Probability and Random Processes

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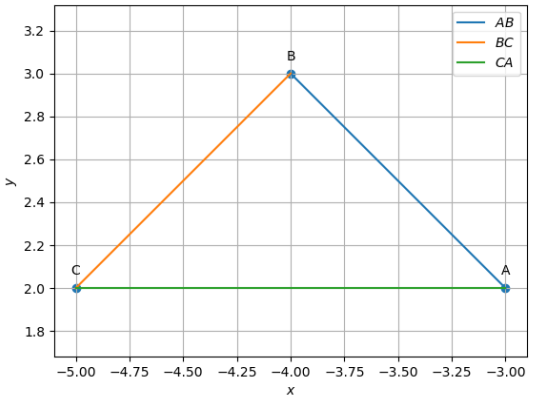
$$\mathbf{A} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}; \mathbf{B} = \begin{pmatrix} -4 \\ 3 \end{pmatrix}; \mathbf{C} = \begin{pmatrix} -5 \\ 2 \end{pmatrix}$$

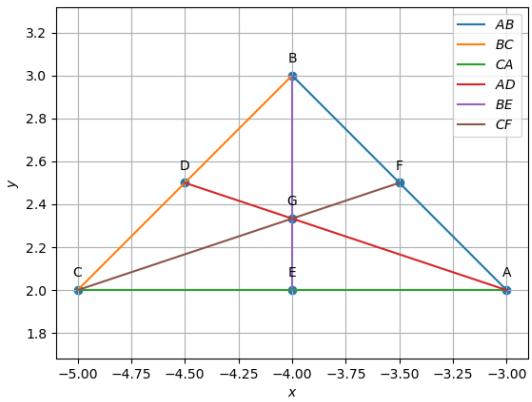


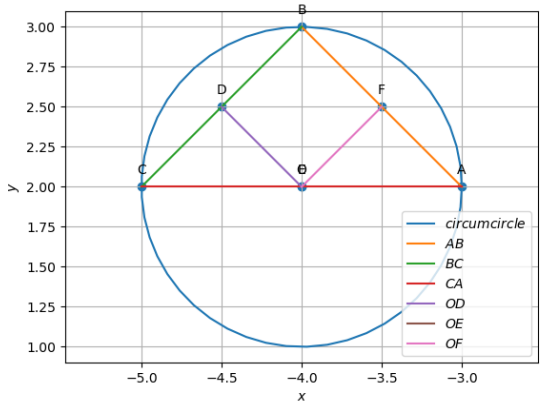
I. Vertices

Parameters	Values	Description
$\mathbf{m_1}$	$\begin{pmatrix} -1 \\ 1 \end{pmatrix}$	$\mathbf{B} - \mathbf{A}$
$\mathbf{m_2}$	$\begin{pmatrix} -1 \\ -1 \end{pmatrix}$	$\mathbf{C} - \mathbf{B}$
$\mathbf{m_3}$	$\begin{pmatrix} 2 \\ 0 \end{pmatrix}$	$\mathbf{A} - \mathbf{C}$
$\|\mathbf{B} - \mathbf{A}\|$	$\sqrt{2}$	length of AB
$\|\mathbf{C} - \mathbf{B}\|$	$\sqrt{2}$	length of BC
$\|\mathbf{A} - \mathbf{C}\|$	2	length of CA
$\text{rank}\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{A} & \mathbf{B} & \mathbf{C} \end{pmatrix}$	3	Non-collinear
$\mathbf{n_1}$	$\begin{pmatrix} 1 \\ 1 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\mathbf{m_1}$
$\mathbf{n_2}$	$\begin{pmatrix} -1 \\ 1 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\mathbf{m_2}$
$\mathbf{n_3}$	$\begin{pmatrix} 0 \\ -2 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\mathbf{m_3}$
$\frac{1}{2}\|\mathbf{m_1} \times \mathbf{m_2}\|$	1	Area
$\angle A$	45°	Angle A
$\angle B$	90°	Angle B
$\angle C$	45°	Angle C

II. Centroid

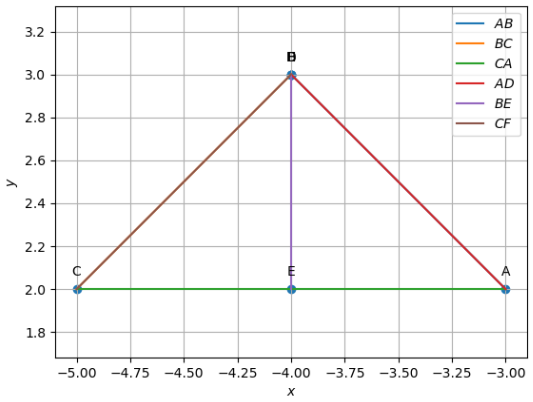
Parameters	Values	Description
$\mathbf{D}$	$\begin{pmatrix} -\frac{9}{2} \\ \frac{5}{2} \end{pmatrix}$	$\frac{\mathbf{A+B}}{2}$
$\mathbf{E}$	$\begin{pmatrix} -4 \\ 2 \end{pmatrix}$	$\frac{\mathbf{C+A}}{2}$
$\mathbf{F}$	$\begin{pmatrix} -\frac{7}{2} \\ \frac{5}{2} \end{pmatrix}$	$\frac{\mathbf{B+C}}{2}$
$\mathbf{m_4}$	$\begin{pmatrix} -\frac{3}{2} \\ \frac{1}{2} \end{pmatrix}$	$\mathbf{D - A}$
$\mathbf{m_5}$	$\begin{pmatrix} 0 \\ -1 \end{pmatrix}$	$\mathbf{E - B}$
$\mathbf{m_6}$	$\begin{pmatrix} \frac{3}{2} \\ \frac{1}{2} \end{pmatrix}$	$\mathbf{F - C}$
$\mathbf{n_4}$	$\begin{pmatrix} \frac{1}{2} \\ \frac{3}{2} \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\mathbf{m_4}$
$\mathbf{n_5}$	$\begin{pmatrix} -1 \\ 0 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\mathbf{m_5}$
$\mathbf{n_6}$	$\begin{pmatrix} \frac{1}{2} \\ -\frac{3}{2} \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\mathbf{m_6}$
$\mathbf{G}$	$\begin{pmatrix} -4 \\ \frac{7}{3} \end{pmatrix}$	$\frac{\mathbf{A+B+C}}{3}$
$\|\mathbf{A - G}\|$	1.054	$\therefore \frac{AG}{GD} = \frac{BG}{GE} = \frac{CG}{GF} = 2$
$\|\mathbf{D - G}\|$	0.527	
$\|\mathbf{B - G}\|$	0.666	
$\|\mathbf{E - G}\|$	0.333	
$\|\mathbf{C - G}\|$	1.054	
$\|\mathbf{F - G}\|$	0.527	
$\text{rank}\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{A} & \mathbf{D} & \mathbf{G} \end{pmatrix}$	2	The points are collinear
$\text{rank}\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{B} & \mathbf{E} & \mathbf{G} \end{pmatrix}$		
$\text{rank}\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{C} & \mathbf{F} & \mathbf{G} \end{pmatrix}$		
AF	$\begin{pmatrix} 1/2 \\ -1/2 \end{pmatrix}$	AFDE is a quadrilateral
ED		





III. Orthocentre

Parameters	Values	Description
$\mathbf{n_7}$	$\begin{pmatrix}-1\\-1\end{pmatrix}$	alt AD_1
$\mathbf{n_8}$	$\begin{pmatrix}2\\0\end{pmatrix}$	alt BE_1
$\mathbf{n_9}$	$\begin{pmatrix}-1\\1\end{pmatrix}$	alt CF_1
$\mathbf{H}$	$\begin{pmatrix}-4\\3\end{pmatrix}$	orthocentre

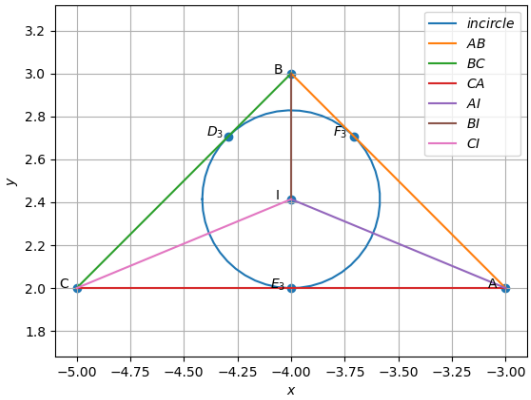


IV. Circumcentre

Parameters	Values	Description
$\mathbf{O}$	$(-4, 2)$	circumcentre
$\|\mathbf{O}-\mathbf{A}\|$	1	circumradius
$\|\mathbf{O}-\mathbf{B}\|$		
$\|\mathbf{O}-\mathbf{C}\|$		

V. Incentre

Parameters	Values	Description
$\mathbf{I}-\mathbf{A}$	$\begin{pmatrix}1.70\\-0.70\end{pmatrix}$	angle bisector of A
$\mathbf{I}-\mathbf{B}$	$\begin{pmatrix}0\\-1.41\end{pmatrix}$	angle bisector of B
$\mathbf{I}-\mathbf{C}$	$\begin{pmatrix}-1.70\\-0.70\end{pmatrix}$	angle bisector of C
$\mathbf{I}$	$\begin{pmatrix}-4\\2.41\end{pmatrix}$	incentre
r	0.414	incentre radius
$\angle BAI$	22.5°	bisector of A
$\angle CAI$		
$\angle ABI$	135°	bisector of B
$\angle CBI$		
$\angle BCI$	157.5°	bisector of C
$\angle ACI$		
$\mathbf{D_3}$	$\begin{pmatrix}-4.29\\2.70\end{pmatrix}$	points of intersection
$\mathbf{E_3}$	$\begin{pmatrix}-4\\2\end{pmatrix}$	
$\mathbf{F_3}$	$\begin{pmatrix}-3.70\\2.70\end{pmatrix}$	


incircle
AB
BC
CA
AI
BI
CI
B
D_3
F_3
I
C
E_3
A
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
y
−5.00
−4.75
−4.50
−4.25
−4.00
−3.75
−3.50
−3.25
−3.00
x