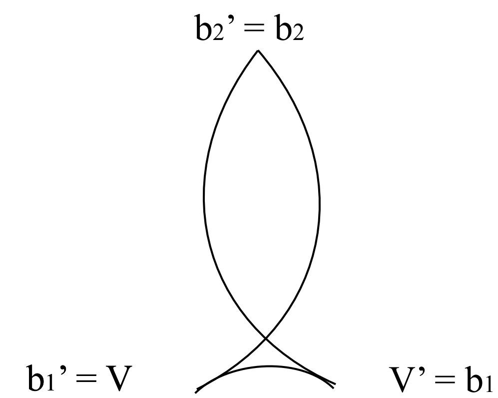
$b_1' = V$
$V' = b_1$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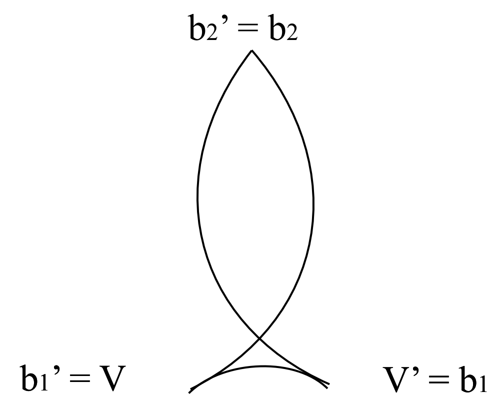
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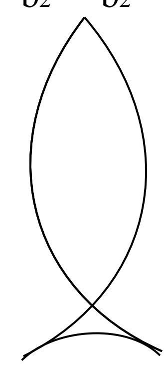
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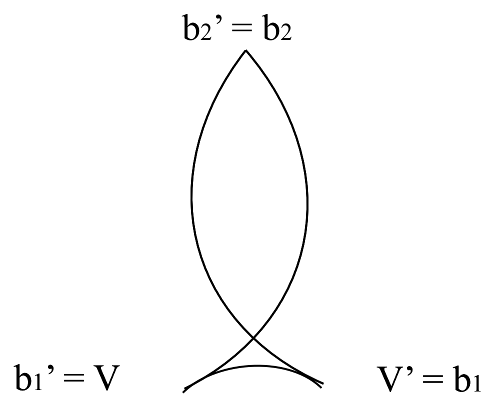
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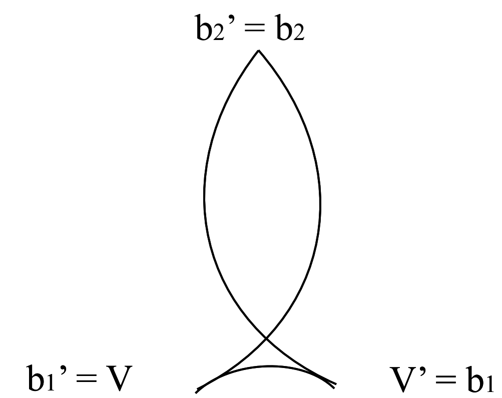
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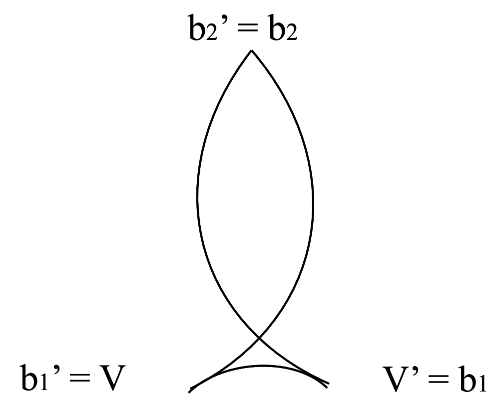
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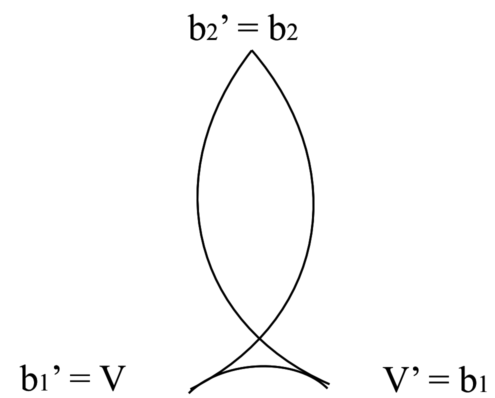
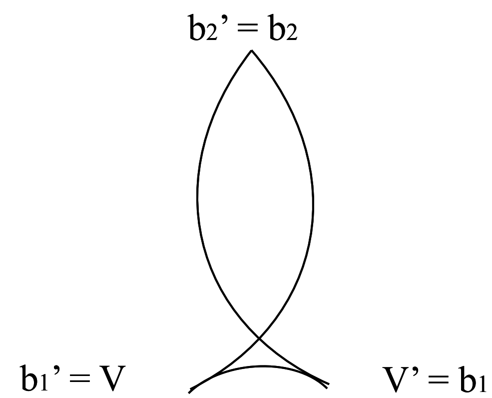


The contour of the fishes
built from two symmetric1-cones
(is also the complete hollow 1-cone of the fishes)

V



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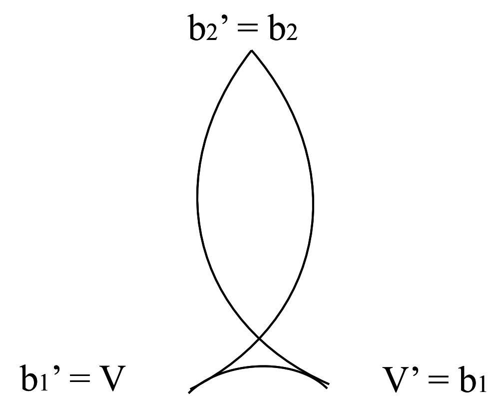

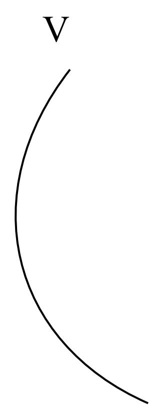

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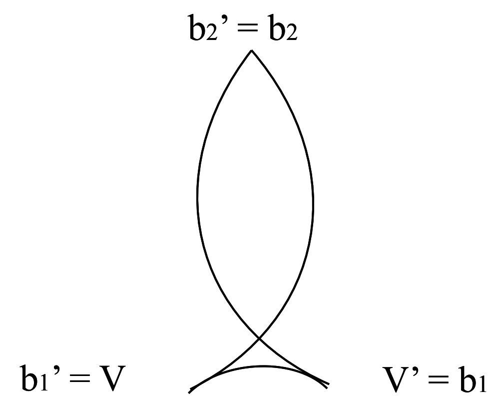

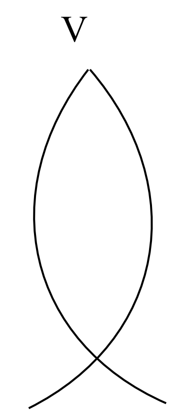

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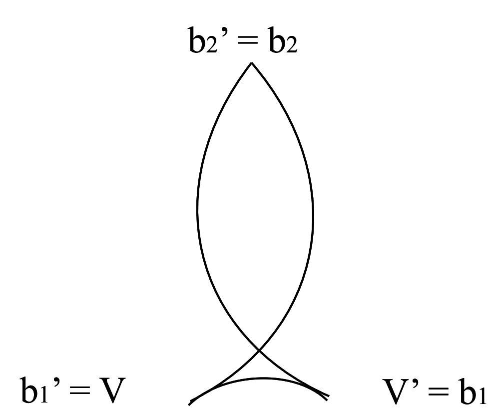

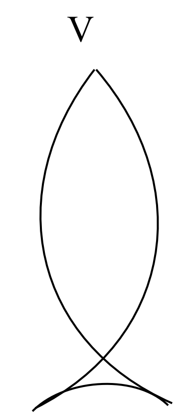

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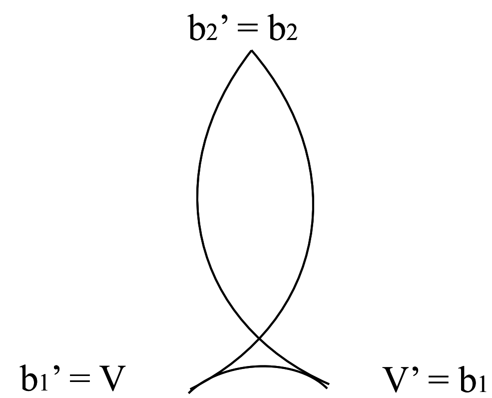

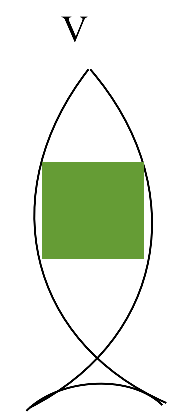

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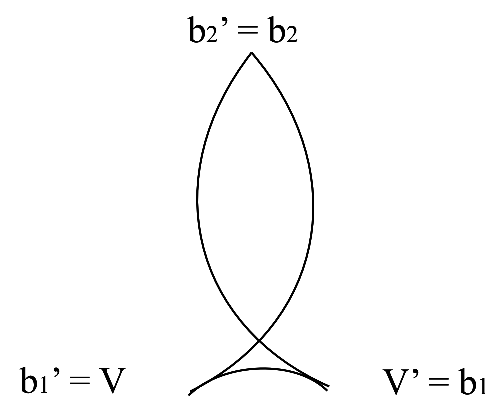

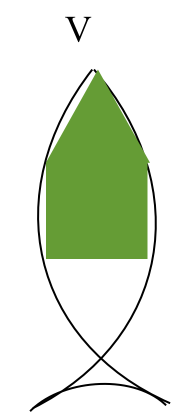

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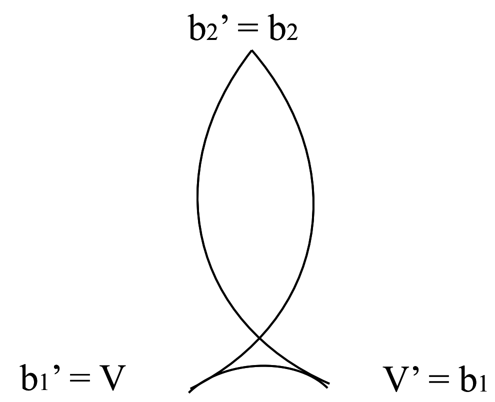

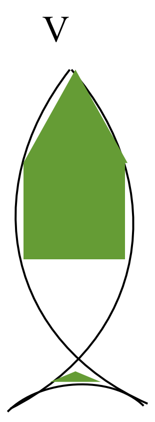

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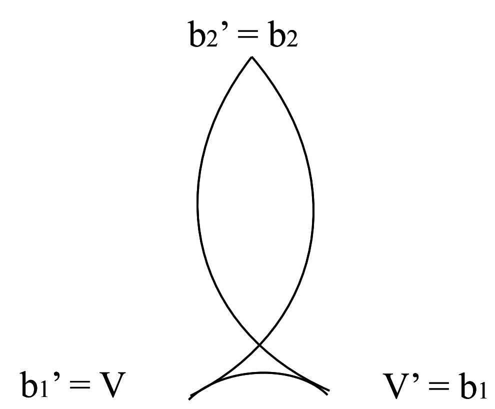

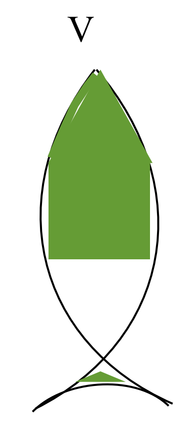

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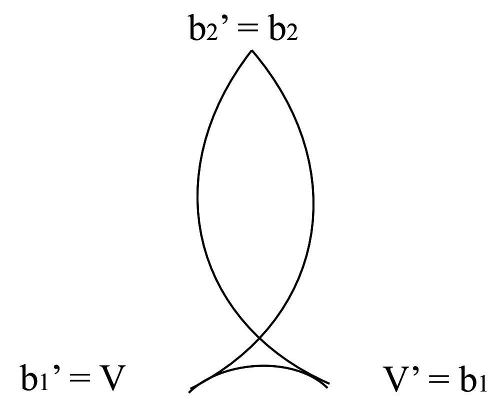

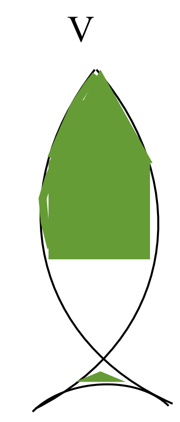

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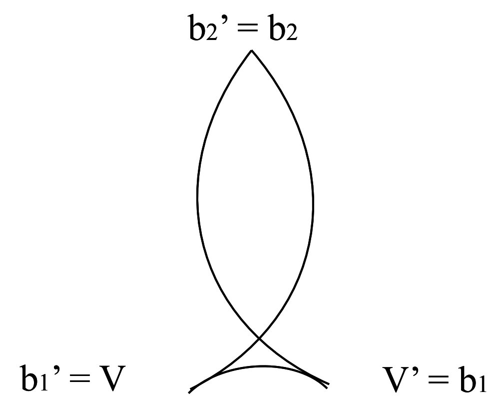

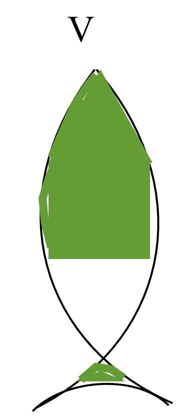

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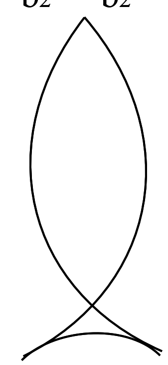

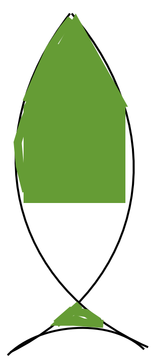

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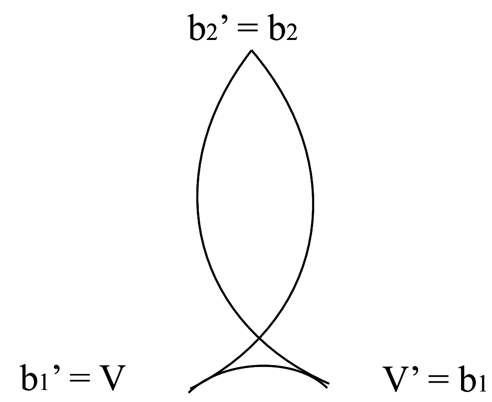

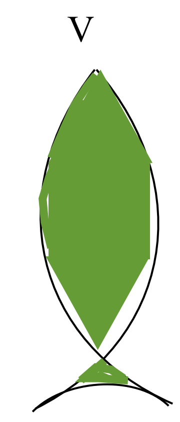

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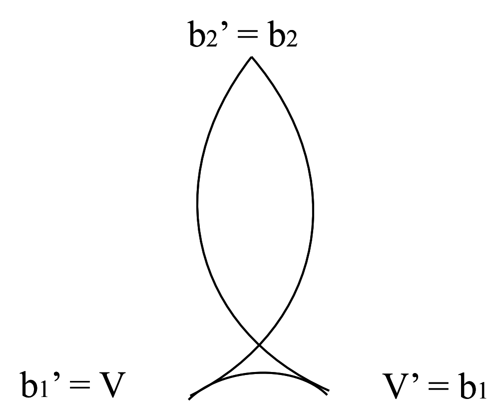

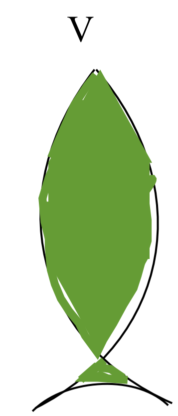

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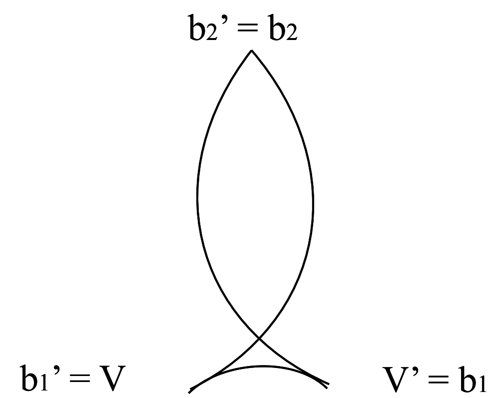

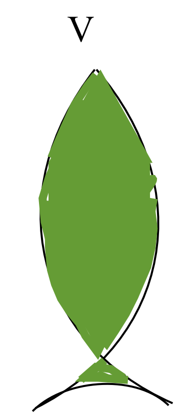

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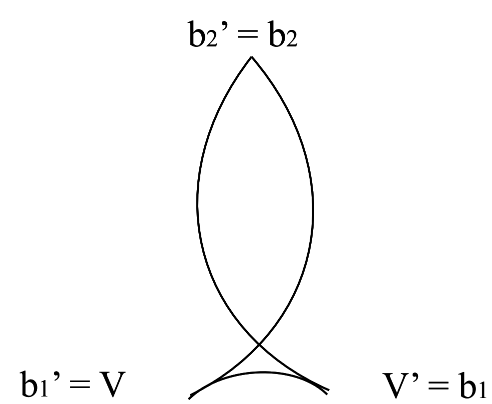

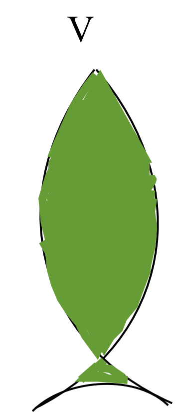

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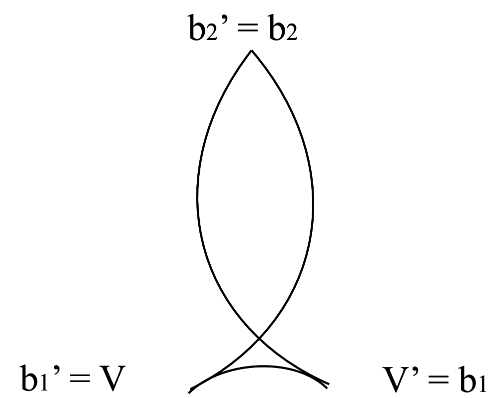
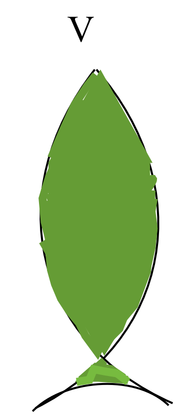
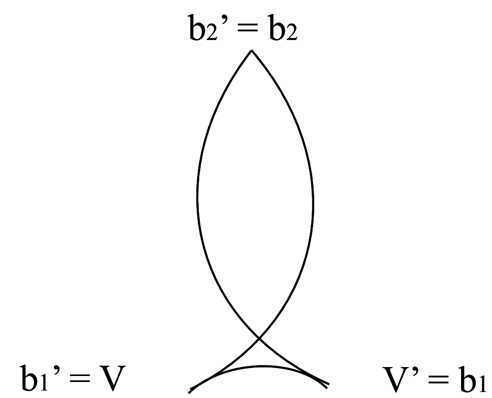
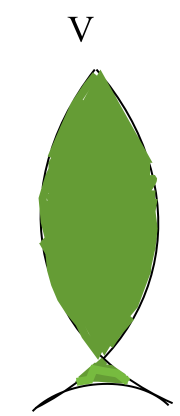




The contour of the fishes
built from two symmetric1-cones
(is also the complete hollow 1-cone of the fishes)





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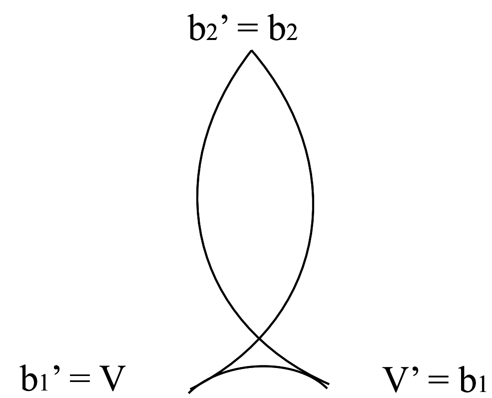

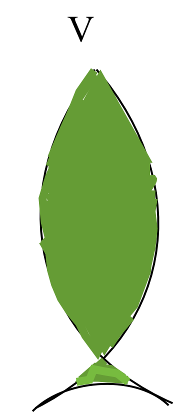

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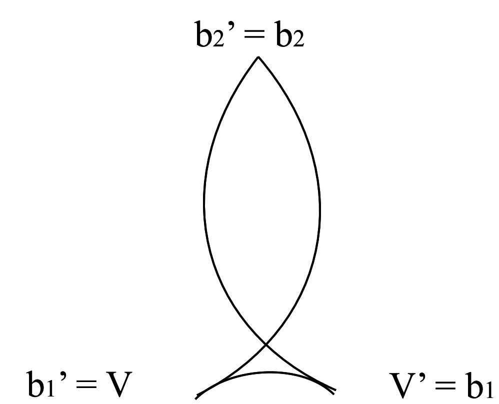

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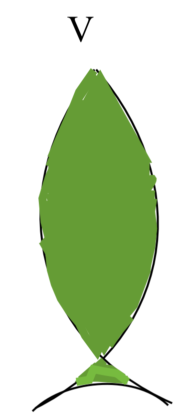
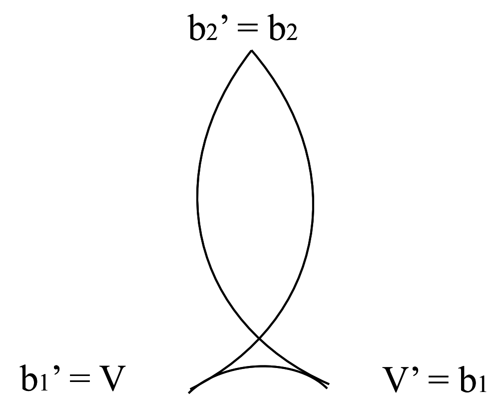


The body of the green fish as one
full 2-cone in the plane

V



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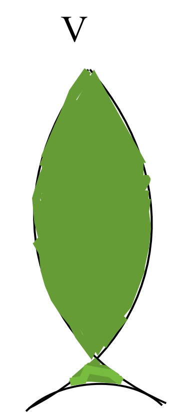

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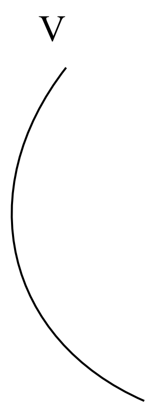

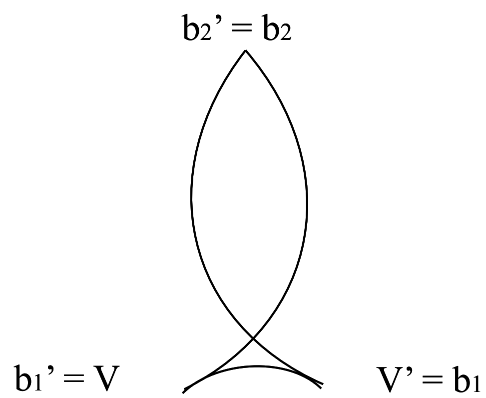

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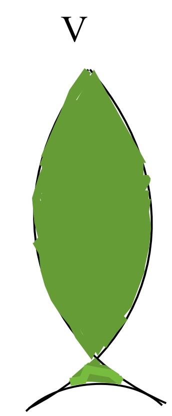

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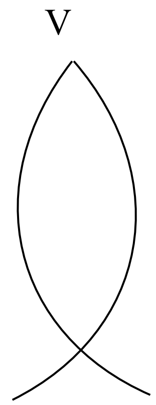

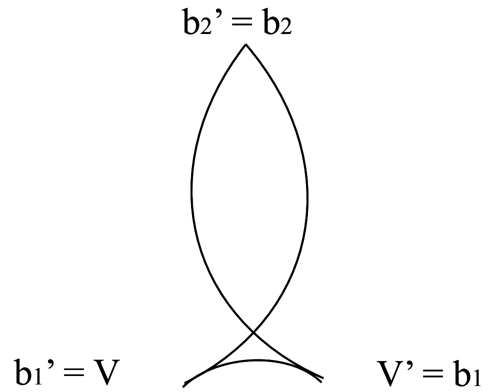

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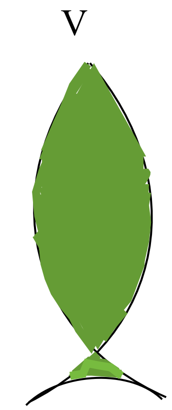

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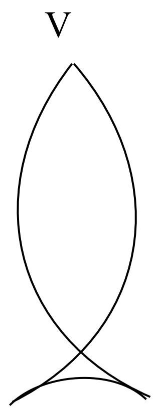

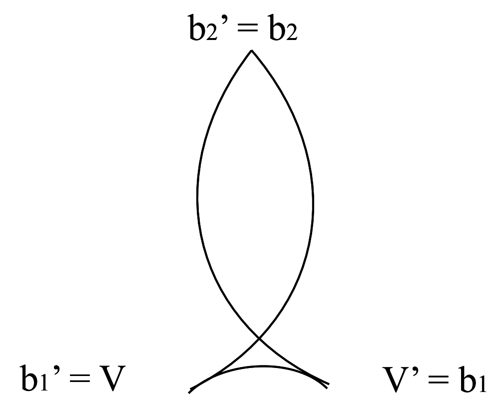

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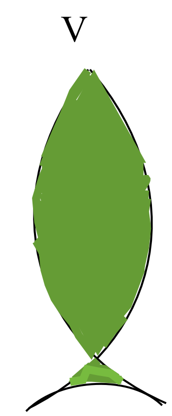

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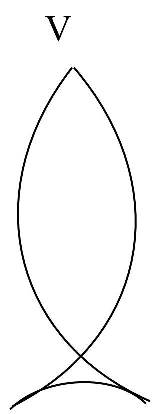
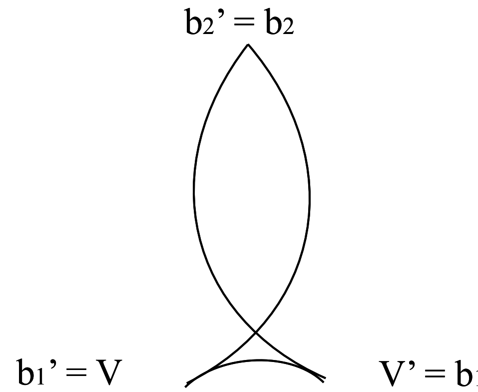


The body of the white fish as one
full 2-cone in the plane



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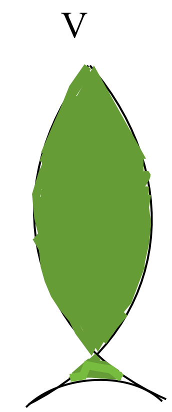


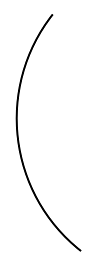
The body of the green fish as one
full 2-cone in the plane

Excrescence of cones, Flags

Excrescence of cones, Flags

Λ is a curve, a **singular curve** of a shape S

Excrescence of cones, Flags



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Excrescence of cones, Flags

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Excrescence of cones, Flags

Λ is a curve, a **singular curve** of a shape S

V any point of Λ

Excrescence of cones, Flags

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C(V) is a cone, named the **local motive**

Excrescence of cones, Flags

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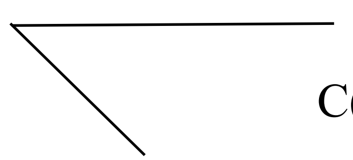

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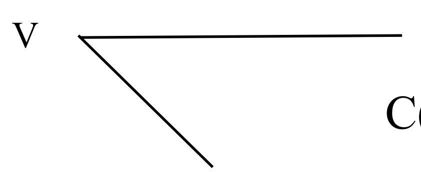

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Excrescence of cones, Flags

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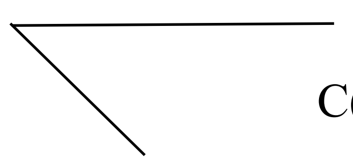
V



C(V) is a cone, named the **local motive**

$S = \cup \{C(V) / V \in \Lambda\}$ is the shape

it is the regular conical excrescence of C along Λ

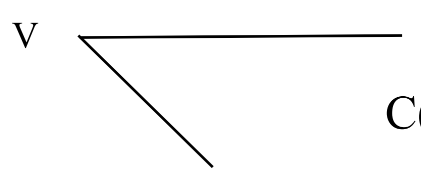
(When all the motives are the clones of a particular cone C

$S = \Lambda \times C$ from the set theoretical point of view)

Excrescence of cones, Flags

Λ is a curve, a **singular curve** of a shape S

V any point of Λ



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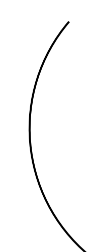

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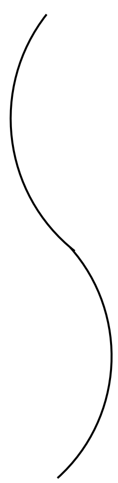
Excrescence of cones, Flags



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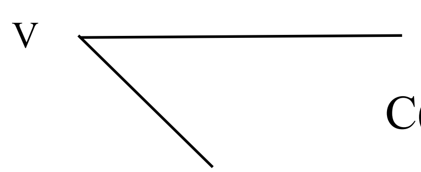

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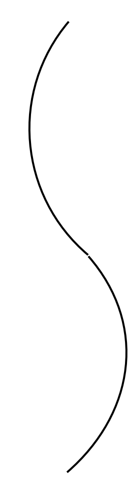

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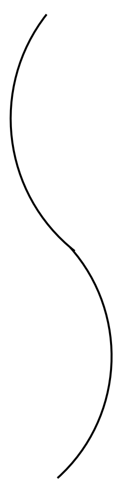

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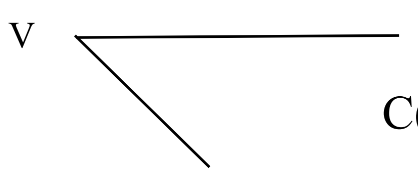

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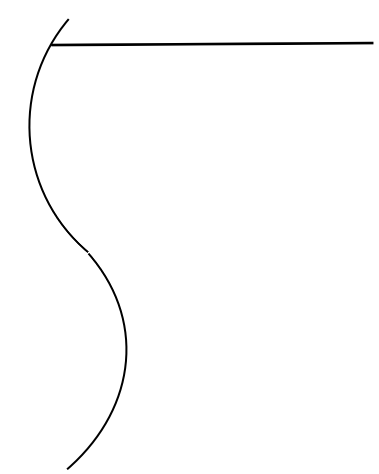

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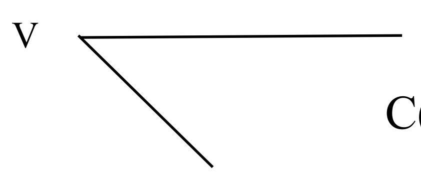
Excrescence of cones, Flags

Λ is a curve, a **singular curve** of a shape S

V any point of Λ



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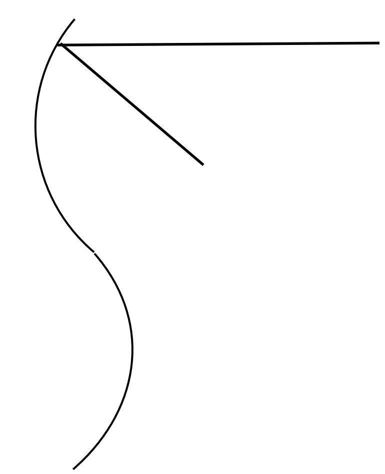

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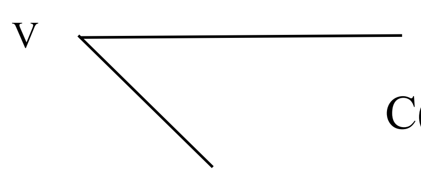

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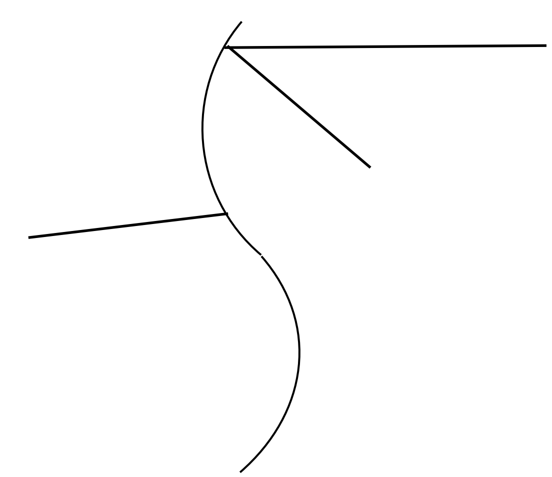

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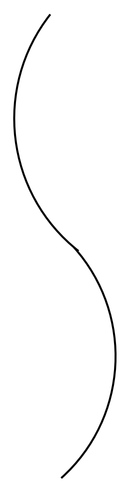

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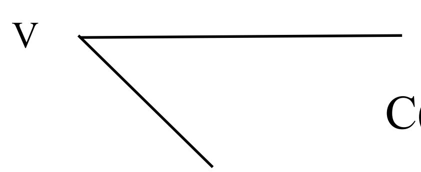

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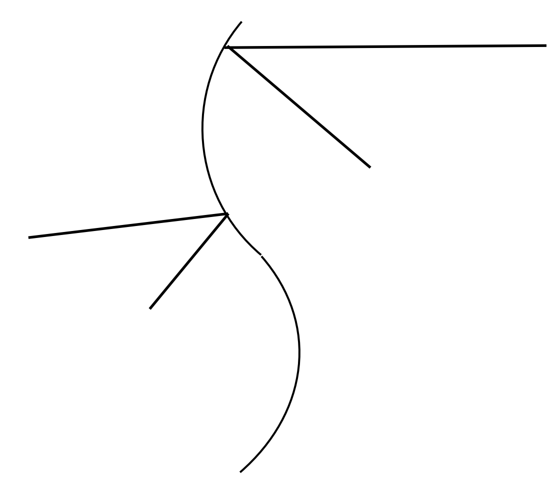
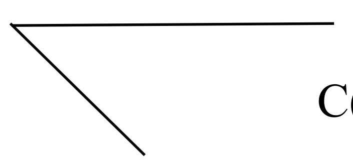


Excrescence of cones, Flags

Λ is a curve, a **singular curve** of a shape S

V any point of Λ

V



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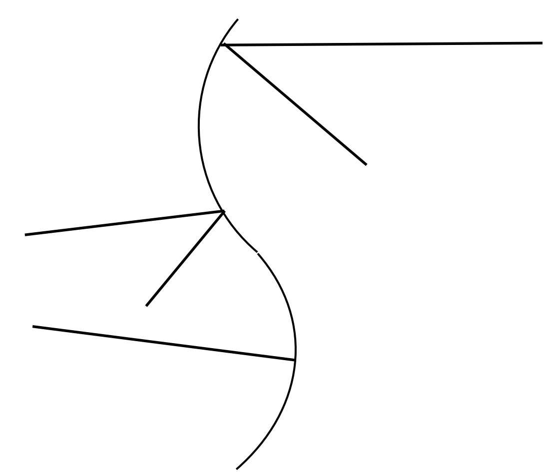

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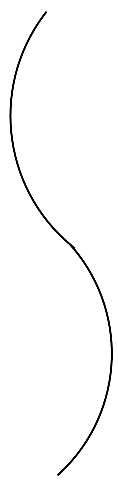

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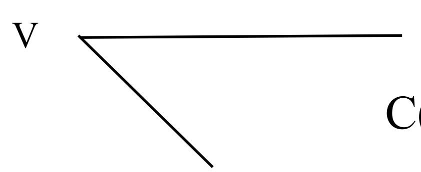

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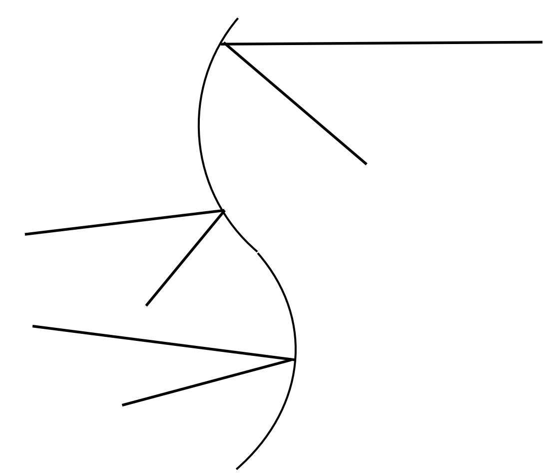

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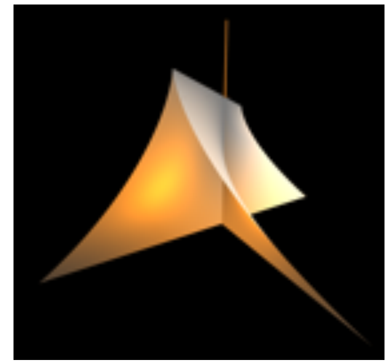
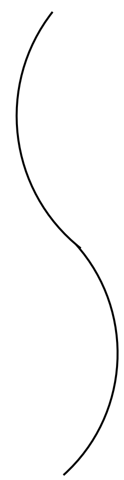
Excrescence of cones, Flags





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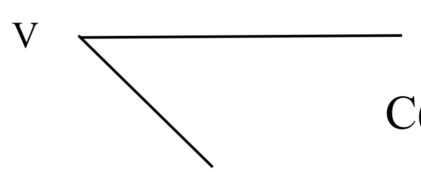
V any point of Λ



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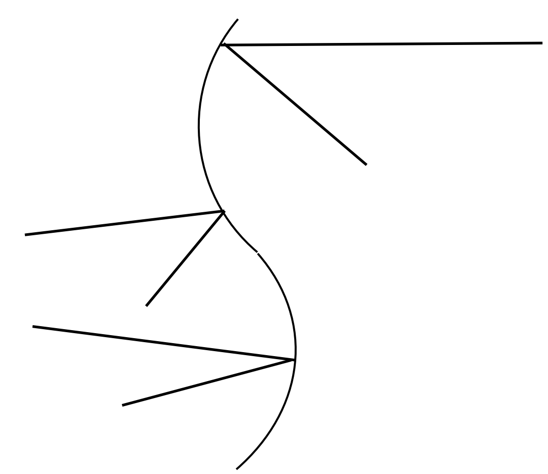

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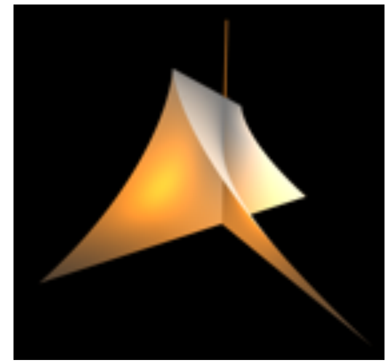

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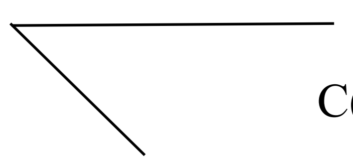
V 

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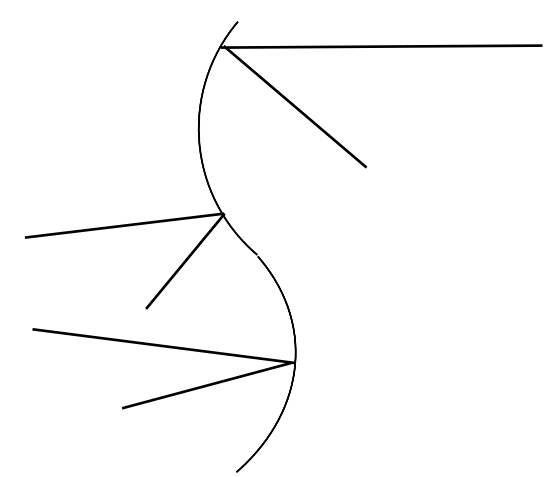

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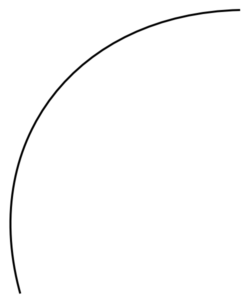
When Λ is a singular line of a cone, S is called a **flag**

Examples from the vegetal world

Examples from the vegetal world



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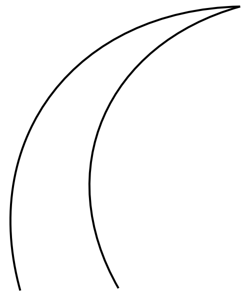

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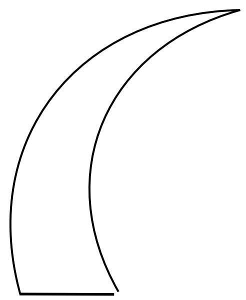

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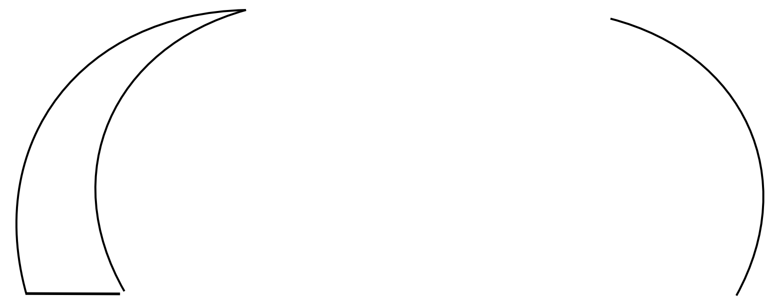

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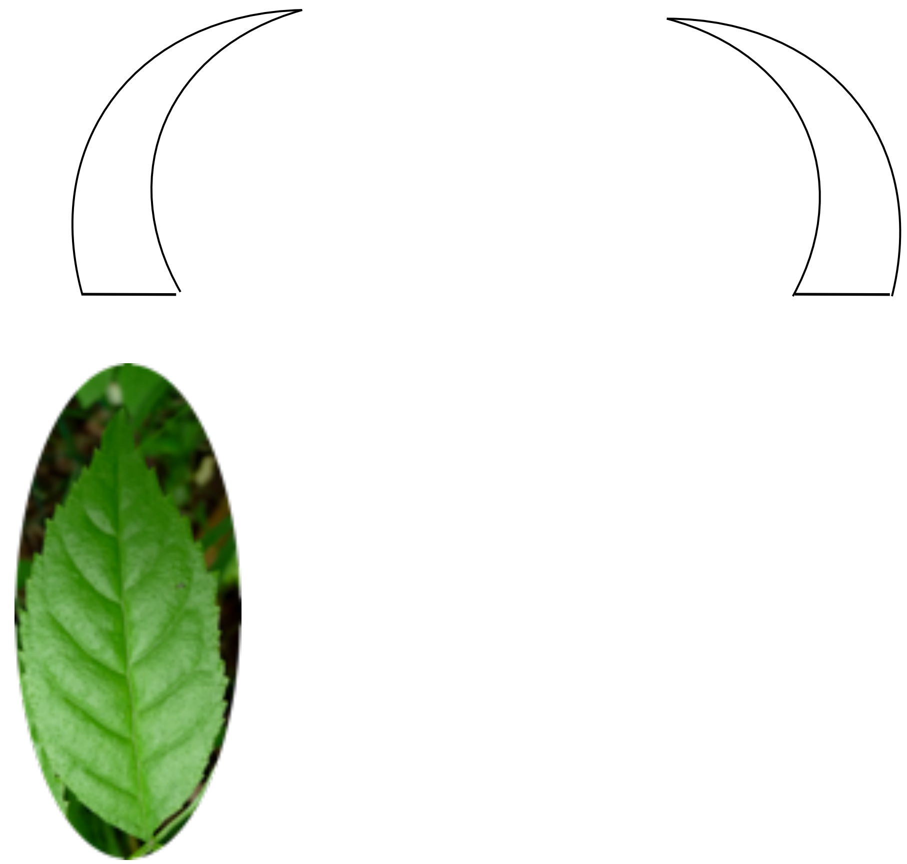

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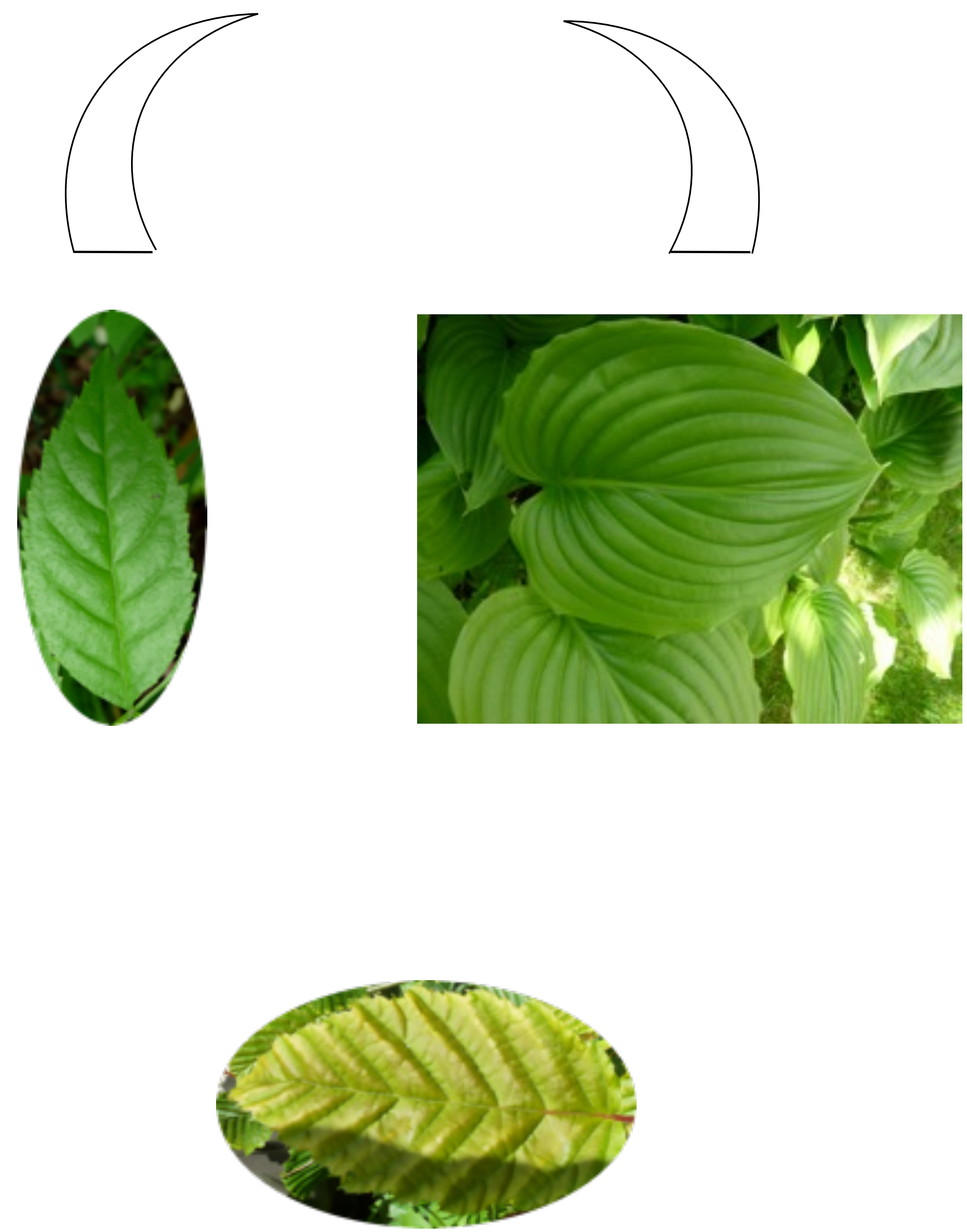

Some Singular Fibers of a cone

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A fiber Σ of the cone is **singular** if it contains an element of curve Λ such that the intersection of its neighborhood with the cone is a shape a flag S whose local conic motive is rough.

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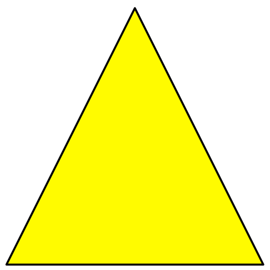

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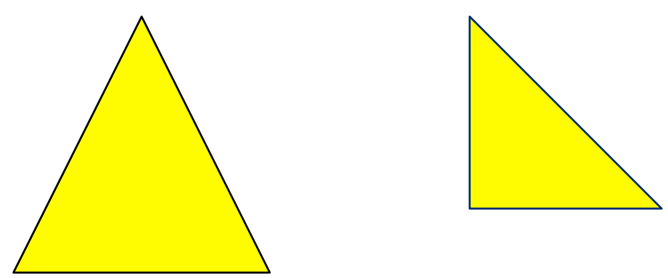

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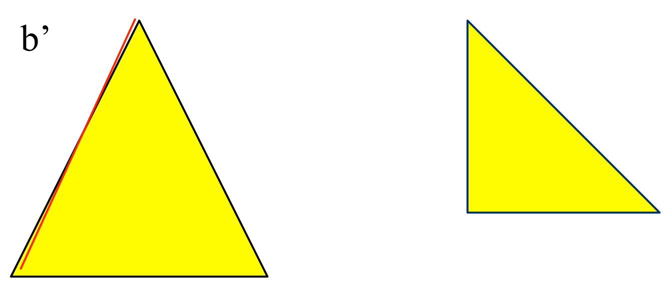

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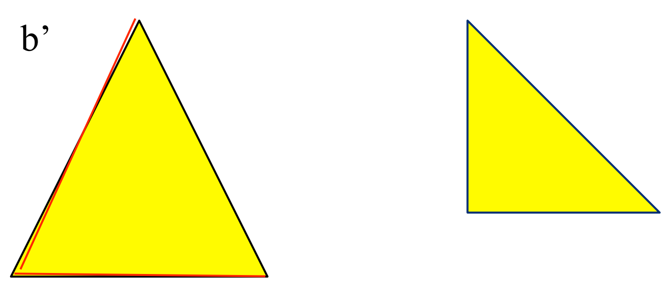

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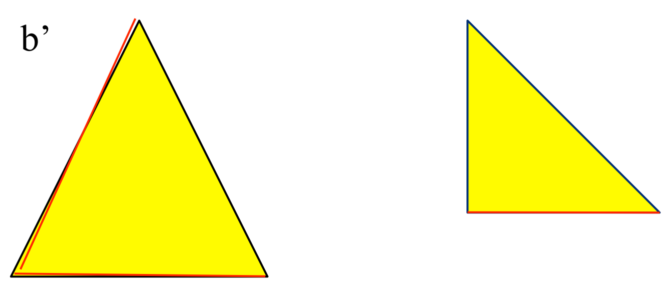

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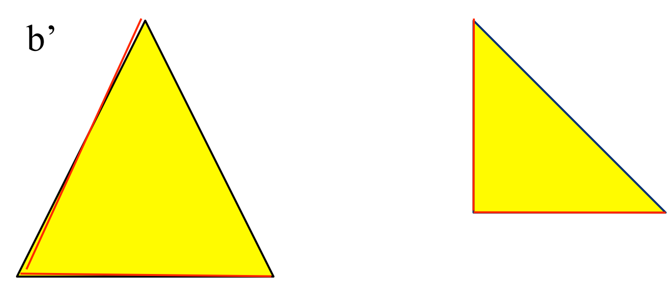

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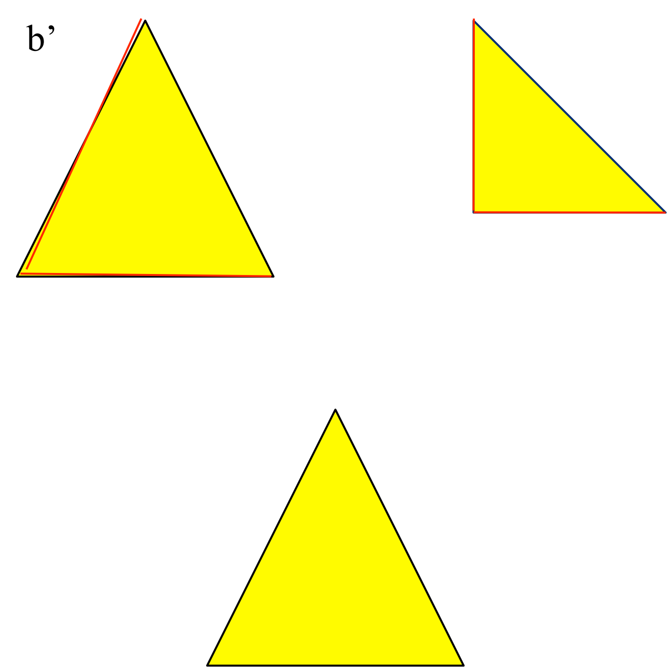

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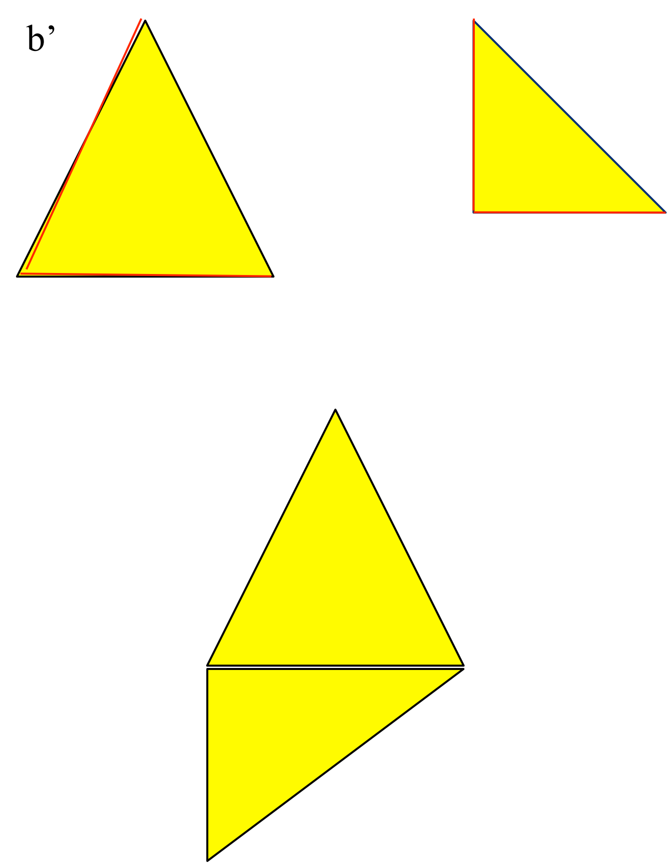

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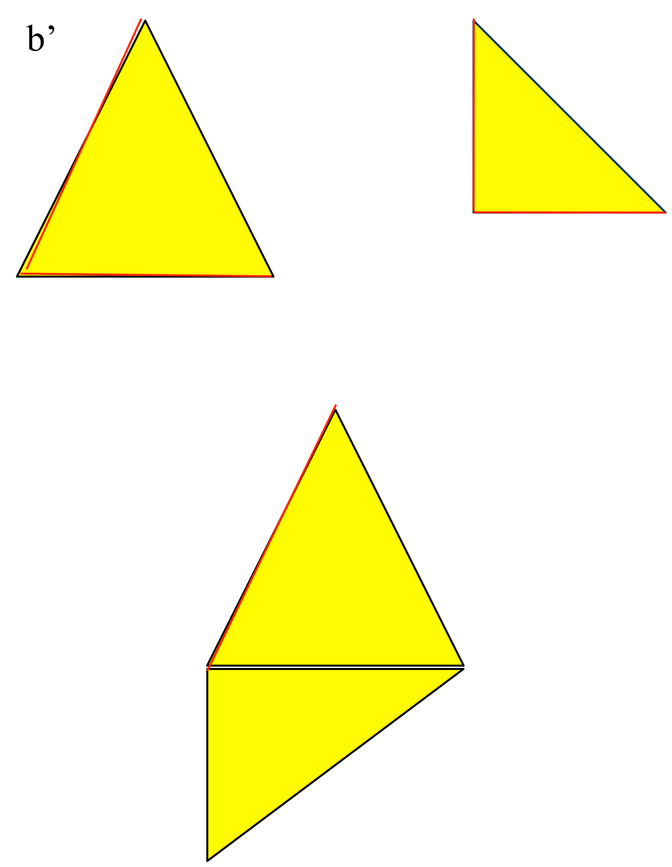

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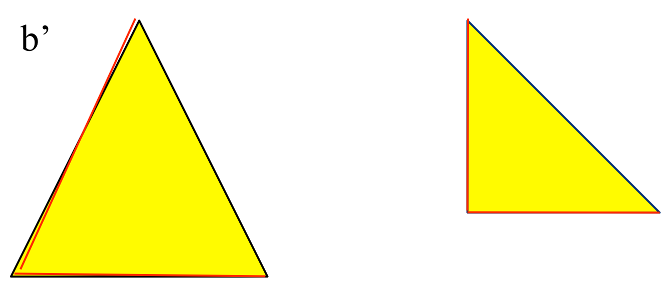

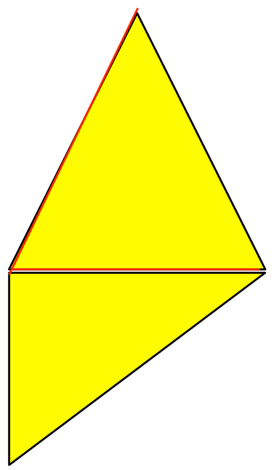

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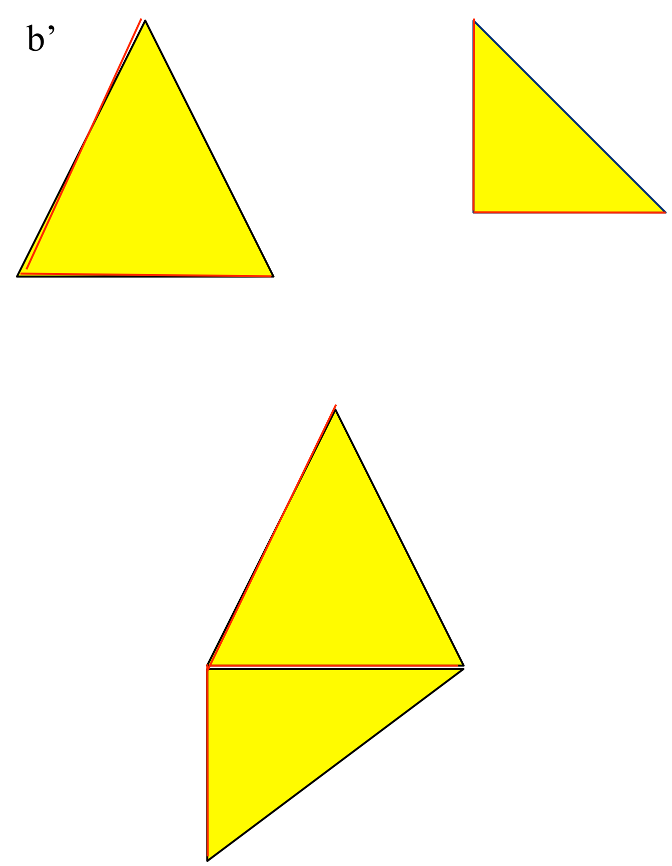

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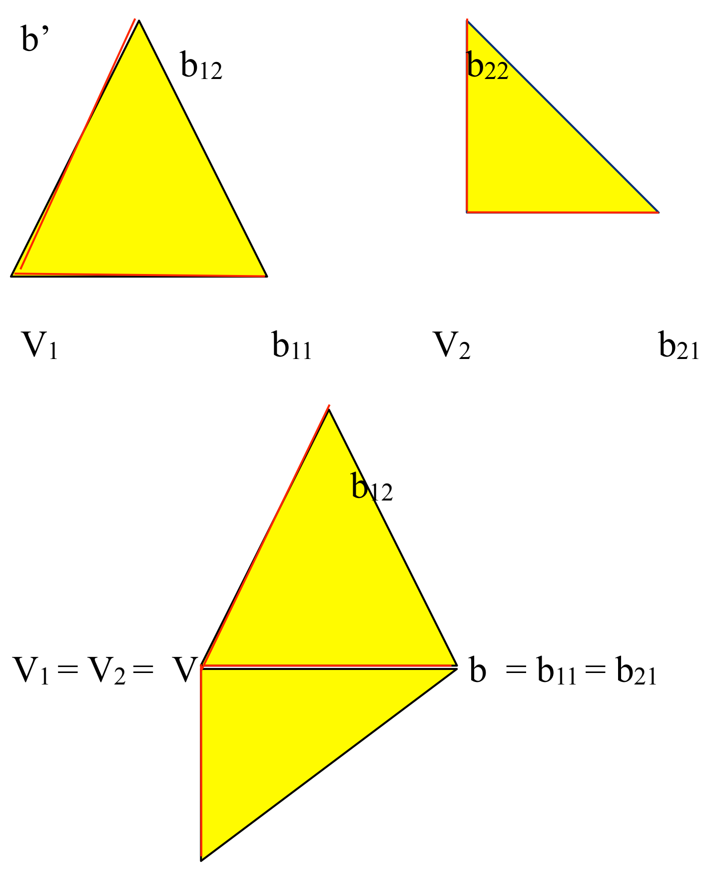
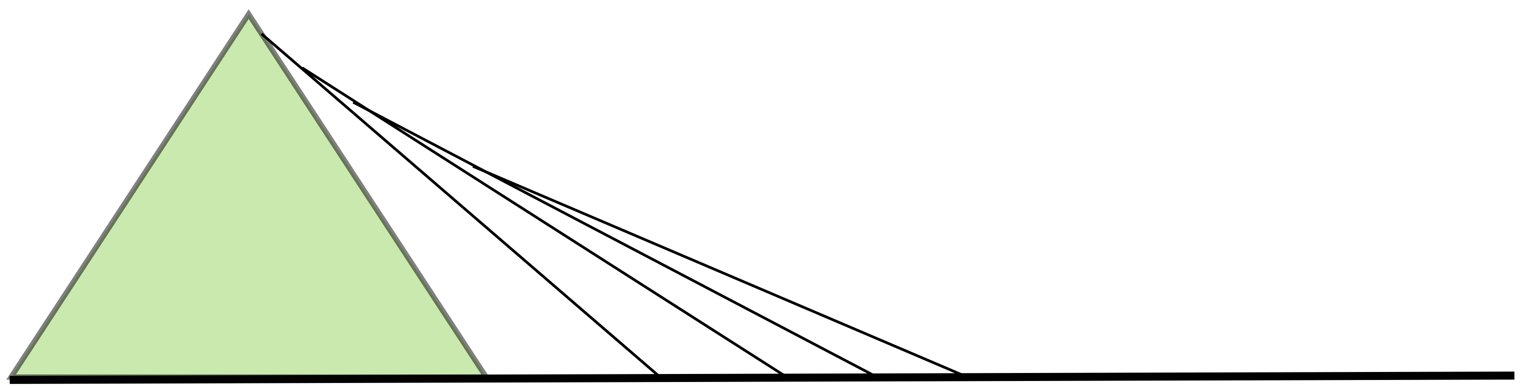
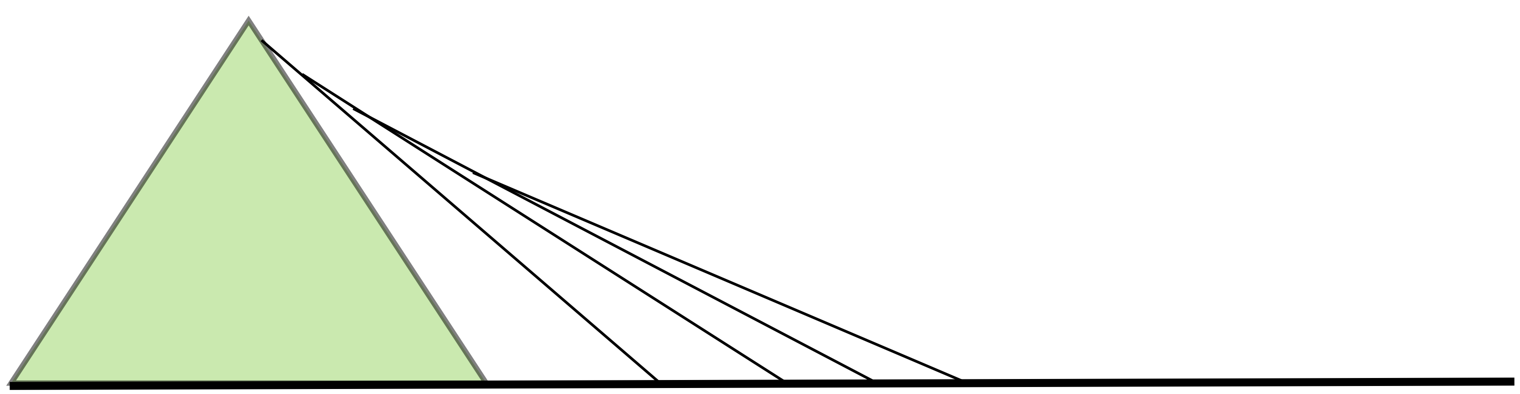
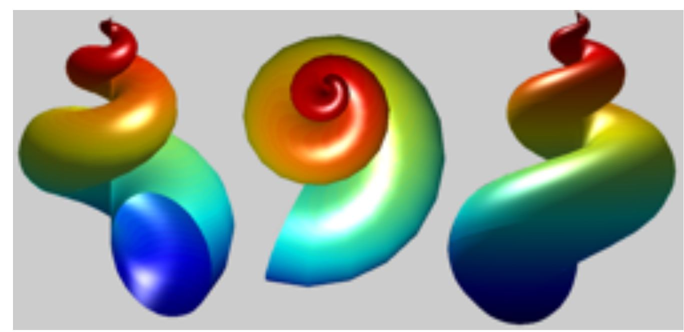


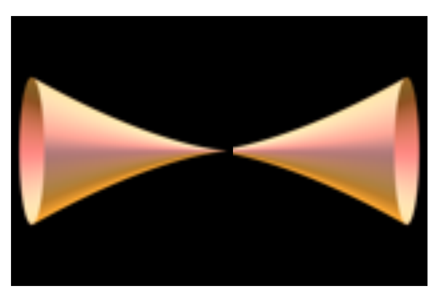


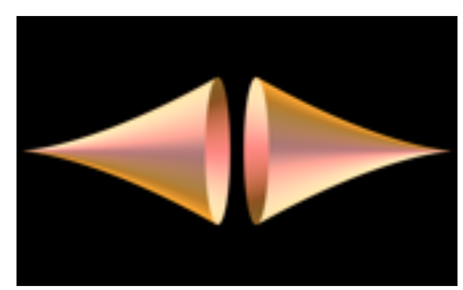
6) ***Attachment by identification of parts of singular fibers with same curvature***

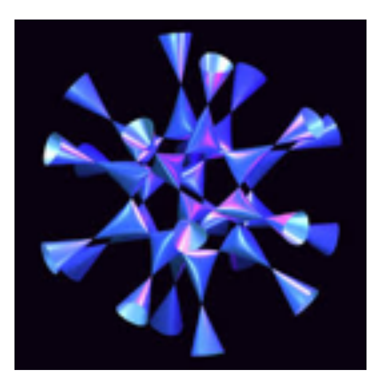


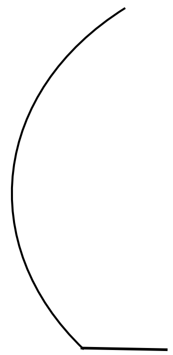
Examples of 2-Cones

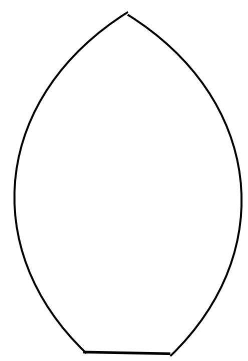


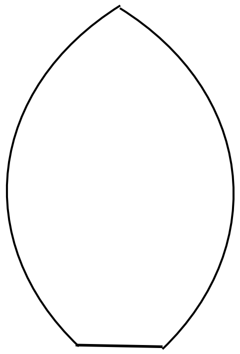


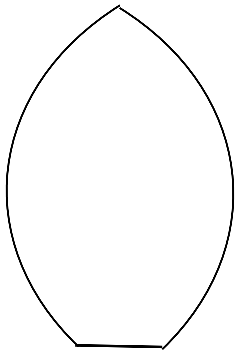


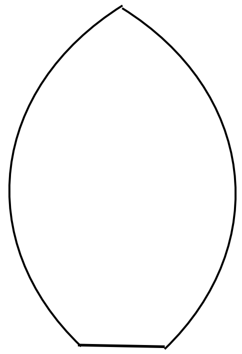




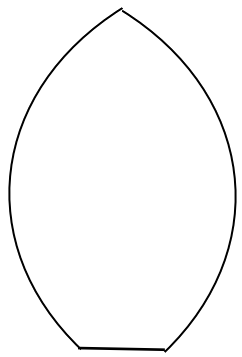


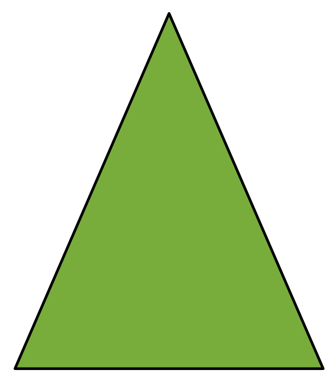




two «Serpinski» garlands





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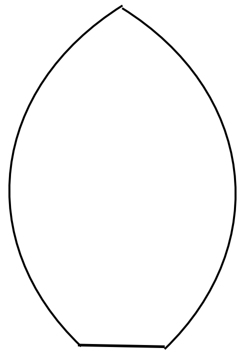

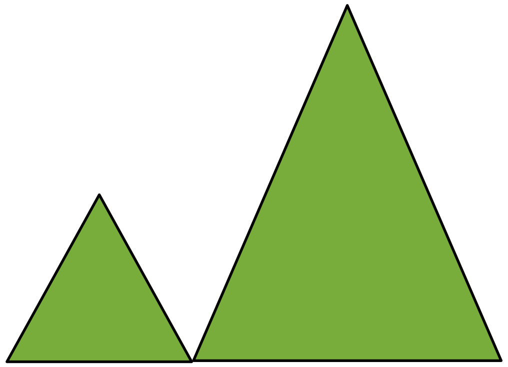

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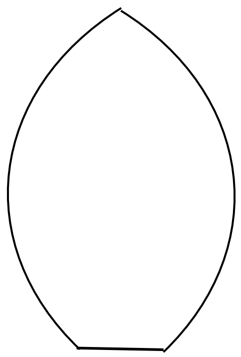

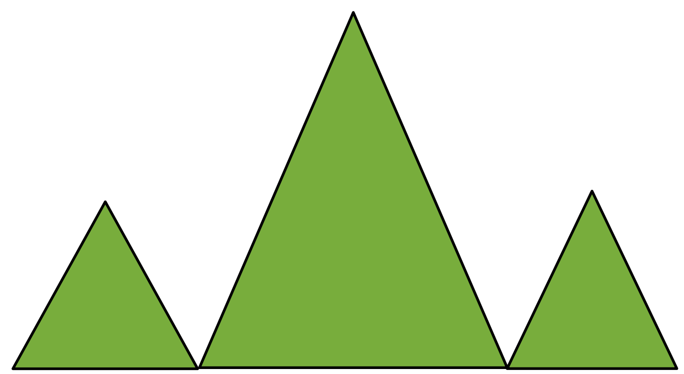

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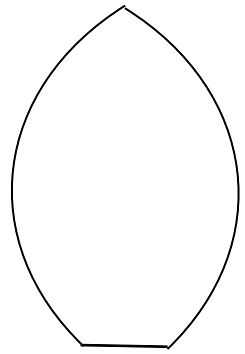

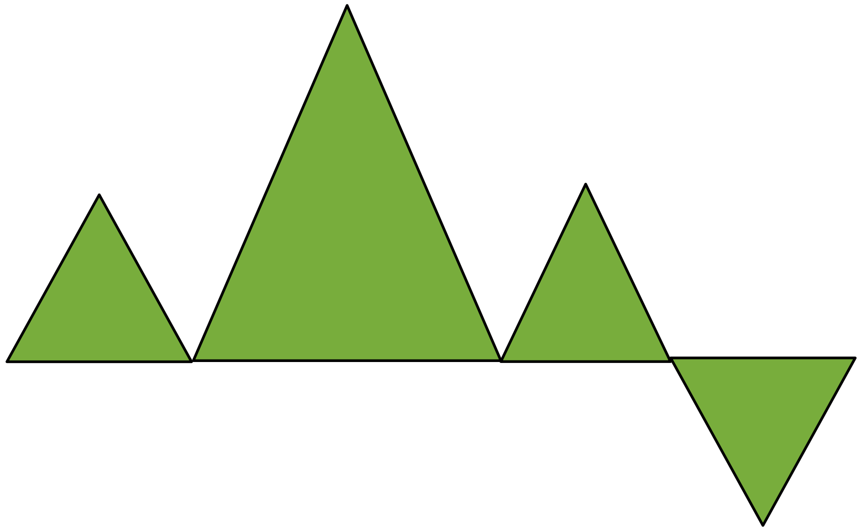

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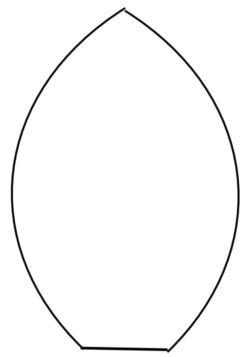

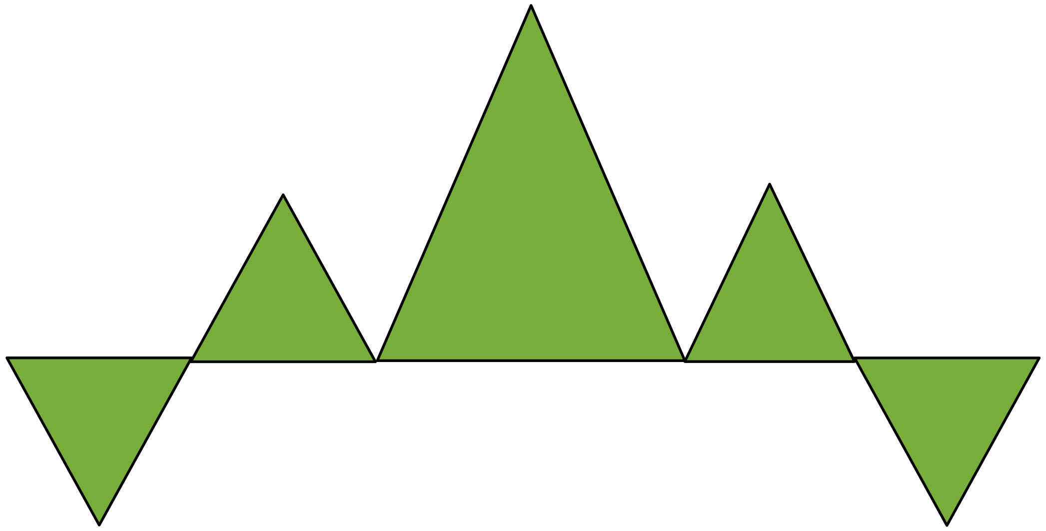

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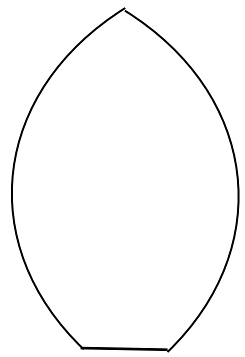

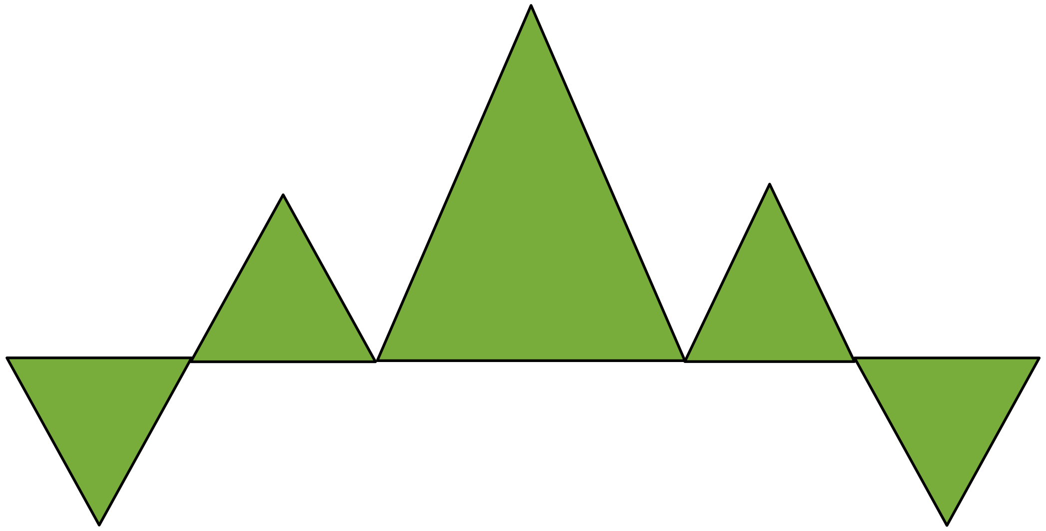

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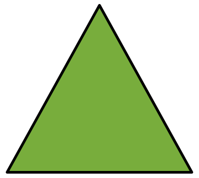

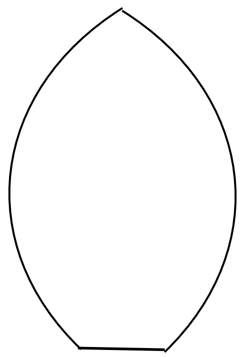

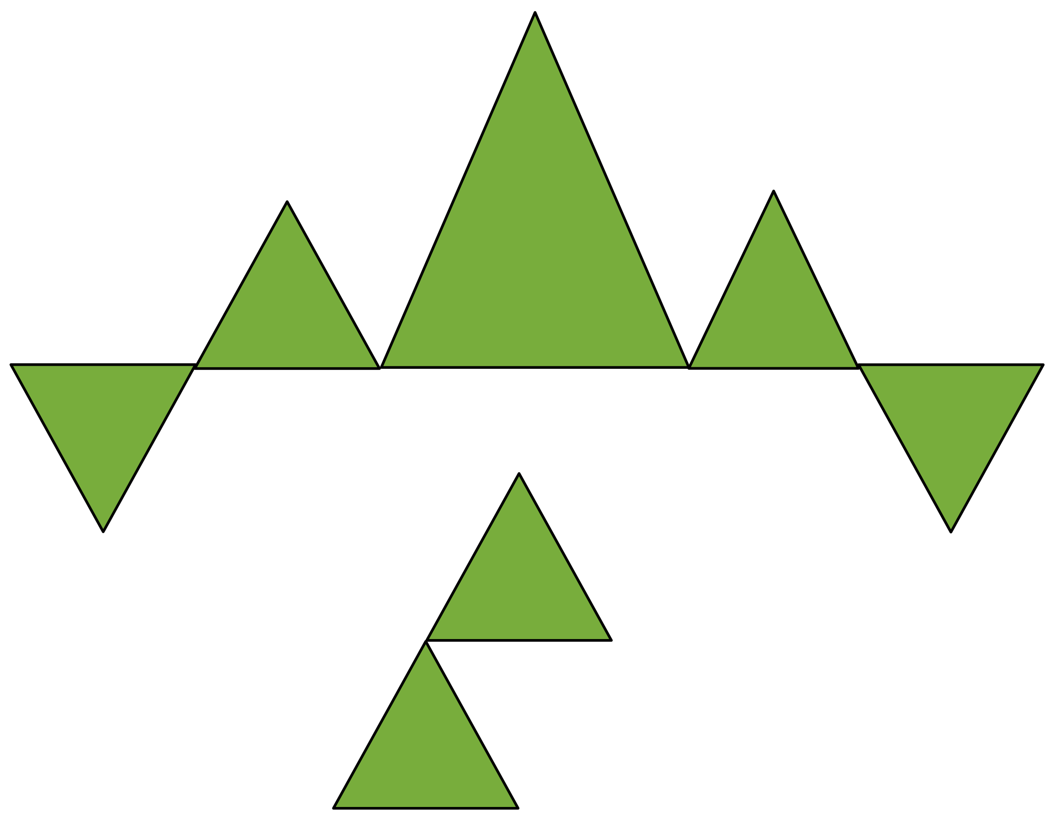

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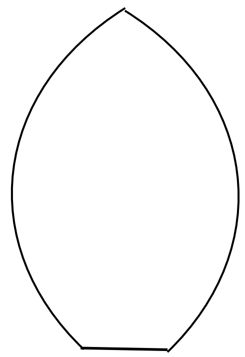

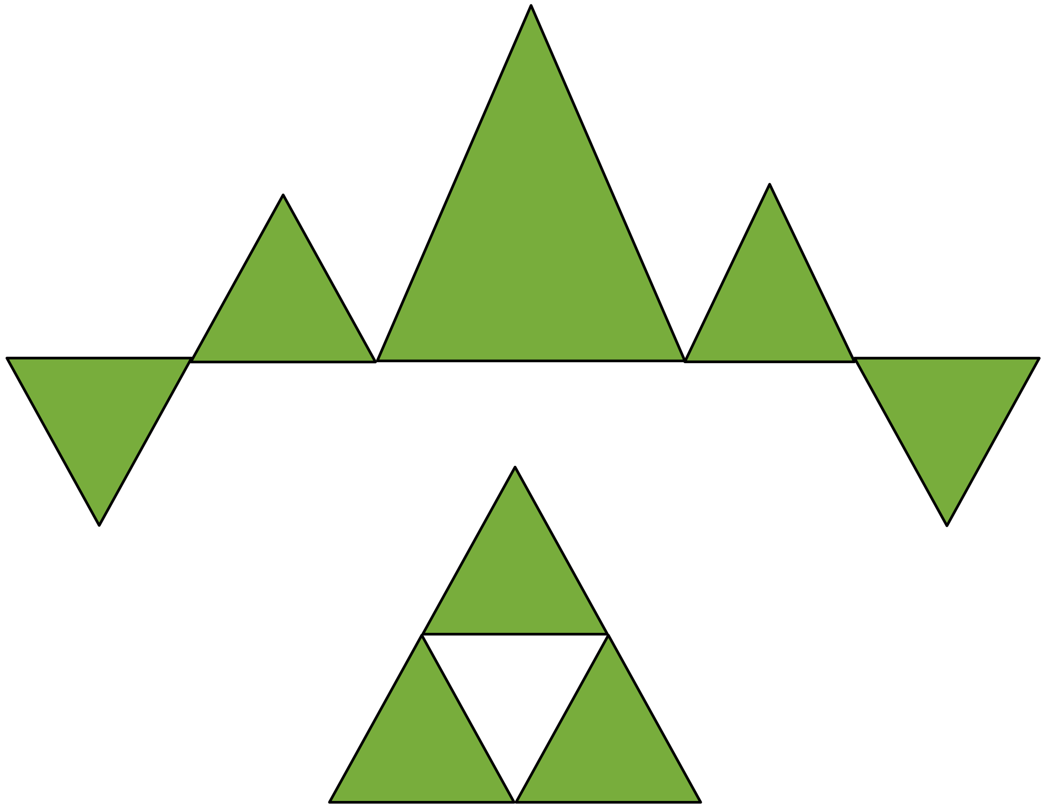

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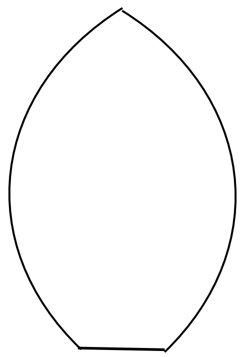

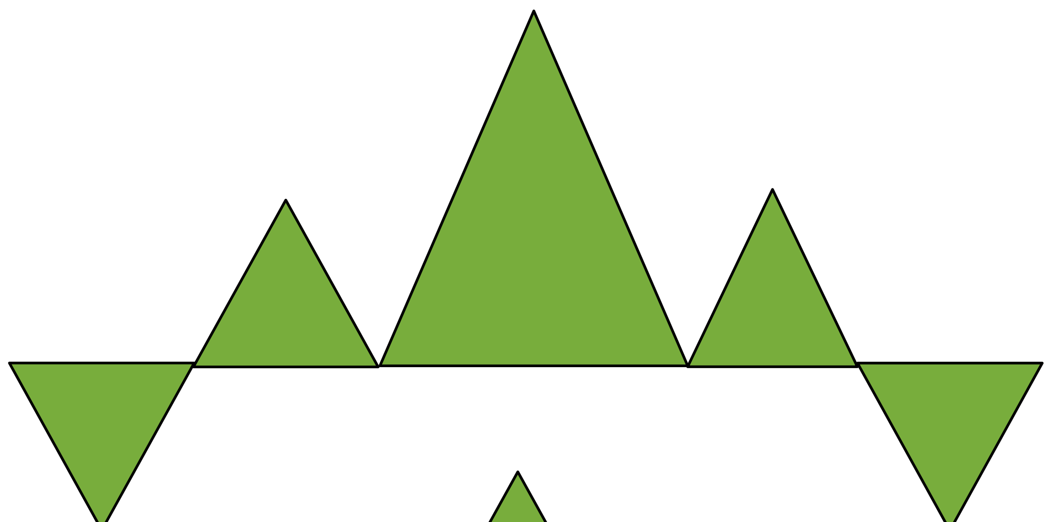

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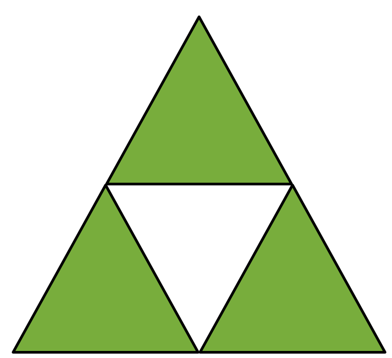

(polygonal or knotted)

Example from the vegetal world

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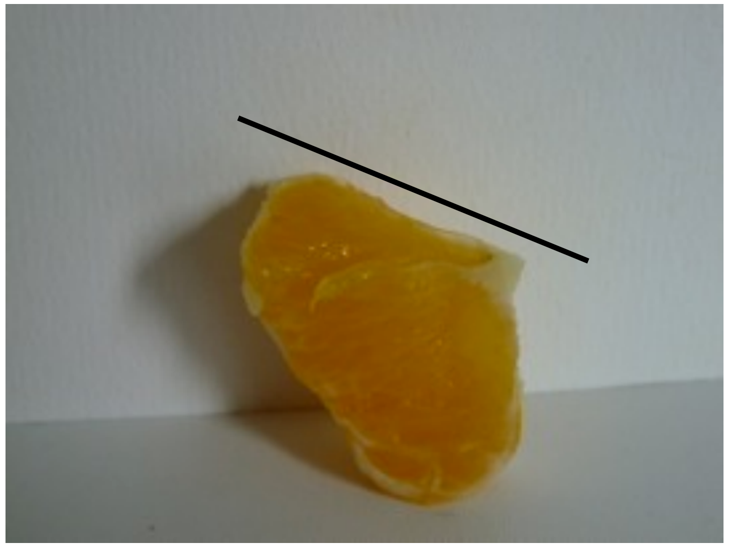

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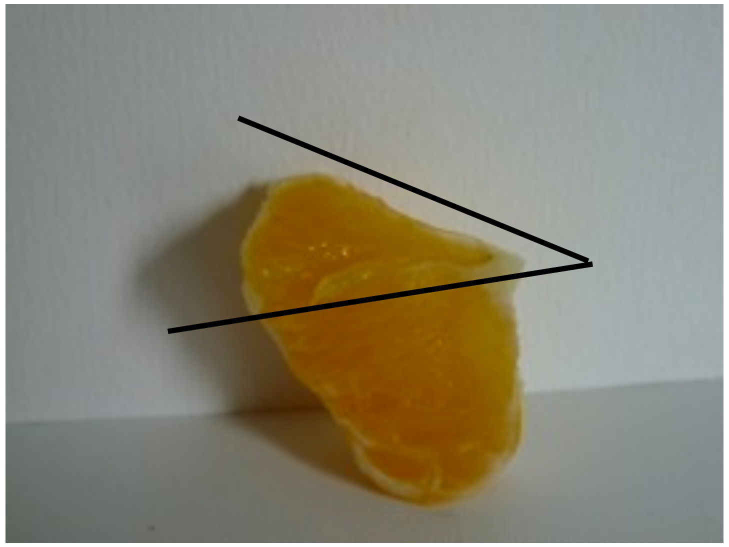

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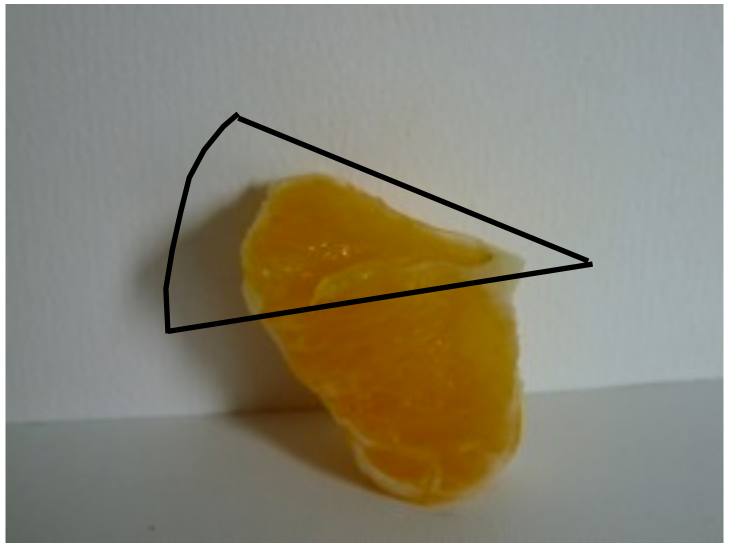

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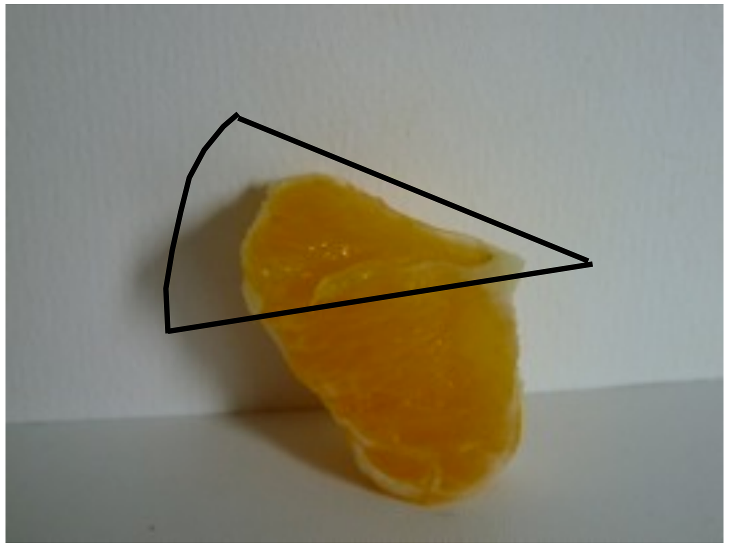

a standard cone

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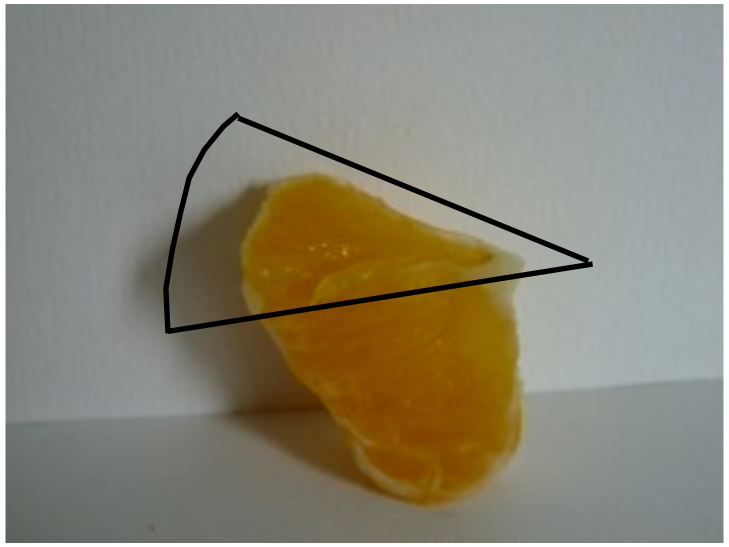

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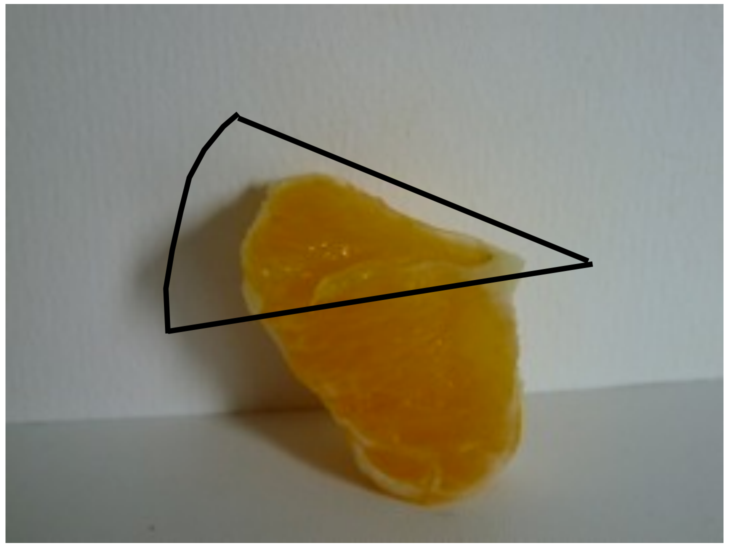

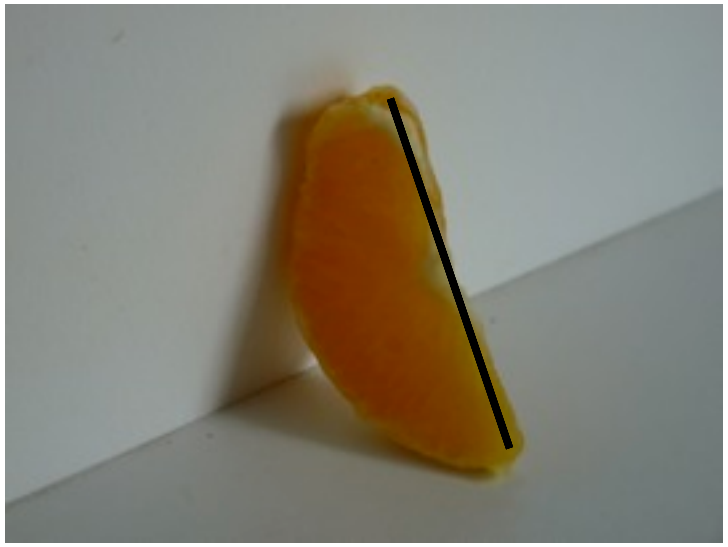

a standard cone

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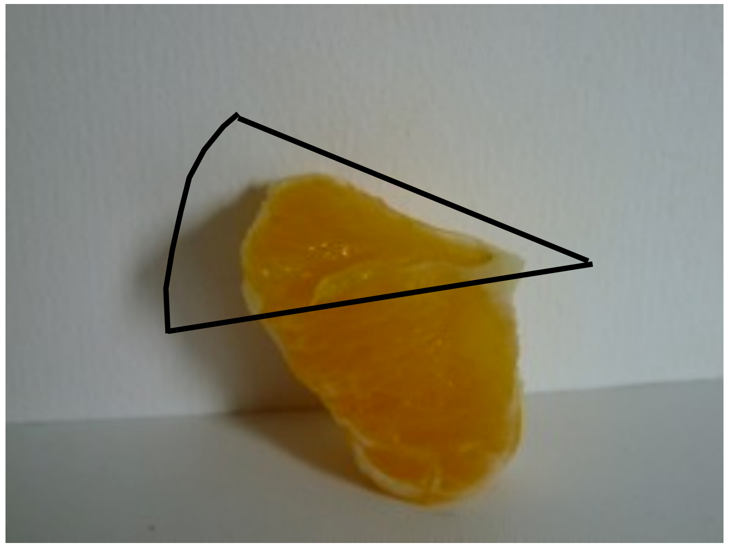
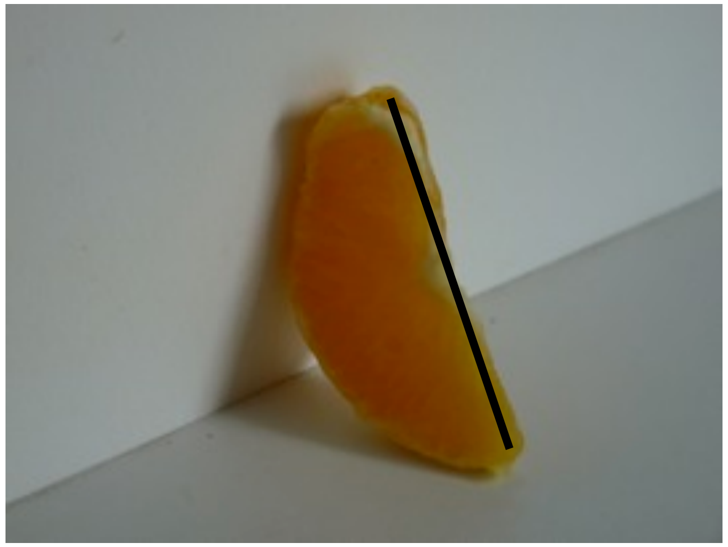
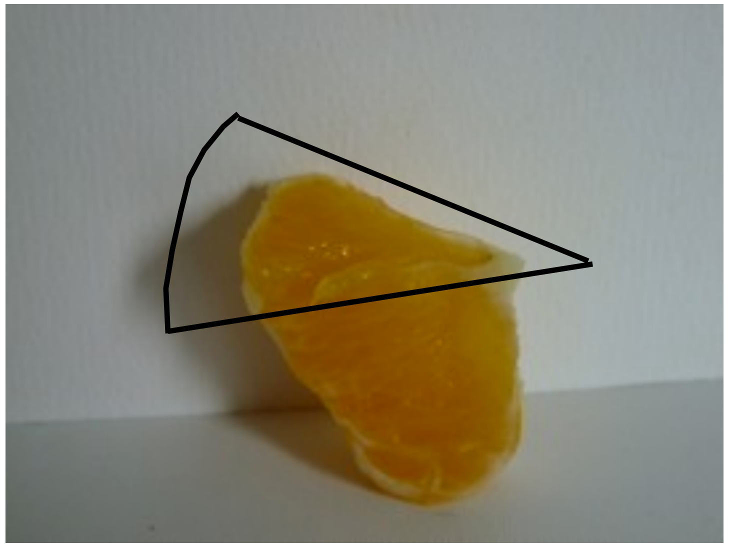


a standard cone

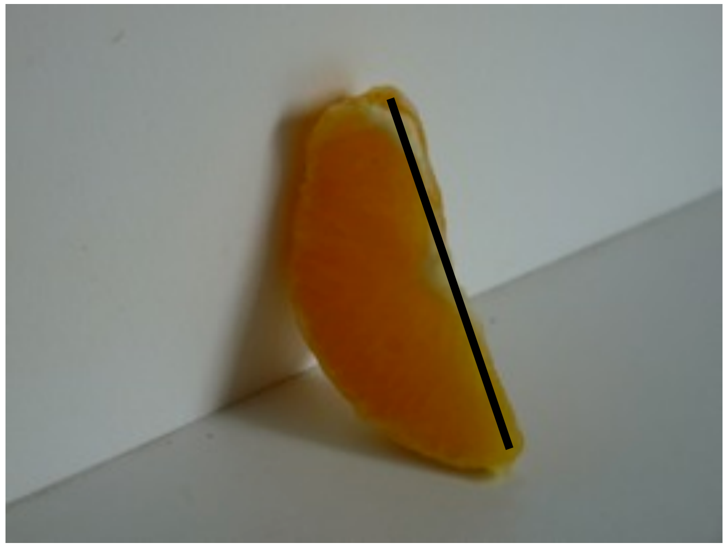


flag with homothetic cones

Example from the vegetal world



a standard cone



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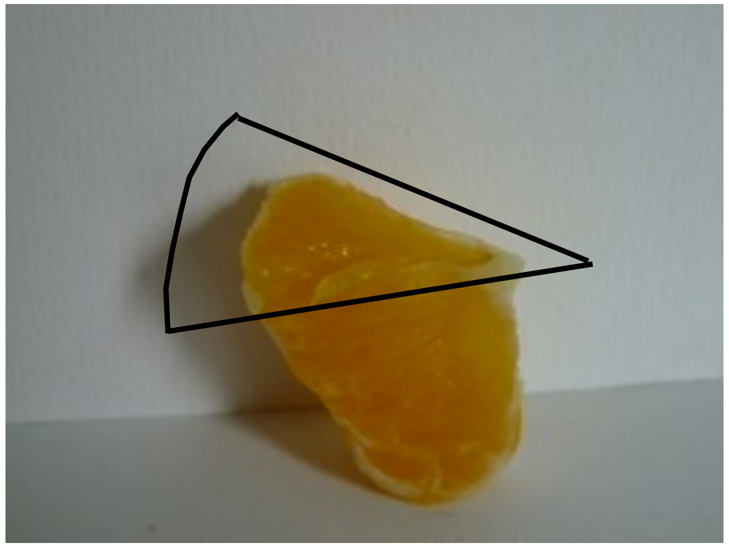
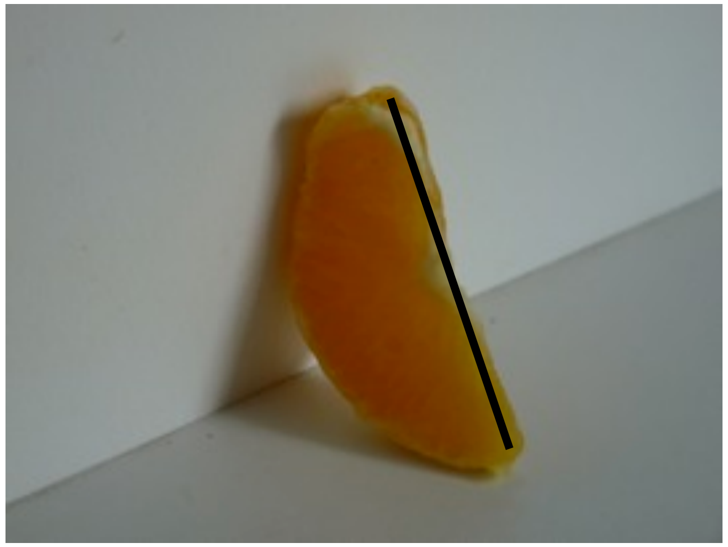


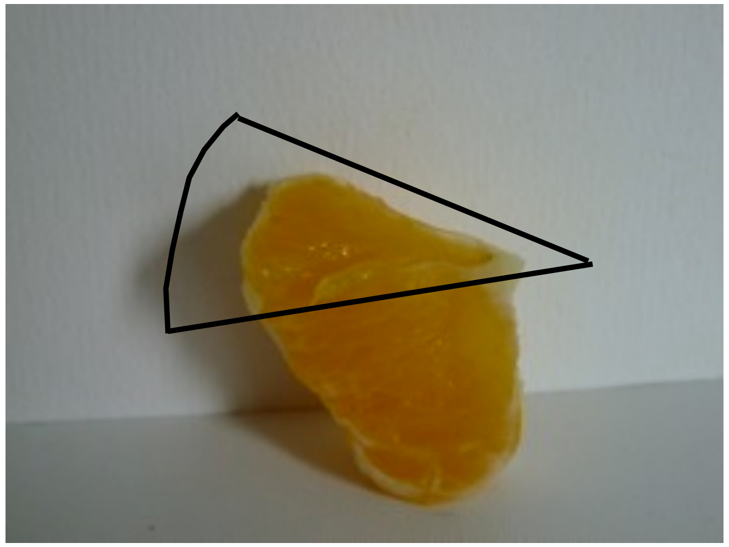
a standard cone



flag with homothetic cones

polygonal

Example from the vegetal world



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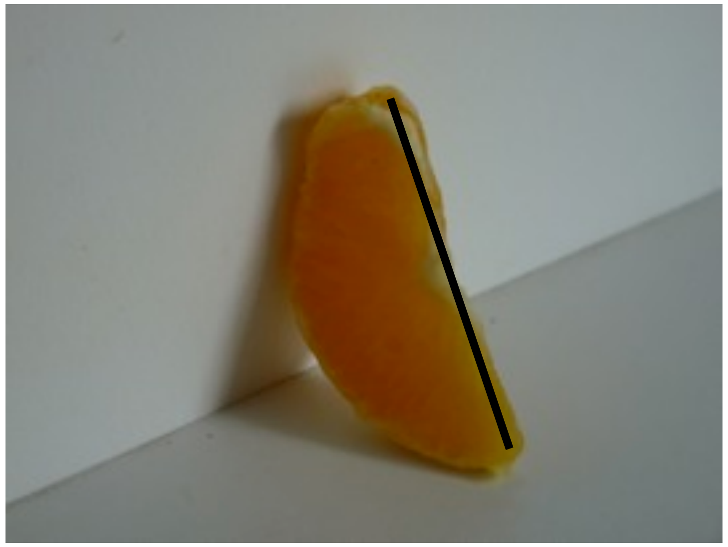

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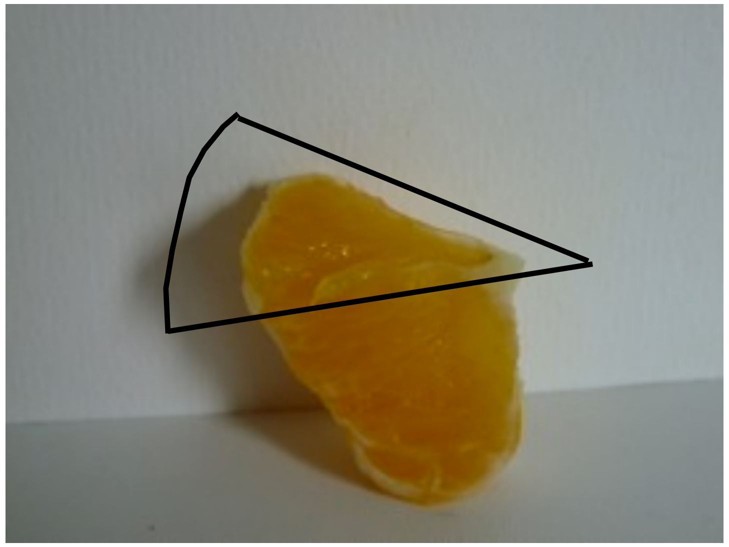

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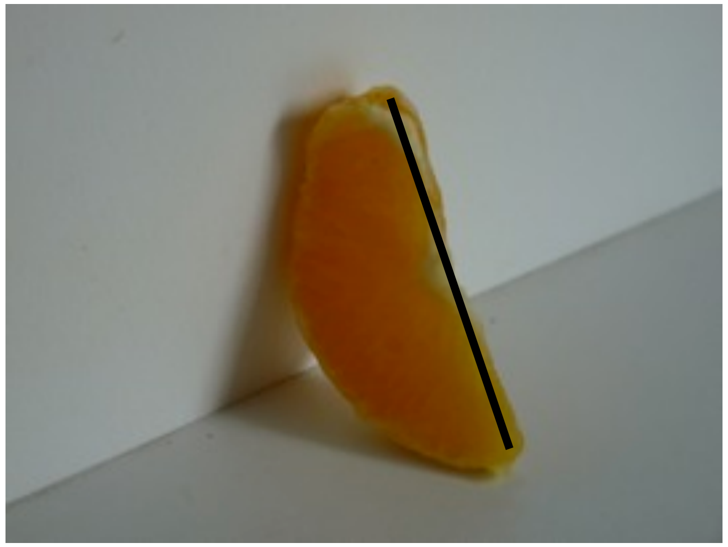

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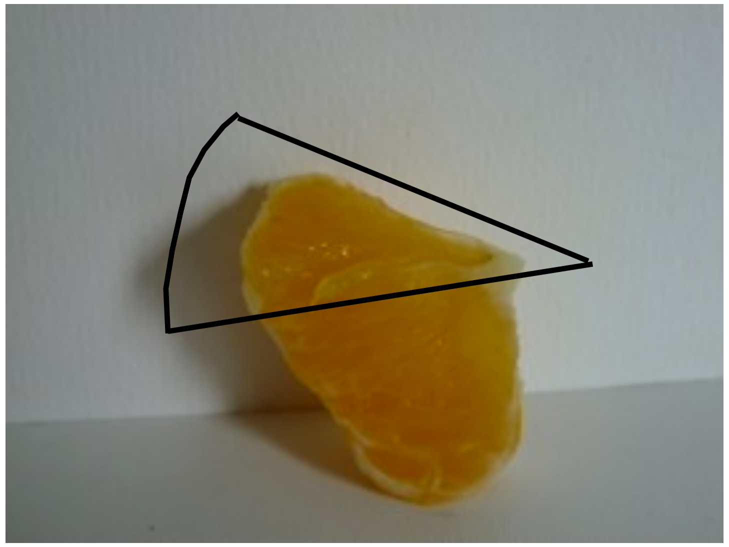

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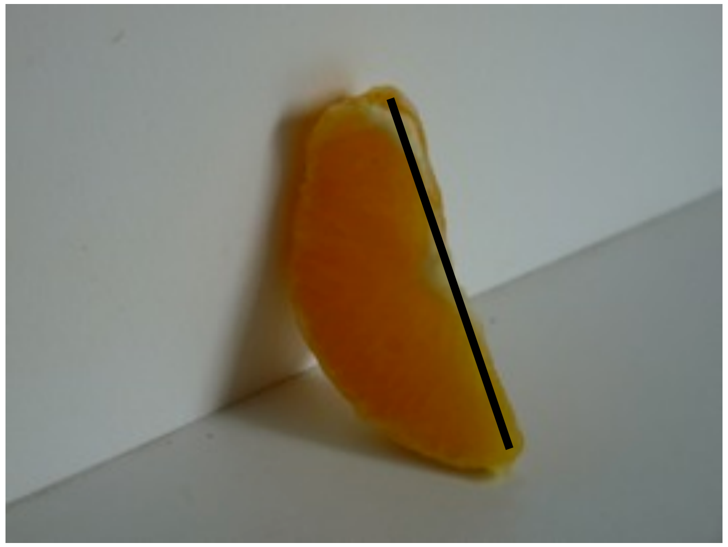

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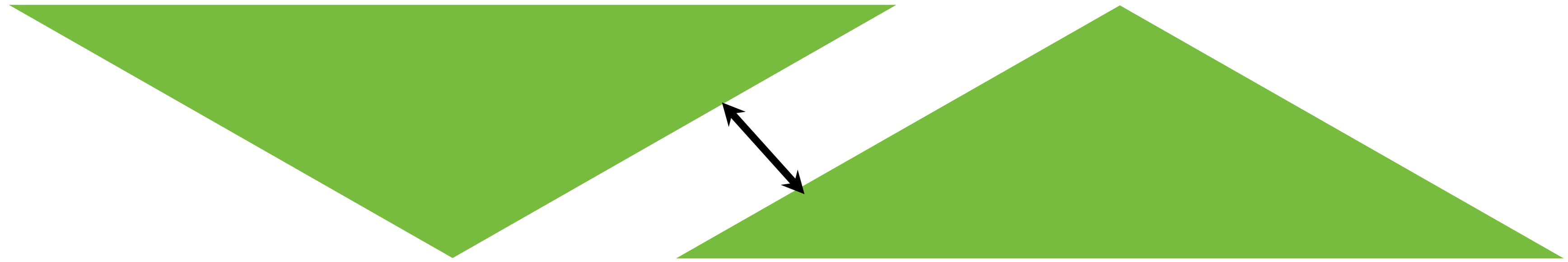
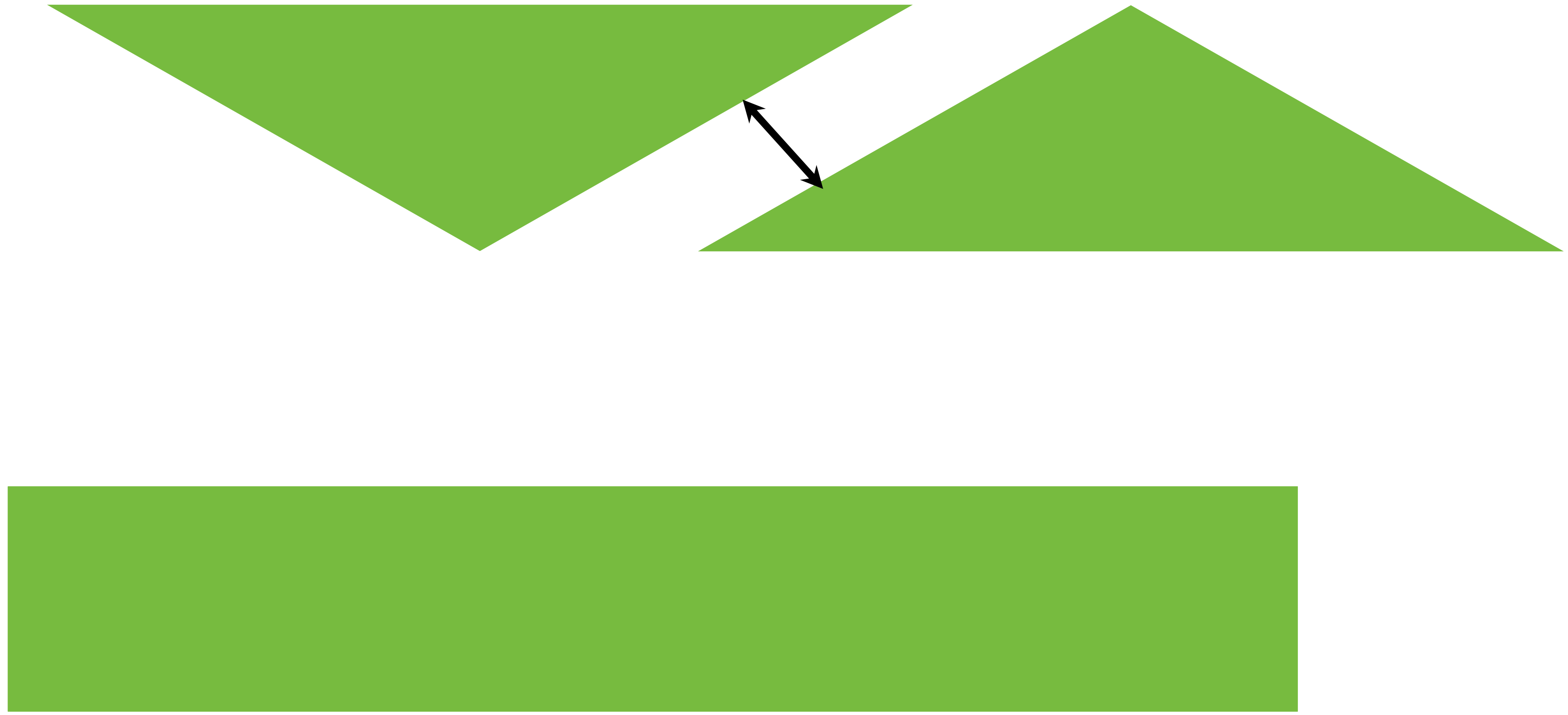
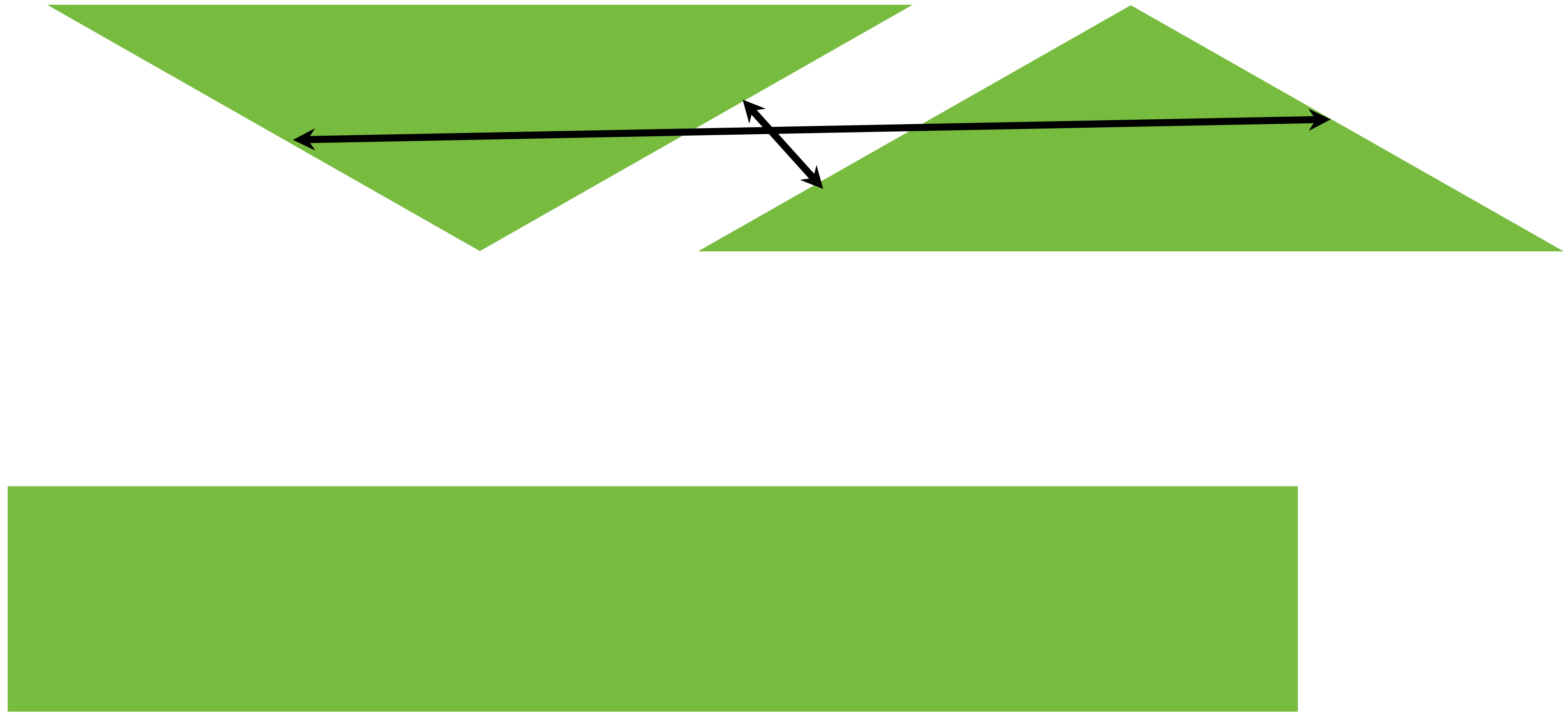
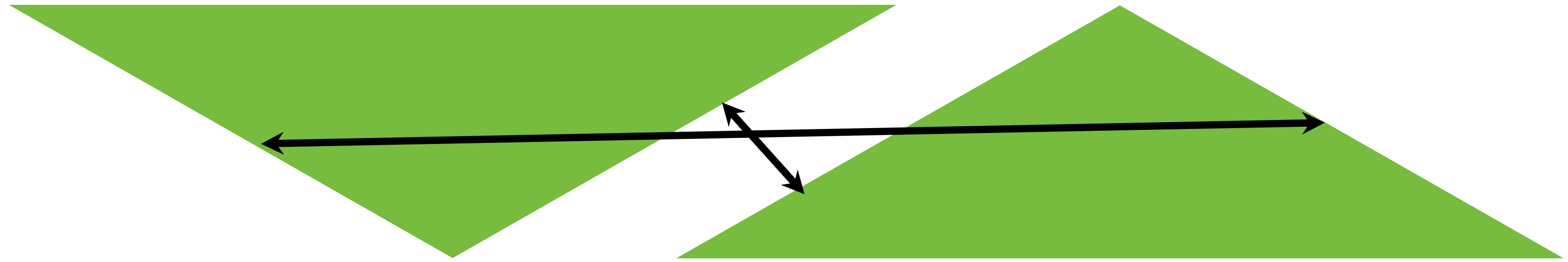
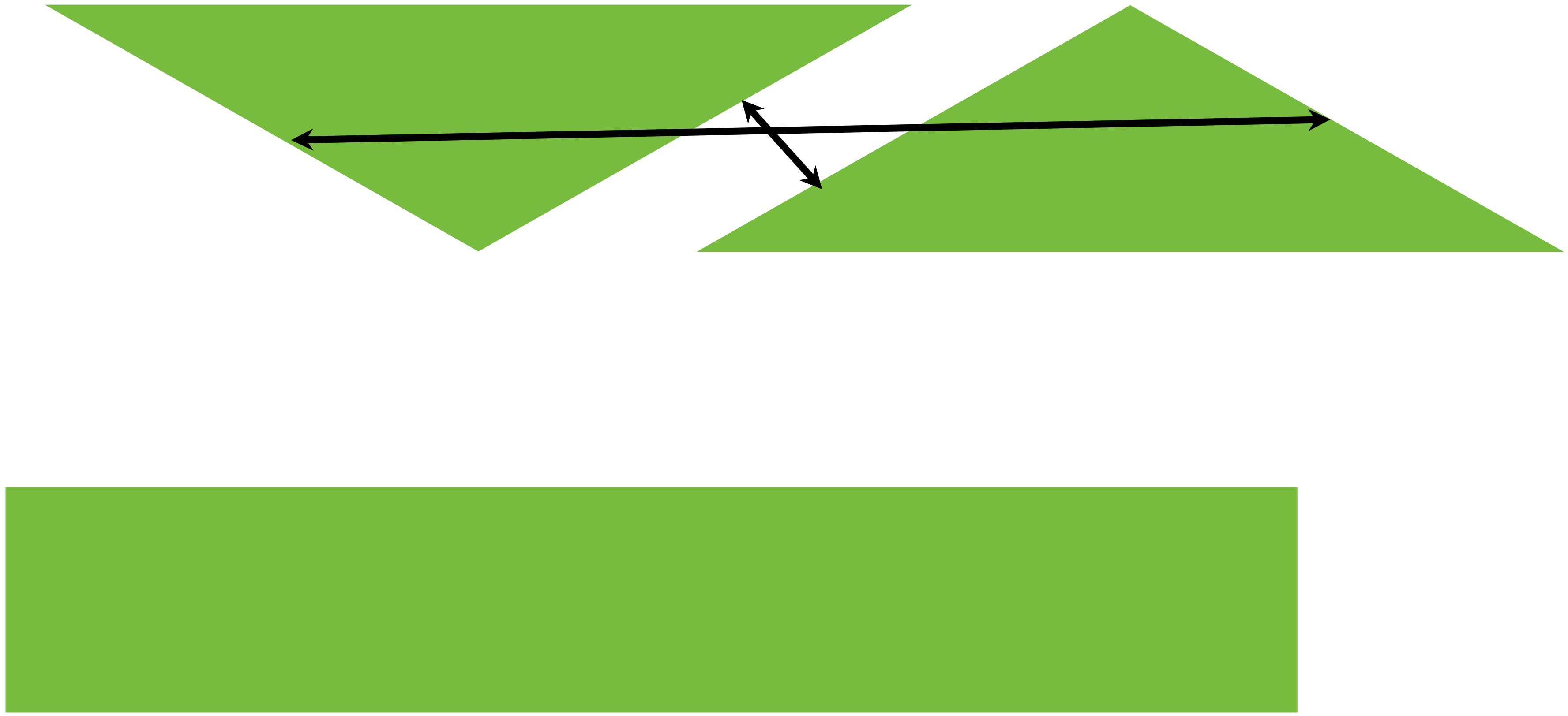









Canon



Jos Leys

Other Topics

Other Topics

Creation (versus suppression) and rounding of a main vertex, a singularity V, a singular curve

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Biconique 2 by Philippe Charbonneau

Other Topics

Creation (versus suppression) and rounding of a main vertex, a singularity V, a singular curve

V

Biconique 2 by Philippe Charbonneau

Other Topics

Creation (versus suppression) and rounding of a main vertex, a singularity V, a singular curve

V

V'

Biconique 2 by Philippe Charbonneau

Other Topics

Creation (versus suppression) and rounding of a main vertex, a singularity V, a singular curve

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V’

Biconique 2 by Philippe Charbonneau

Creation of 2-cones from 1-cones and 2-cones

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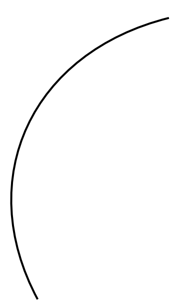

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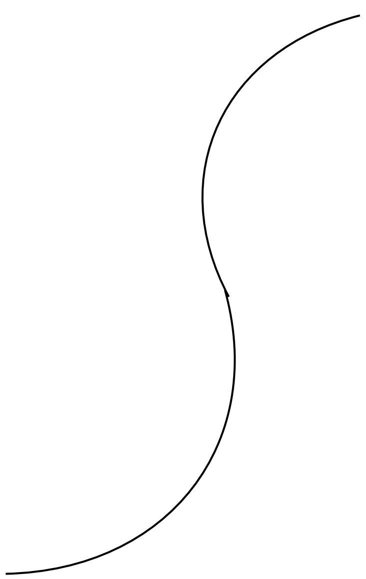

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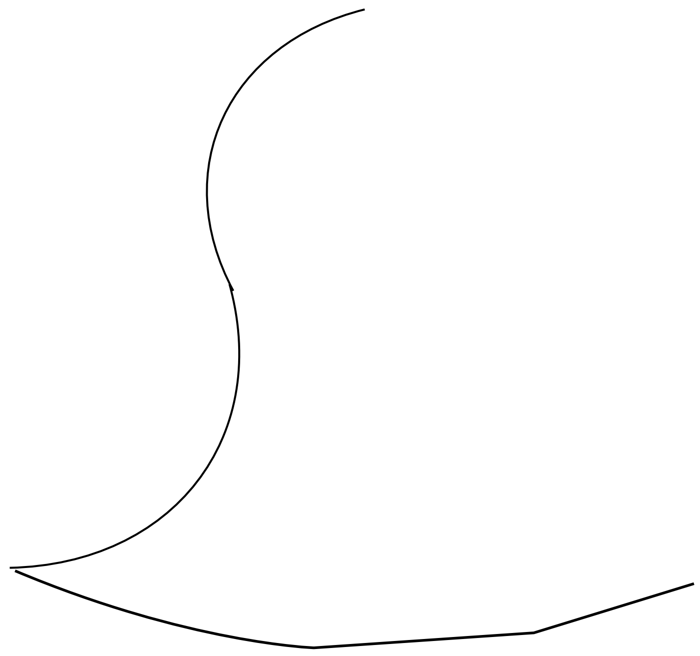

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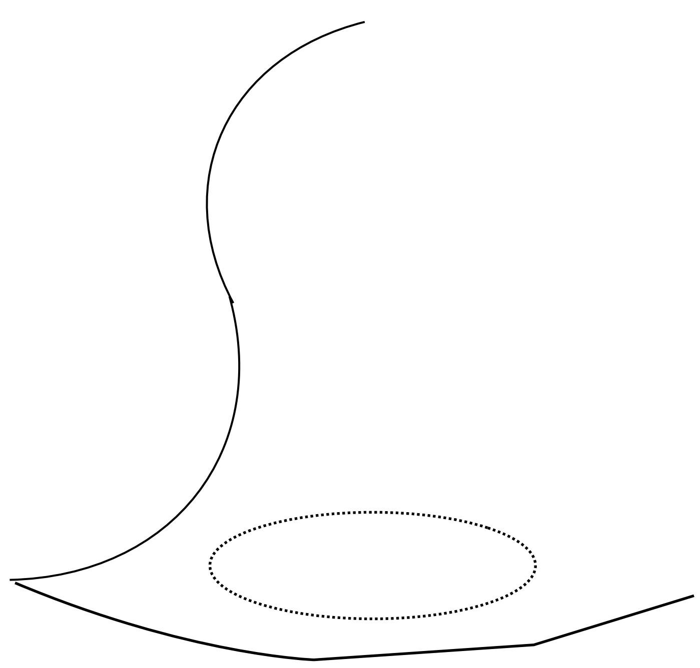

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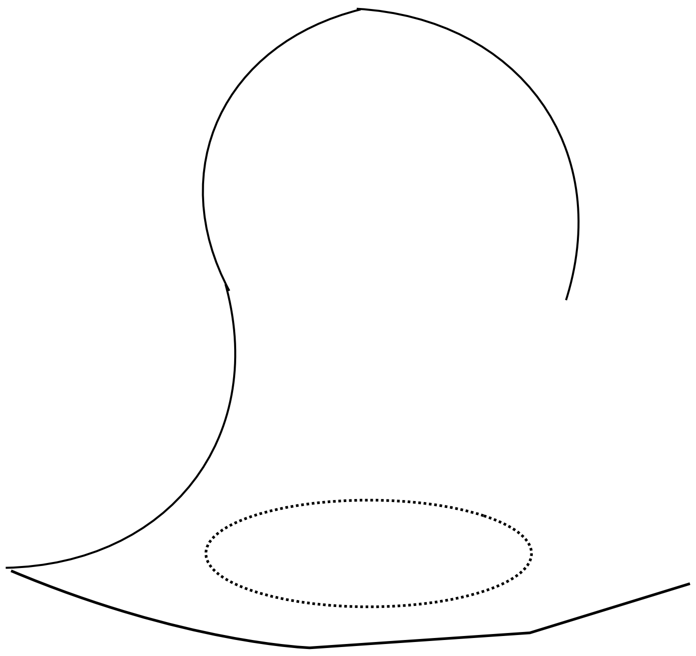

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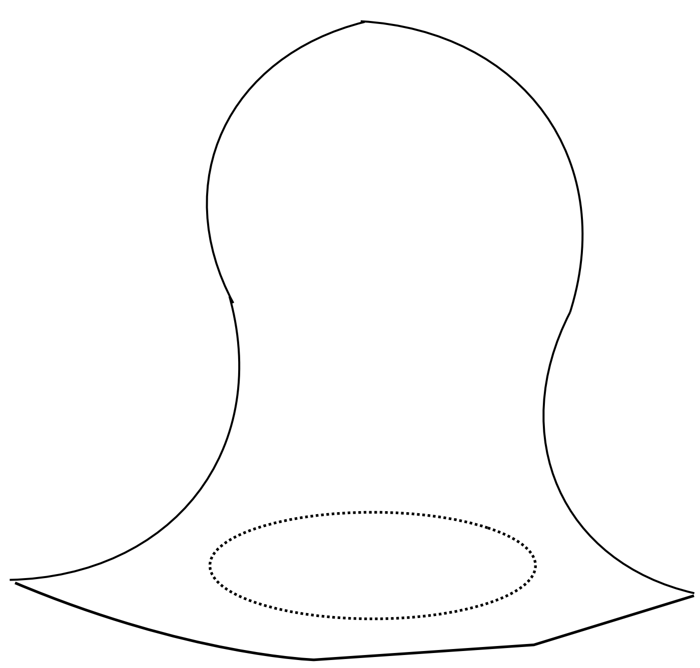

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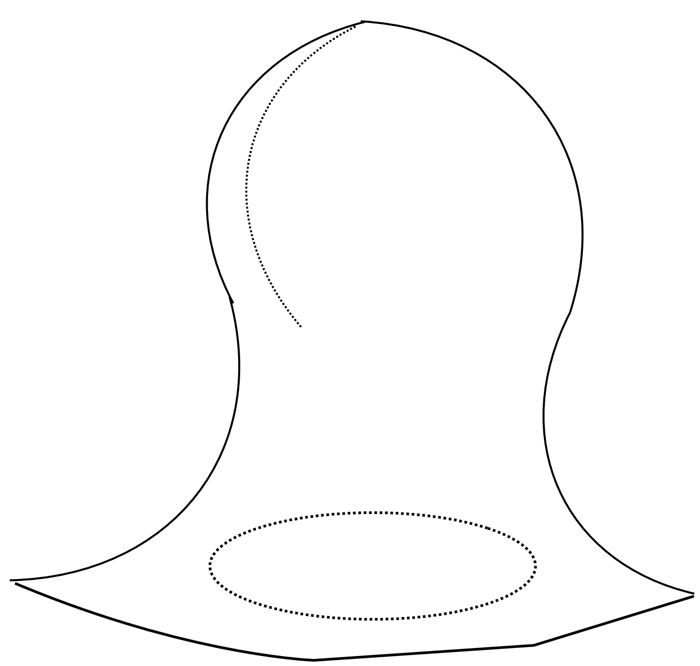

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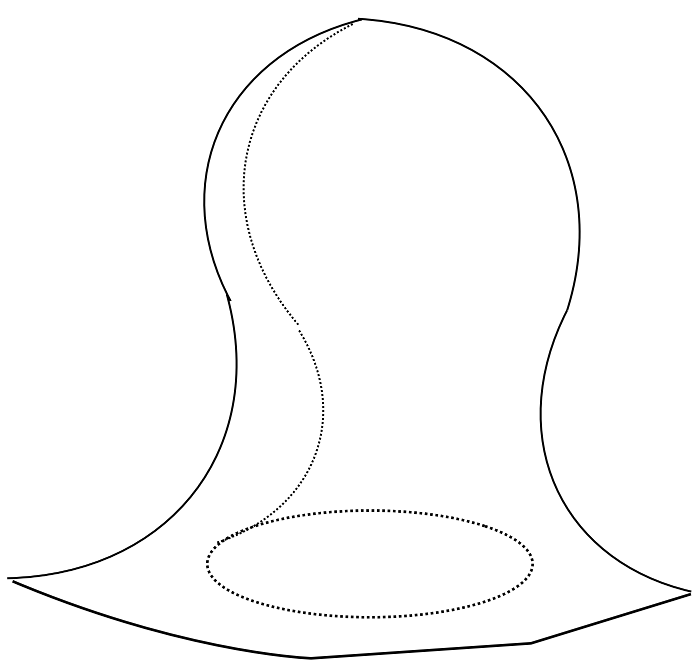

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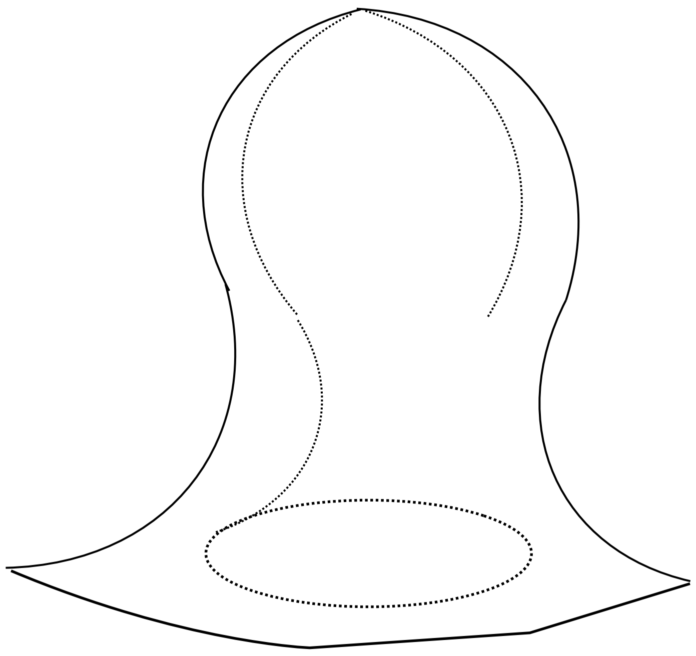

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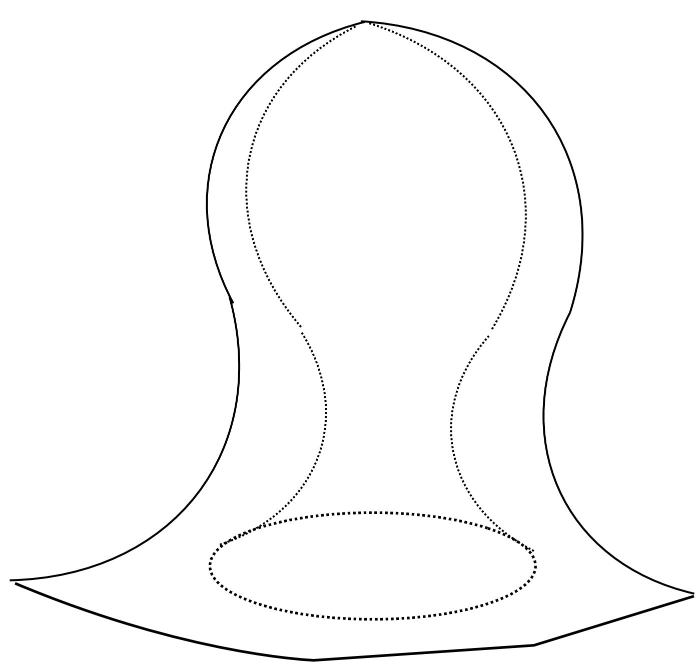

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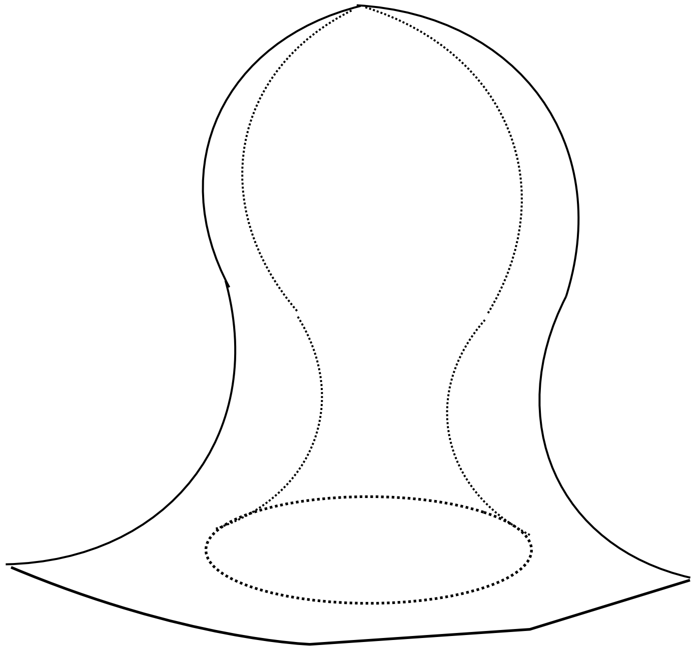

The bell

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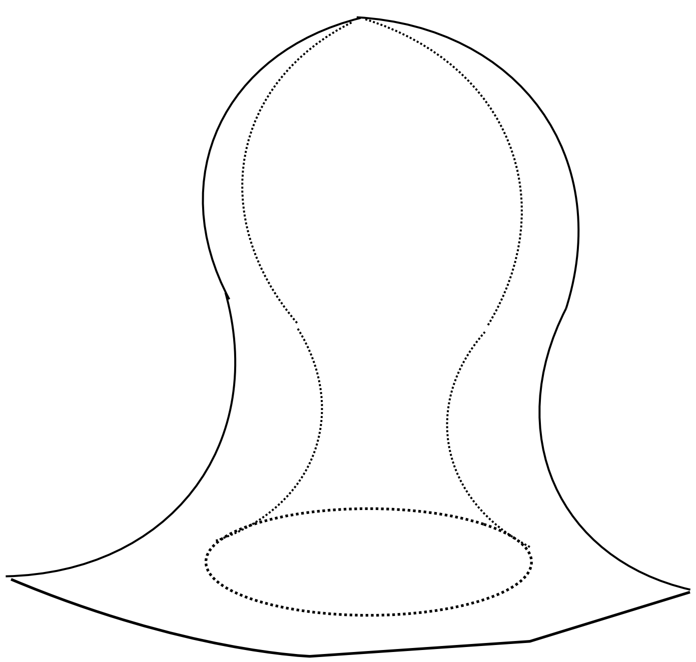

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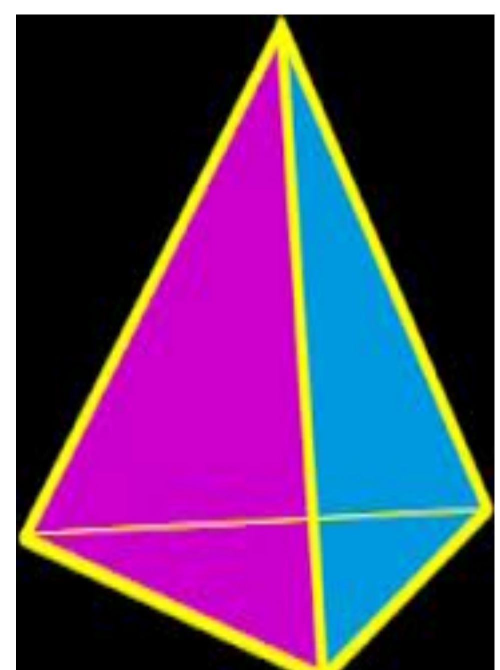
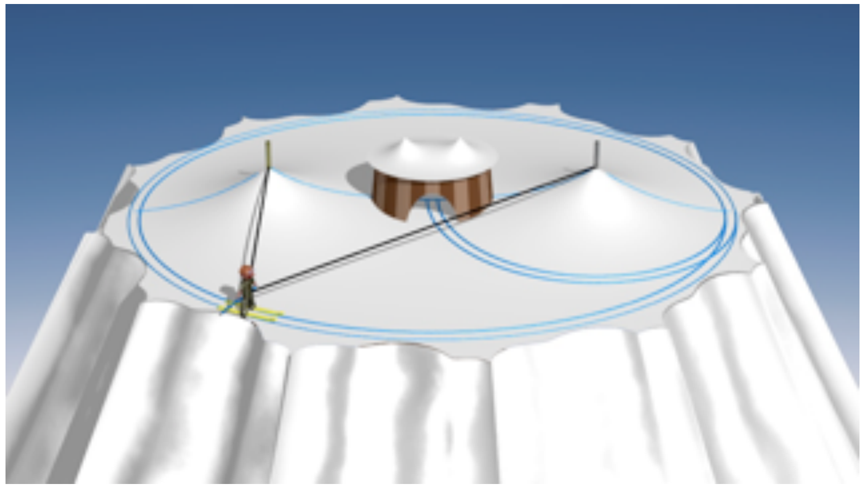
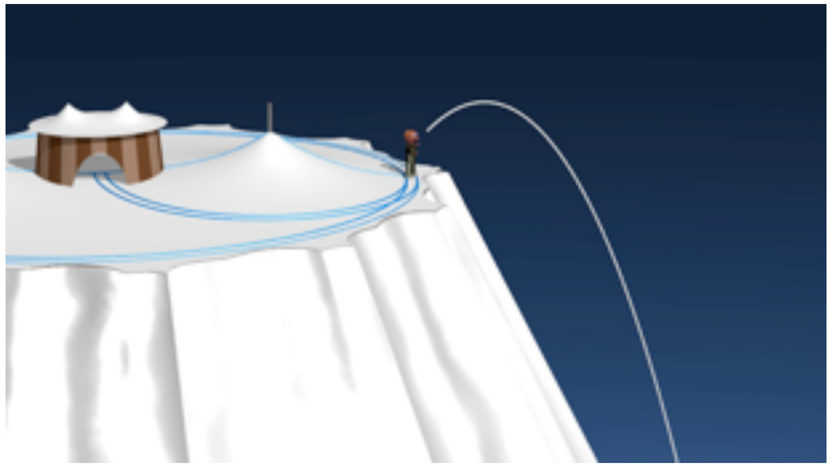
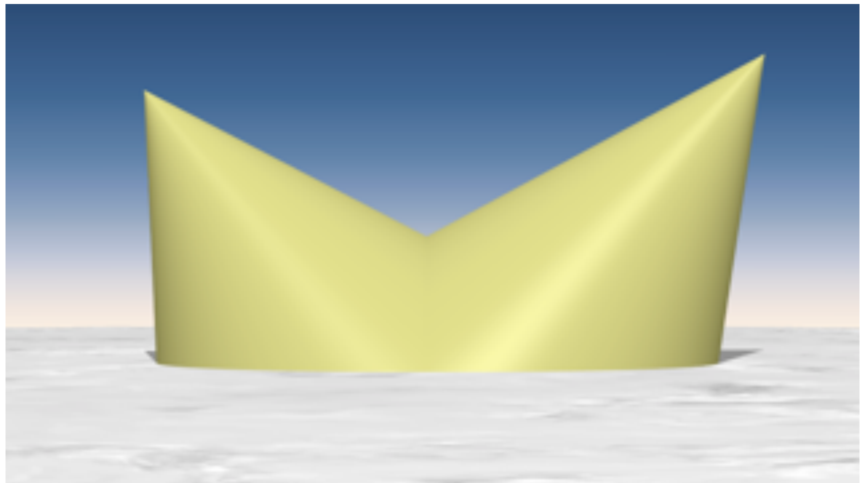


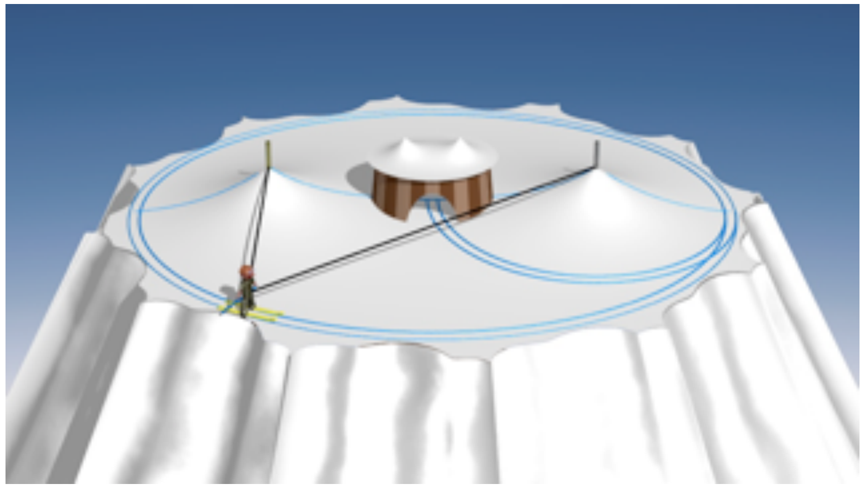


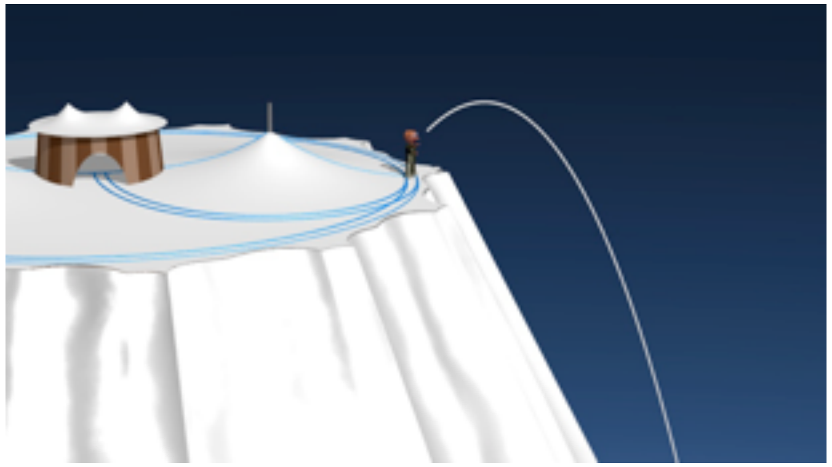


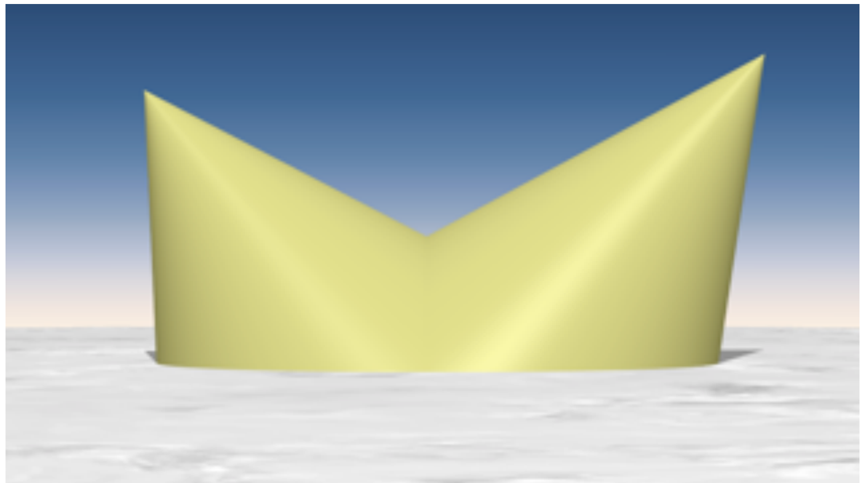


Double cones
Illustrations by Jos Leys

Creation of double cones from (simple) cones







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Incarnation in the vegetal world

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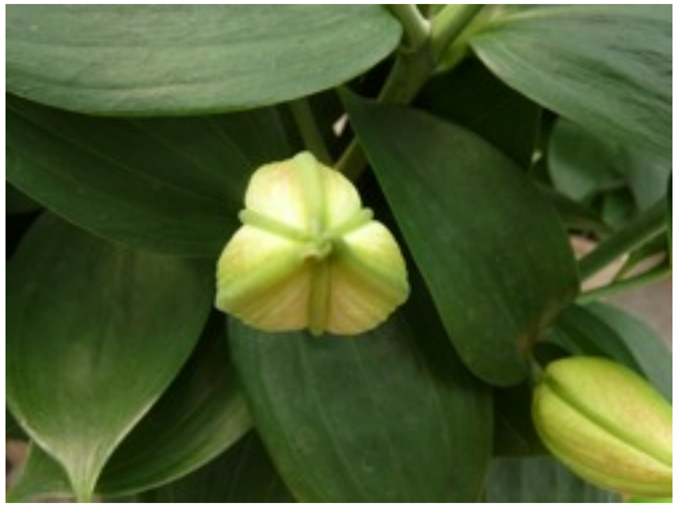

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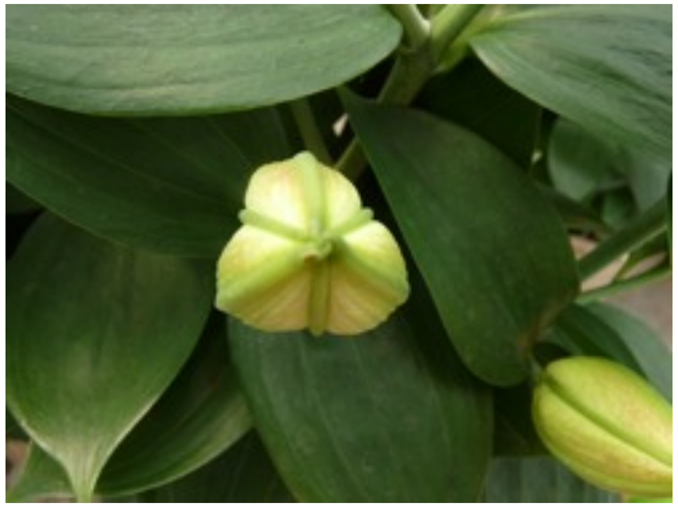

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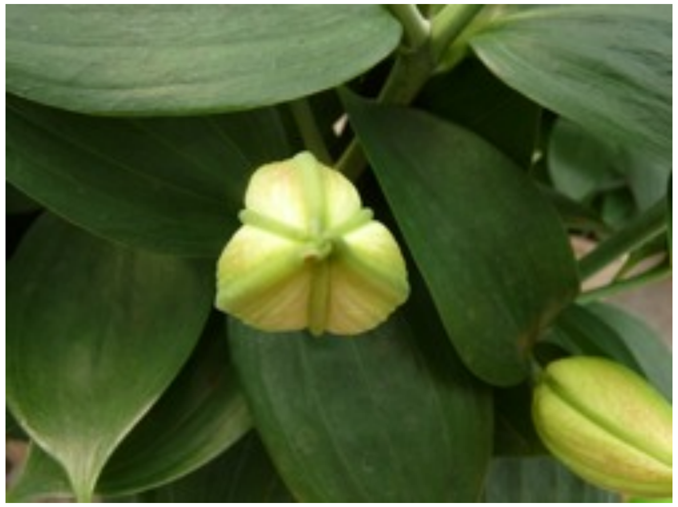

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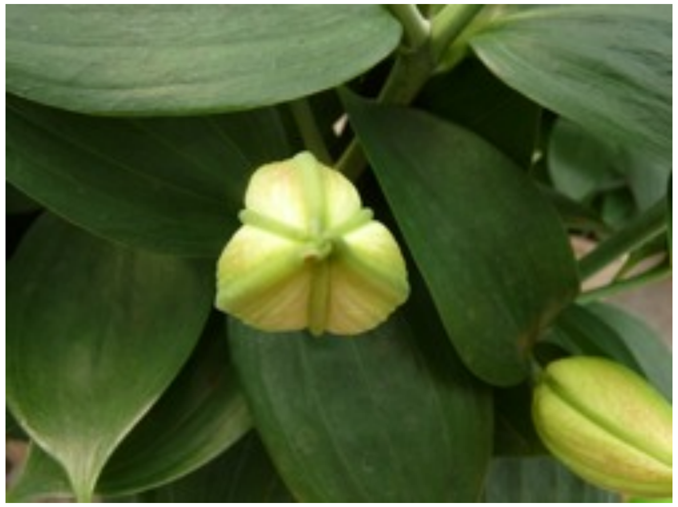

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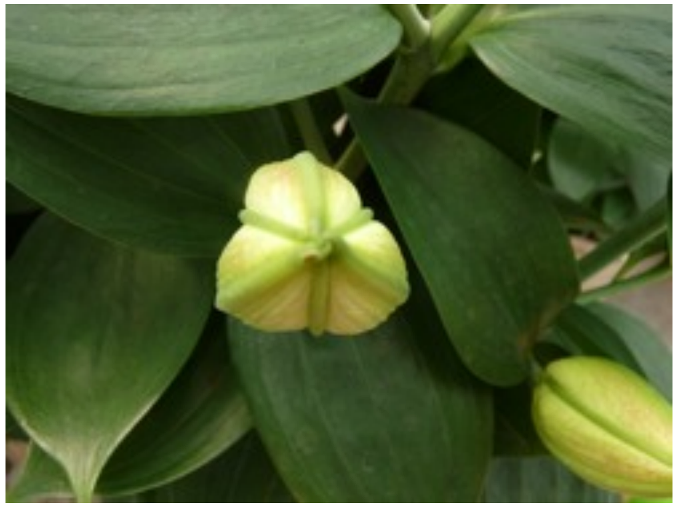

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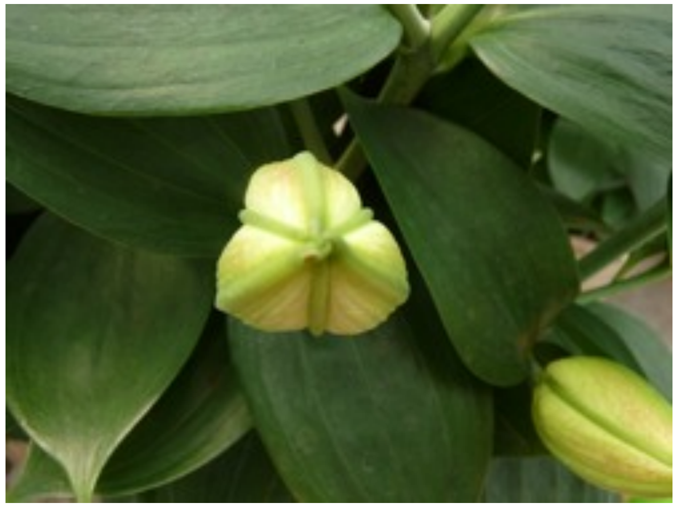
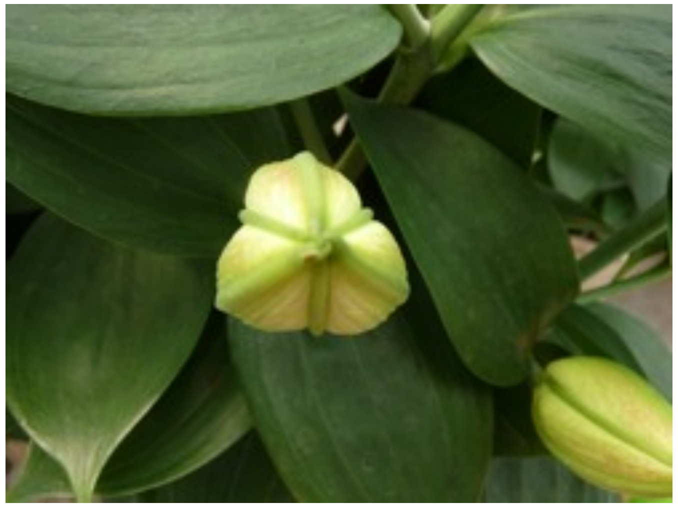



Incarnation in the vegetal world

Here, it is interesting to notice that the visible part of the complete flower itself (right) has the shape of an half octahedron



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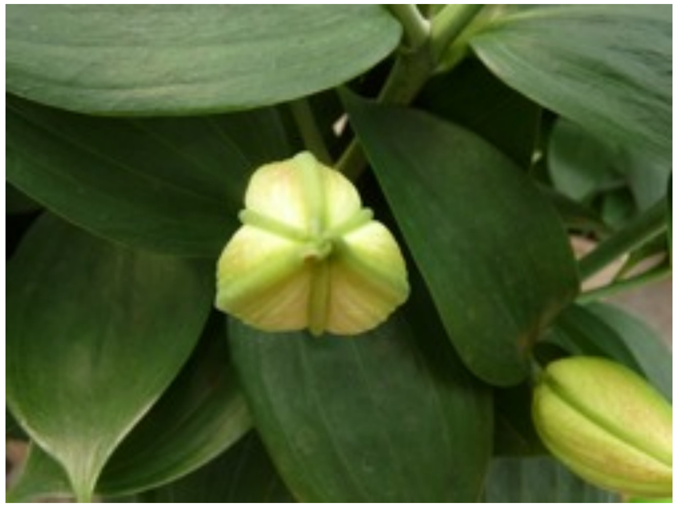

Two suggestions from the vegetal world

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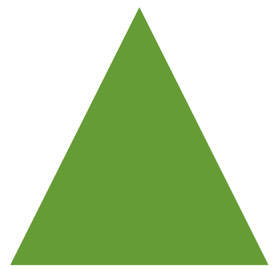
Multicovering

Two suggestions from the vegetal world



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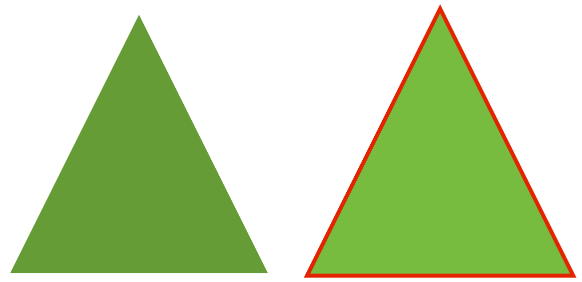

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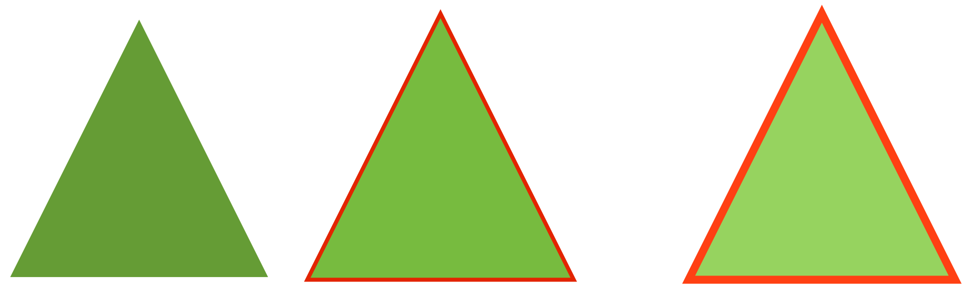

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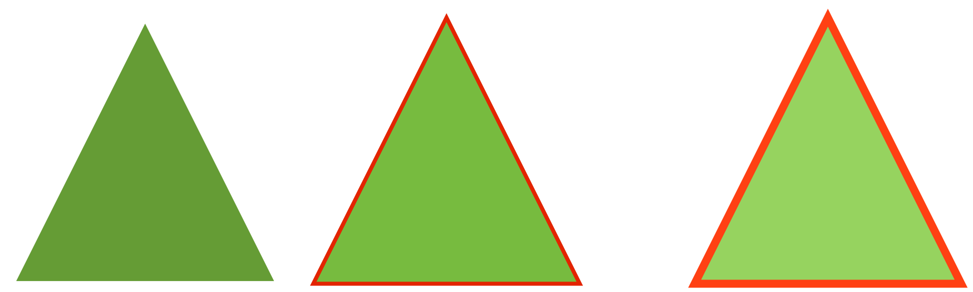

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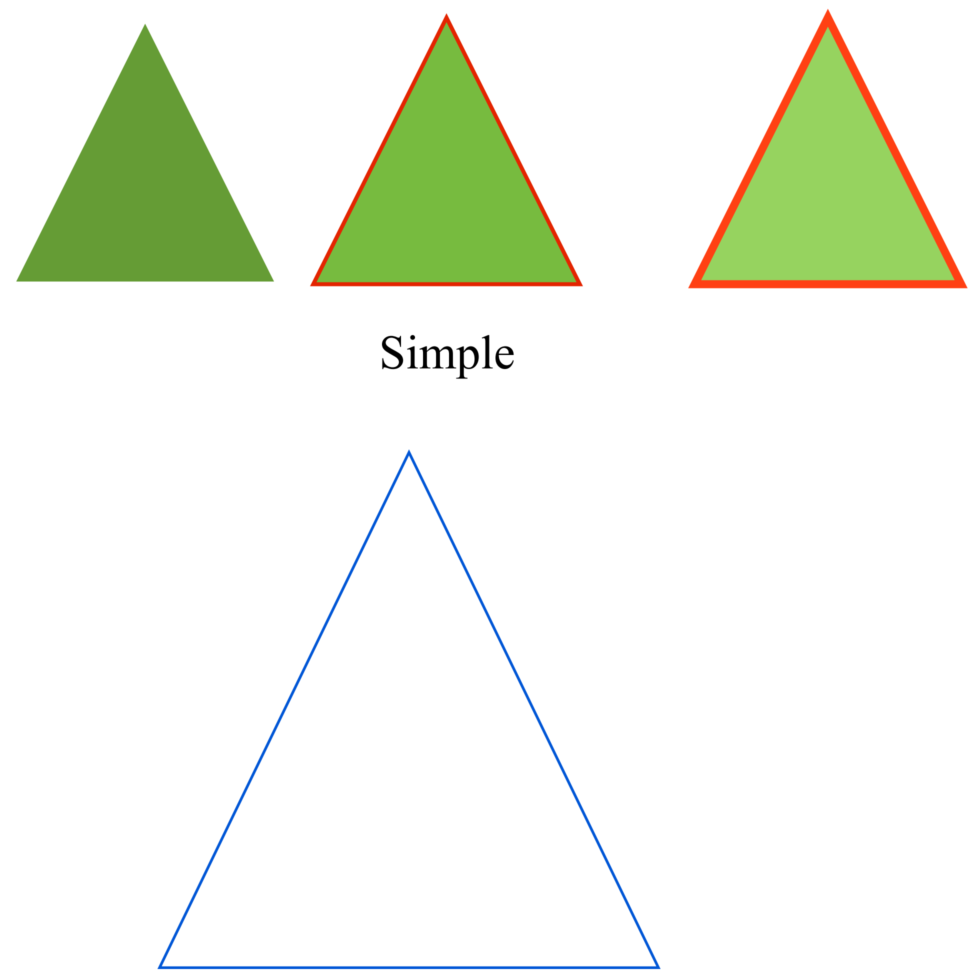

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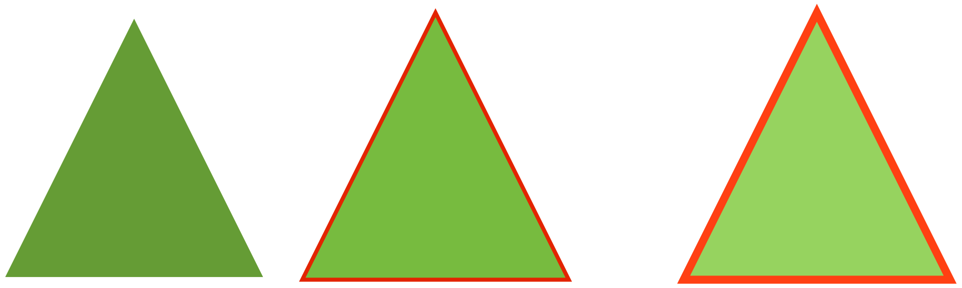

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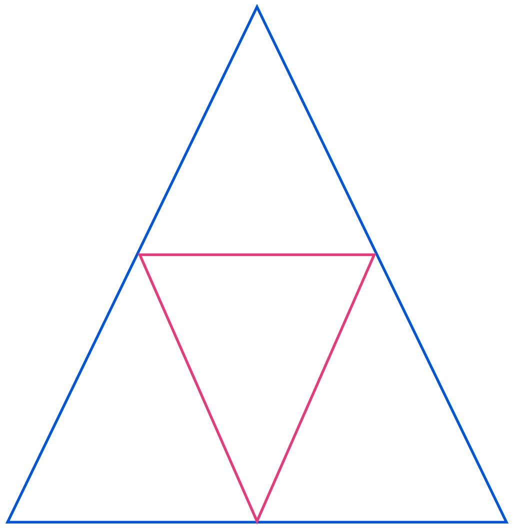

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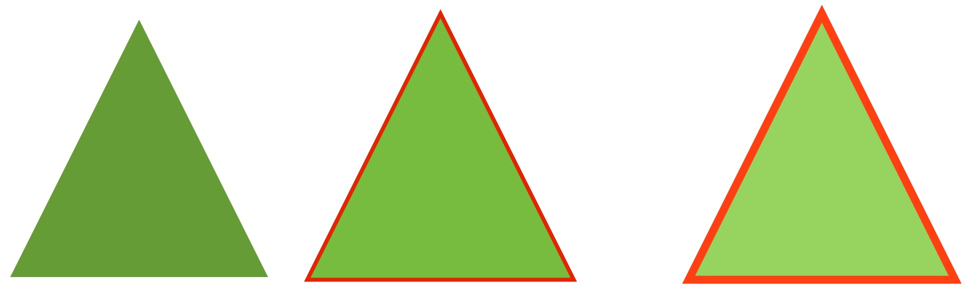

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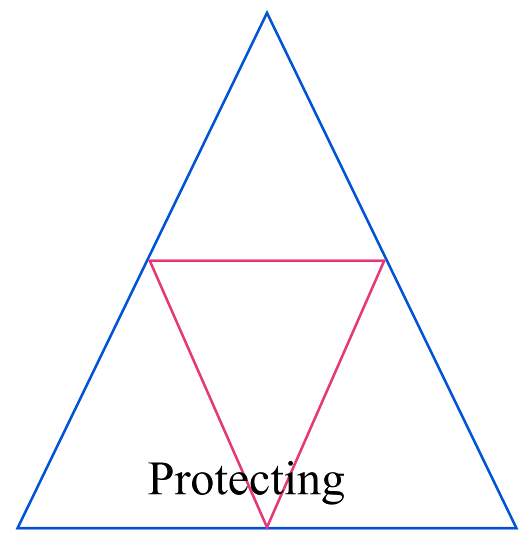

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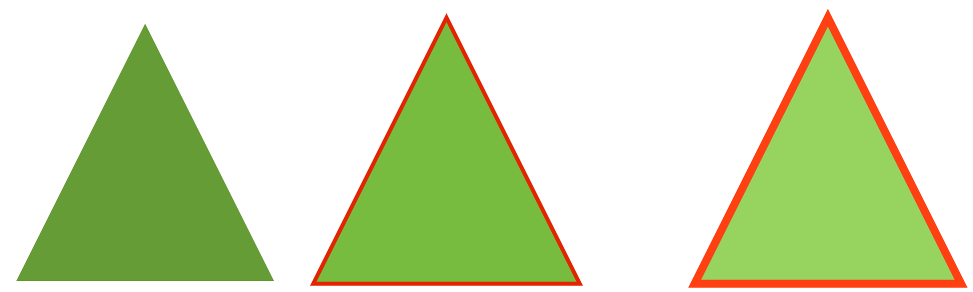

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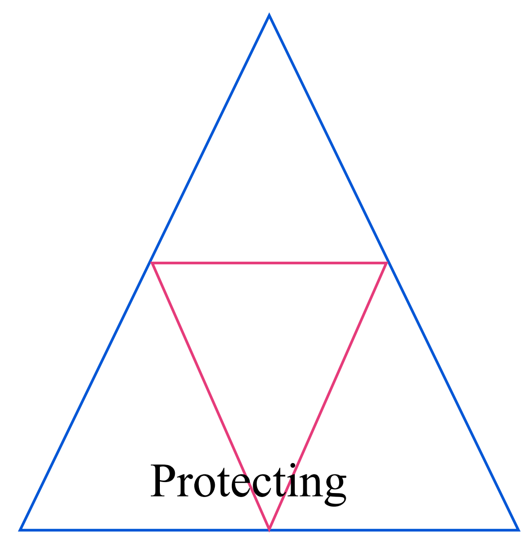

Exfoliation

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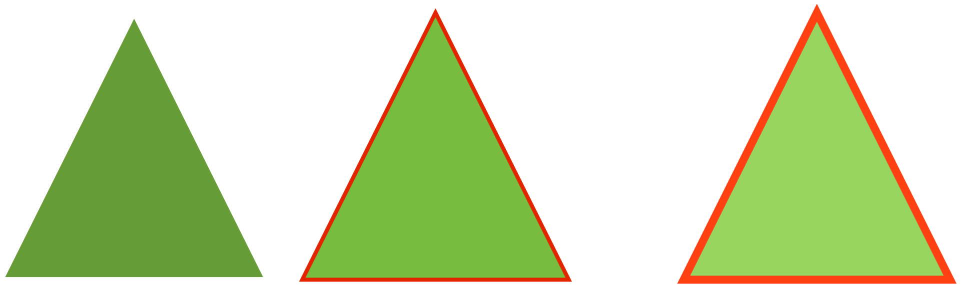

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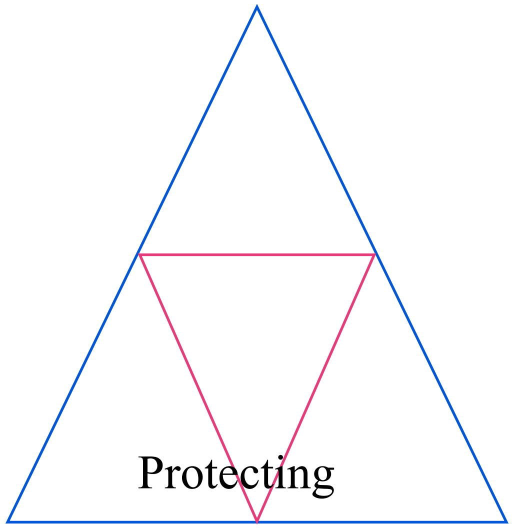

Exfoliation

Works

Works

For the mathematicians

Works

For the mathematicians

expand the mathematical content along several directions :

assembly of cones in multidimensional spaces

projections, sections and intersections, apparent contours, in Euclidean spaces or not

intimate structure (foliations)

duality, transformations,

enumeration,

analytic, algebraic and numerical representations

trajectories

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For the pedagogue

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intimate structure (foliations)

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trajectories

For the pedagogue

a pleasant pedagogical theory:

accessible to everybody,

permitting the creation of a multitude of 2D and 3D cones, shapes and compositions,

using modeling clay, strings and wires, scissors, paper, pieces of cardboard, glue, brush, headlights

later, software permitting, constructions on computers

and

For the Artist ?

and

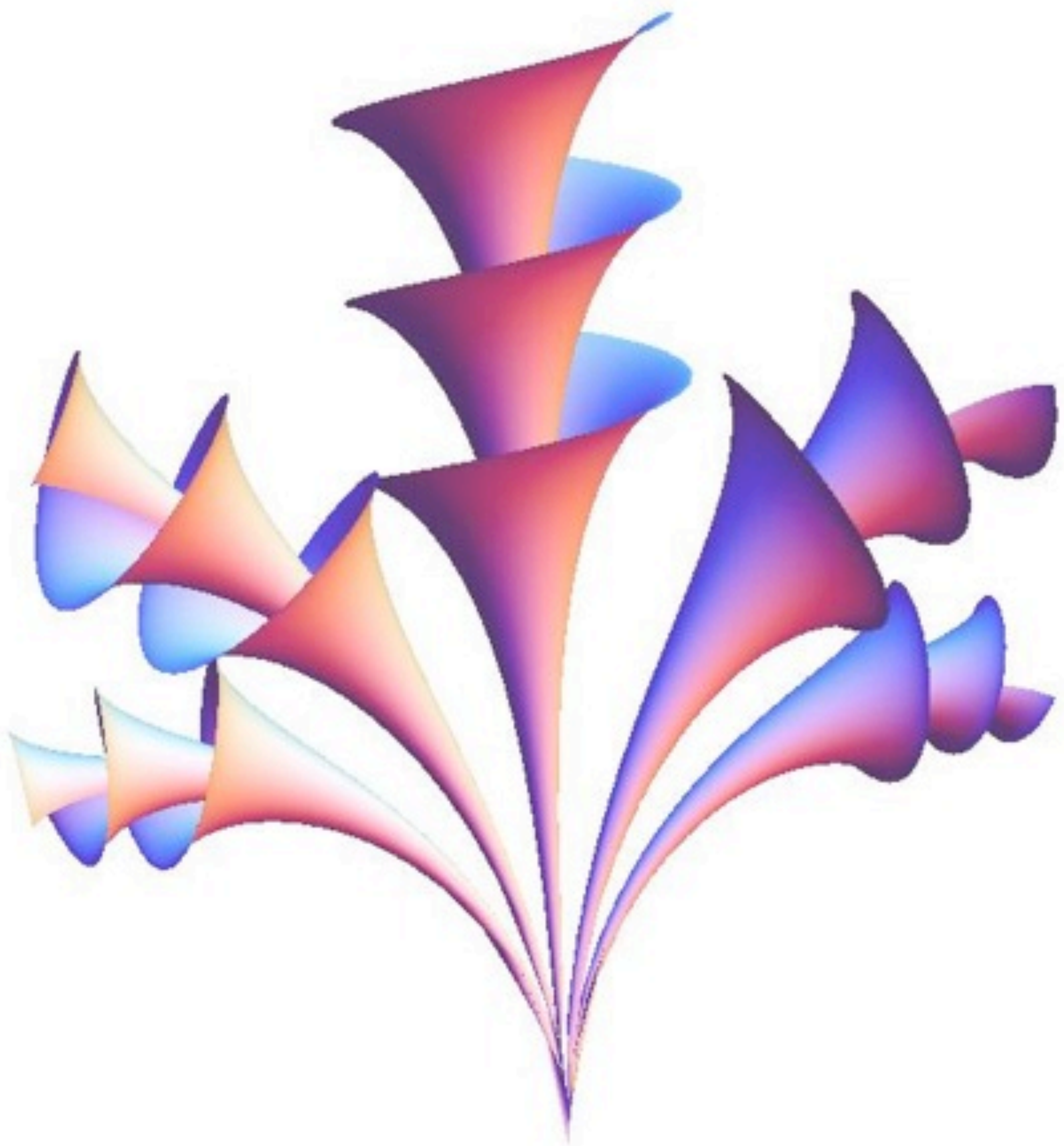
For the Artist ?

follow the Italian example

and

For the Artist ?

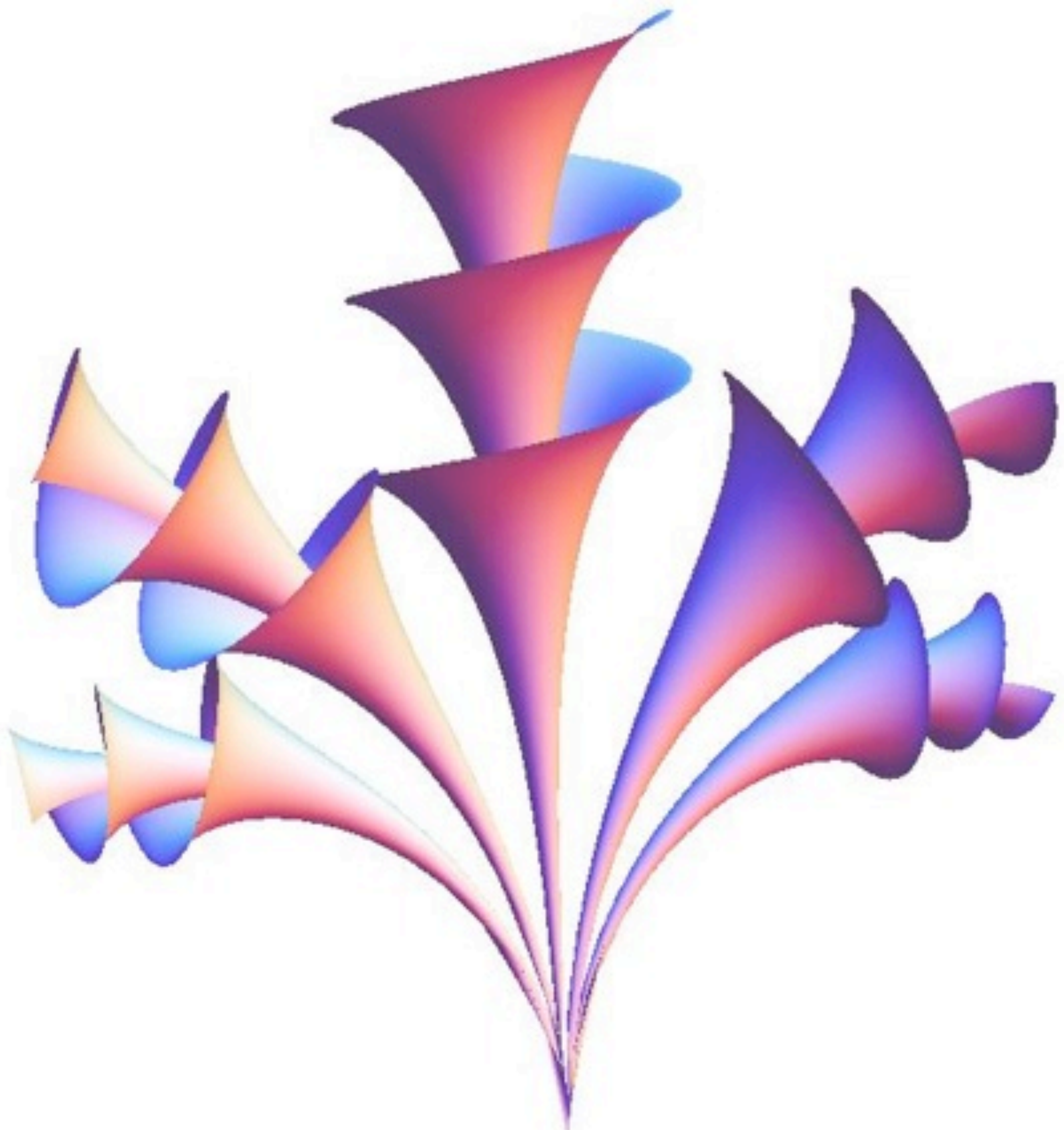
follow the Italian example



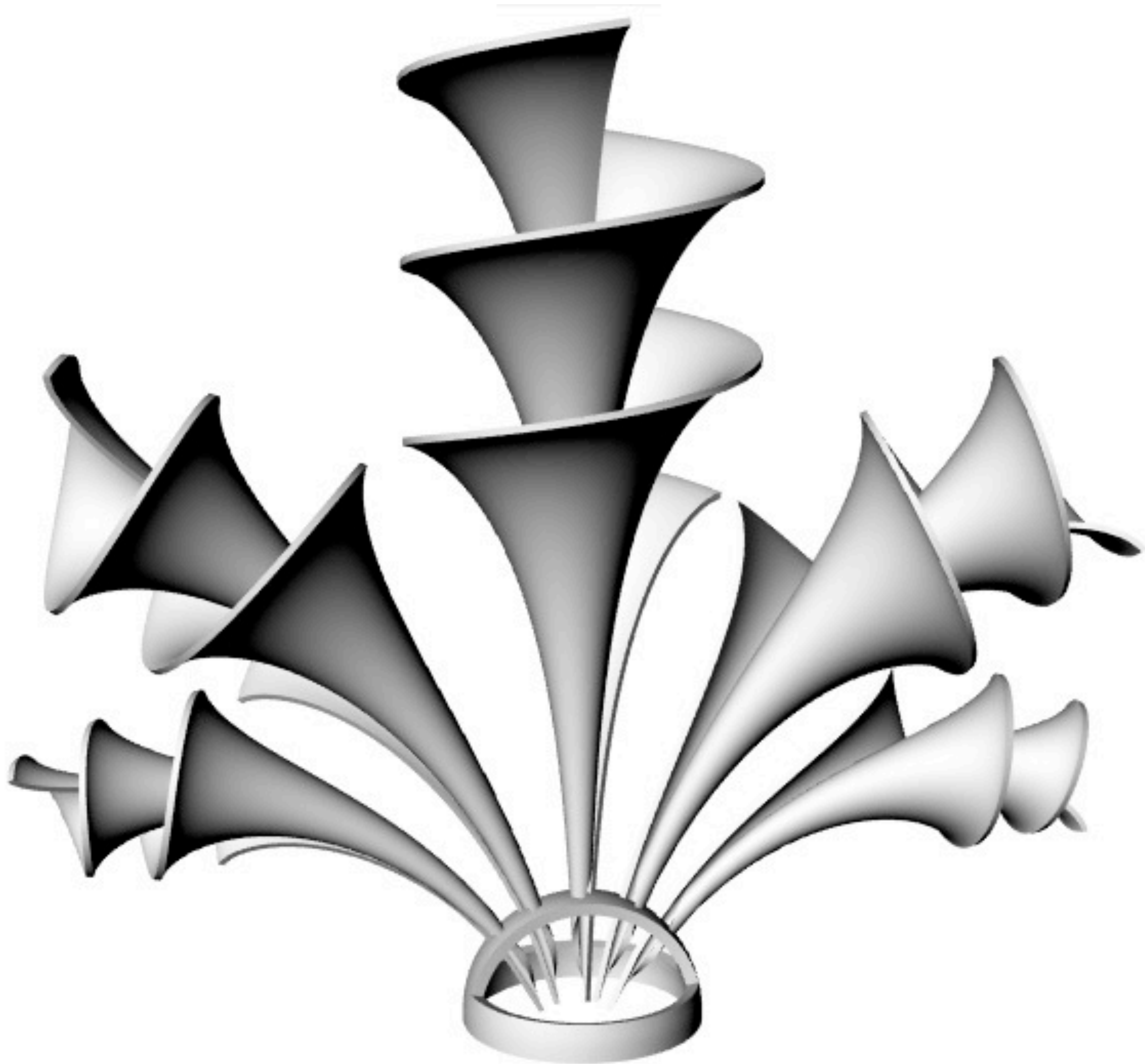
and

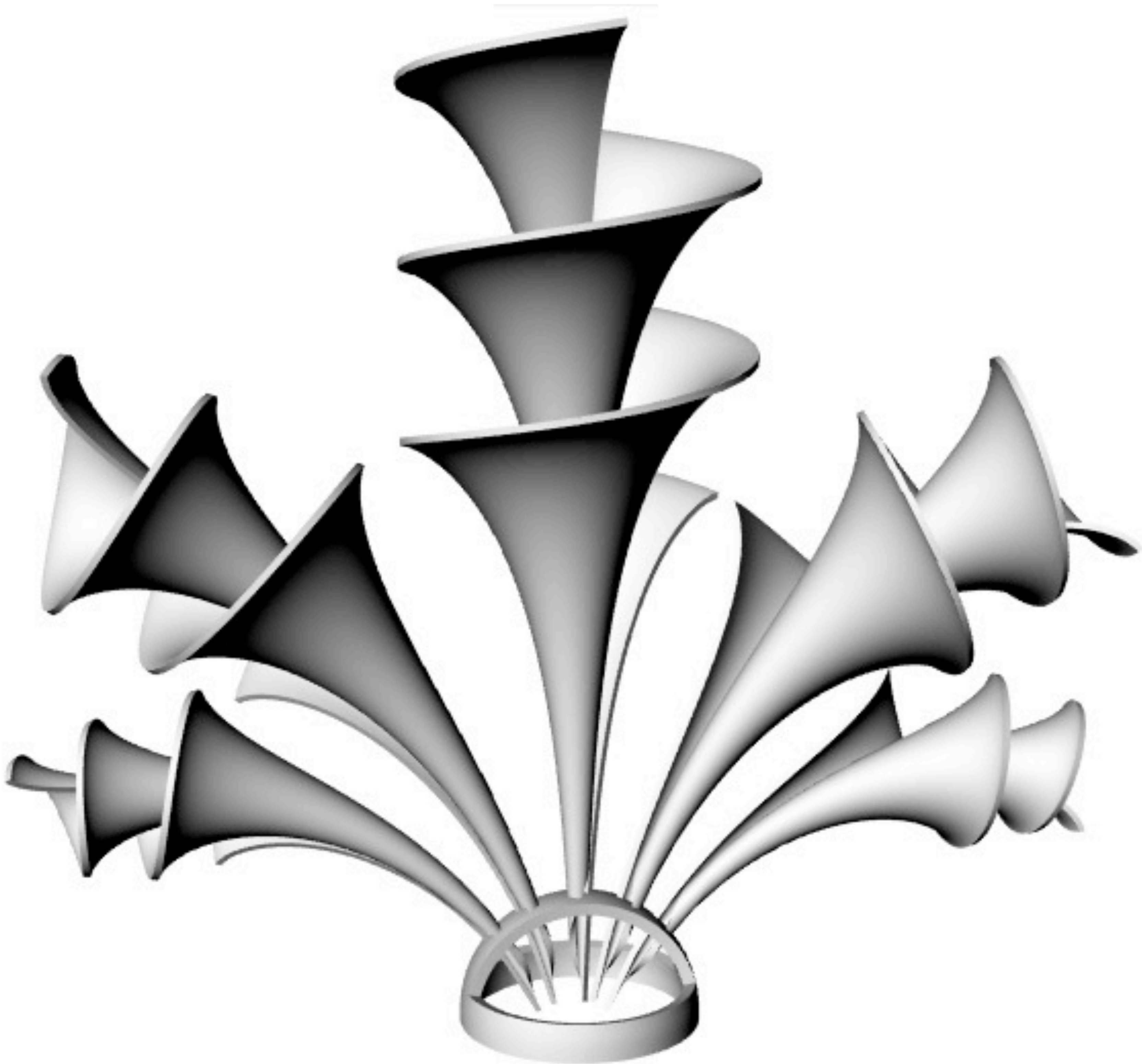
For the Artist ?

follow the Italian example



Paola PIU





Thanks to Paola Piu and Gregorio Franzoni