Random vector

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Consider a triangle with vertices

$$\mathbf{A} = \begin{pmatrix} -3 \\ -4 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} 1 \\ -5 \end{pmatrix} \tag{1}$$

1 Vectors

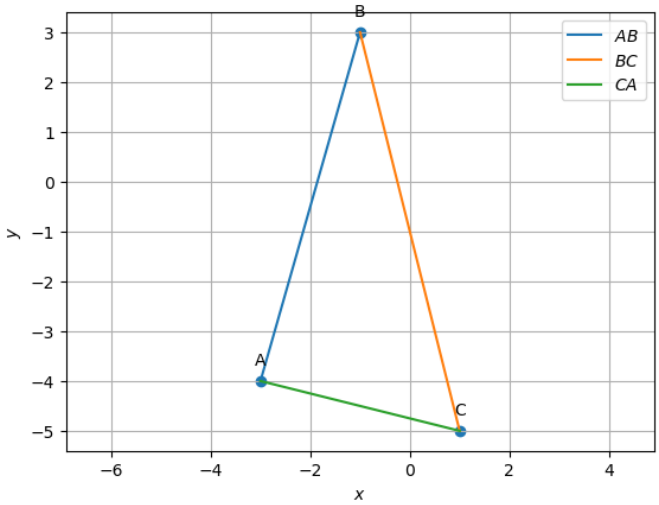

Fig. 1: triangle plotted using python

parameters	values	description
$\mathbf{m_1}$	$\begin{pmatrix} 2 \\ 7 \end{pmatrix}$	AB
$\mathbf{m_2}$	$\begin{pmatrix} 2 \\ -8 \end{pmatrix}$	BC
$\mathbf{m_3}$	$\begin{pmatrix} -4 \\ 1 \end{pmatrix}$	CA
$\|A-B\|$	7.280	length of AB
$\|B-C\|$	8.246	length of BC
$\|C-A\|$	4.123	length of CA
rank$\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{A} & \mathbf{B} & \mathbf{C} \end{pmatrix}$	3	non collinear
$\mathbf{n_1}$	$\begin{pmatrix} 7 \\ -2 \end{pmatrix}$	AB
c_1	-13	
$\mathbf{n_2}$	$\begin{pmatrix} -8 \\ -2 \end{pmatrix}$	BC
c_2	2	
$\mathbf{n_3}$	$\begin{pmatrix} 1 \\ 4 \end{pmatrix}$	CA
c_3	-19	
Area	15	Area of Triangle
$\angle A$	88.09°	Angles
$\angle B$	29.98°	
$\angle C$	61.92°	

TABLE 1: Vectors.

2 Median

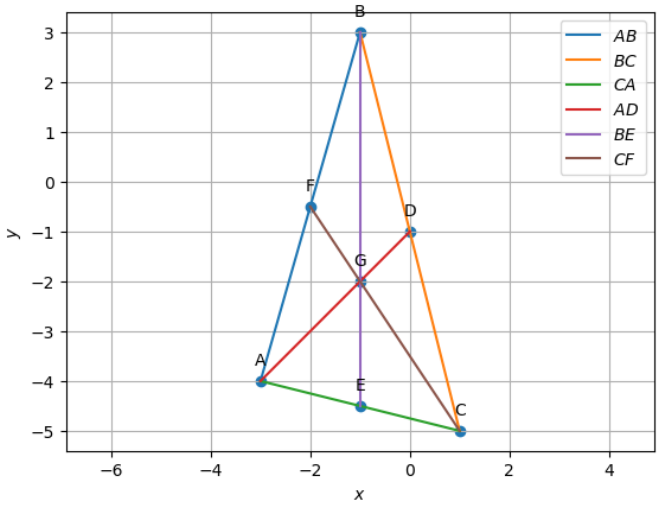

Fig. 2: medians plotted using python

parameters	value	description
$\mathbf{D}$	$\begin{pmatrix}0\\-1\end{pmatrix}$	BC midpoint
$\mathbf{E}$	$\begin{pmatrix}-1\\-4.5\end{pmatrix}$	CA midpoint
$\mathbf{F}$	$\begin{pmatrix}-2\\-0.5\end{pmatrix}$	AB midpoint
$\mathbf{m_4}$	$\begin{pmatrix}3\\3\end{pmatrix}$	AD
$\mathbf{n_4}$	$\begin{pmatrix}3\\-3\end{pmatrix}$	
c_4	3	
$\mathbf{m_5}$	$\begin{pmatrix}0\\-7.5\end{pmatrix}$	BE
$\mathbf{n_5}$	$\begin{pmatrix}-7.5\\0\end{pmatrix}$	
c_5	7.5	
$\mathbf{m_6}$	$\begin{pmatrix}-3\\4.5\end{pmatrix}$	CF
$\mathbf{n_6}$	$\begin{pmatrix}4.5\\3\end{pmatrix}$	
c_6	-10.5	
$\mathbf{G}$	$\begin{pmatrix}-1\\-2\end{pmatrix}$	Centroid
$\frac{BG}{GE}$	2	Division ratio by $\mathbf{G}$
$\frac{CG}{GF}$		
$\frac{AG}{GD}$		
$\text{rank}\begin{pmatrix}1&1&1\\\mathbf{A}&\mathbf{D}&\mathbf{G}\end{pmatrix}$	2	collinear
$\text{rank}\begin{pmatrix}1&1&1\\\mathbf{B}&\mathbf{E}&\mathbf{G}\end{pmatrix}$		
$\text{rank}\begin{pmatrix}1&1&1\\\mathbf{C}&\mathbf{F}&\mathbf{G}\end{pmatrix}$		

TABLE 2: Median.

3 Altitude

parameters	value	description
$\mathbf{D_1}$	$\begin{pmatrix}0.529\\-3.117\end{pmatrix}$	Foot of altitude from $\mathbf{A}$
$\mathbf{E_1}$	$\begin{pmatrix}-2.764\\-4.058\end{pmatrix}$	Foot of altitude from $\mathbf{B}$
$\mathbf{F_1}$	$\begin{pmatrix}-2.962\\-3.867\end{pmatrix}$	Foot of altitude from $\mathbf{C}$
$\mathbf{m_7}$	$\begin{pmatrix}3.529\\0.882\end{pmatrix}$	AD_1
$\mathbf{n_7}$	$\begin{pmatrix}0.882\\-3.529\end{pmatrix}$	
c_7	11.47	
$\mathbf{m_8}$	$\begin{pmatrix}-1.764\\-7.058\end{pmatrix}$	BE_1
$\mathbf{n_8}$	$\begin{pmatrix}-7.05\\1.76\end{pmatrix}$	
c_8	12.35	
$\mathbf{m_9}$	$\begin{pmatrix}-3.96\\1.13\end{pmatrix}$	CF_1
$\mathbf{n_9}$	$\begin{pmatrix}1.132\\3.962\end{pmatrix}$	
c_9	-18.679	
$\mathbf{H}$	$\begin{pmatrix}-2.733\\-3.933\end{pmatrix}$	Orthocentre

TABLE 3: Altitude.

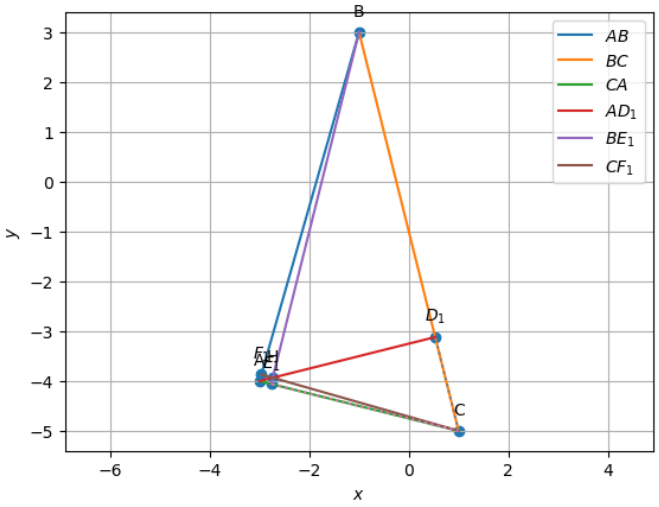

Fig. 3: altitudes plotted using python

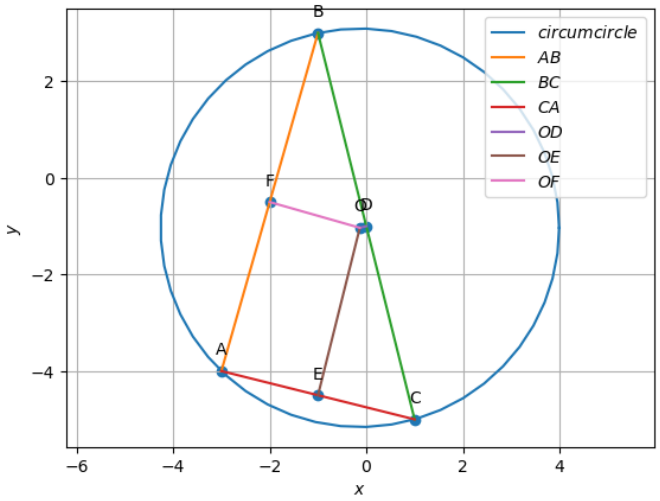

Fig. 4: perpendicular bisectors plotted using python

4 Perpendicular Bisector

parameters	value	description
$\mathbf{m_{10}}$	$\begin{pmatrix}-8\\-2\end{pmatrix}$	AD_1
$\mathbf{n_{10}}$	$\begin{pmatrix}2\\-8\end{pmatrix}$	
c_{10}	8	
$\mathbf{m_{11}}$	$\begin{pmatrix}-1\\-4\end{pmatrix}$	BE_1
$\mathbf{n_{11}}$	$\begin{pmatrix}4\\-1\end{pmatrix}$	
c_{11}	0.5	
$\mathbf{m_{12}}$	$\begin{pmatrix}-7\\2\end{pmatrix}$	CF_1
$\mathbf{n_{12}}$	$\begin{pmatrix}-2\\-7\end{pmatrix}$	
c_{12}	7.5	
$\mathbf{O}$	$\begin{pmatrix}-0.133\\-1.033\end{pmatrix}$	Circumcentre
$\|\mathbf{O}-\mathbf{A}\|$	4.125	$OA = OB = OC = R$
$\|\mathbf{O}-\mathbf{B}\|$		
$\|\mathbf{O}-\mathbf{C}\|$		
R		
$\angle BOC$	176.18°	$\angle BOC = 2\angle BAC$
$\angle BAC$	88.090°	
$\angle AOC$	59.963°	$\angle AOC = 2\angle ABC$
$\angle ABC$	29.981°	
$\angle AOB$	236.14°	$\angle AOB = 2\angle BCA$
$\angle BCA$	61.92°	

TABLE 4: Perpendicular Bisector.

5 Angle Bisector

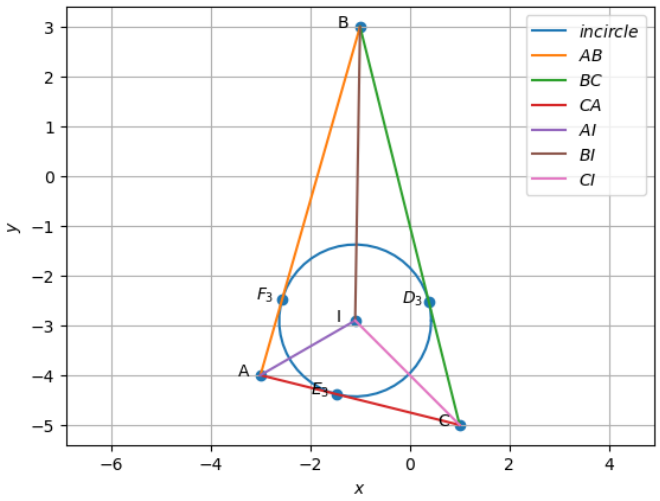

Fig. 5: Angle bisectors plotted using python

parameters	value	description
$\mathbf{m_{13}}$	$\begin{pmatrix}-1.244\\-0.718\end{pmatrix}$	AI
$\mathbf{n_{13}}$	$\begin{pmatrix}-0.718\\1.244\end{pmatrix}$	
c_{13}	-2.822	
$\mathbf{m_{14}}$	$\begin{pmatrix}-0.032\\-1.93\end{pmatrix}$	BI
$\mathbf{m_{14}}$	$\begin{pmatrix}1.93\\-0.03\end{pmatrix}$	
c_{14}	-2.0282	
$\mathbf{m_{15}}$	$\begin{pmatrix}1.212\\-1.212\end{pmatrix}$	CI
$\mathbf{n_{15}}$	$\begin{pmatrix}1.212\\1.212\end{pmatrix}$	
c_{15}	-4.85	
$\mathbf{I}$	$\begin{pmatrix}-1.098\\-2.901\end{pmatrix}$	Incentre
$\mathbf{D_3}$	$\begin{pmatrix}0.382\\-2.53\end{pmatrix}$	Point of contact with BC
$\mathbf{E_3}$	$\begin{pmatrix}-1.468\\-4.382\end{pmatrix}$	Point of contact with AC
$\mathbf{F_3}$	$\begin{pmatrix}-2.56\\-2.482\end{pmatrix}$	Point of contact with AB
$\|\mathbf{I}-\mathbf{D_3}\|$	1.52676	$ID_3 = IE_3 = IF_3 = r$
$\|\mathbf{I}-\mathbf{E_3}\|$		
$\|\mathbf{I}-\mathbf{F_3}\|$		
r		
$\angle BAI$	44.045°	$\angle BAI = \angle CAI$
$\angle CAI$		
$\angle ABI$	14.99°	$\angle ABI = \angle CBI$
$\angle CBI$		
$\angle ACI$	30.96°	$\angle ACI = \angle BCI$
$\angle BCI$		

TABLE 5: Angle Bisectors.