

# Random Vector Assignment

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Consider a triangle with vertices,

$$\mathbf{A} = \begin{pmatrix} 1 \\ -5 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} -4 \\ 5 \end{pmatrix} \quad \mathbf{C} = \begin{pmatrix} -1 \\ 0 \end{pmatrix} \quad (1)$$

## I. VECTORS

Parameter	Value	Description
$\mathbf{m}_{AB}$	$\begin{pmatrix} -5 \\ 0 \end{pmatrix}$	Direction vec of $AB$
$\mathbf{m}_{BC}$	$\begin{pmatrix} 3 \\ -5 \end{pmatrix}$	Direction vec of $BC$
$\mathbf{m}_{CA}$	$\begin{pmatrix} 2 \\ 5 \end{pmatrix}$	Direction vec of $CA$
$\ \mathbf{A} - \mathbf{B}\ $	5.831	Length of $AB$
$\ \mathbf{B} - \mathbf{C}\ $		Length of $BC$
$\ \mathbf{C} - \mathbf{A}\ $		Length of $CA$
$\text{rank} \begin{pmatrix} 1 & 1 & 1 \\ A & B & C \end{pmatrix}$	3	non-collinear
$\mathbf{n}_{AB}$	$\begin{pmatrix} 0 \\ 5 \end{pmatrix}$	Normal vec of $AB$
$\mathbf{c}_{AB}$	25	Constant in $AB$
$\mathbf{n}_{BC}$	$\begin{pmatrix} -5 \\ -3 \end{pmatrix}$	Normal vec of $BC$
$\mathbf{c}_{BC}$	5	Constant in $BC$
$\mathbf{n}_{CA}$	$\begin{pmatrix} 5 \\ -2 \end{pmatrix}$	Normal vec of $CA$
$\mathbf{c}_{CA}$	-5	Constant in $CA$
Area	12.5	Area of $\triangle ABC$
$\cos(\mathbf{A})$	0.3713	cosine of $\angle \mathbf{A}$
$\cos(\mathbf{B})$	0.5145	cosine of $\angle \mathbf{B}$
$\cos(\mathbf{C})$	0.6051	cosine of $\angle \mathbf{C}$

TABLE I  
TRIANGLE

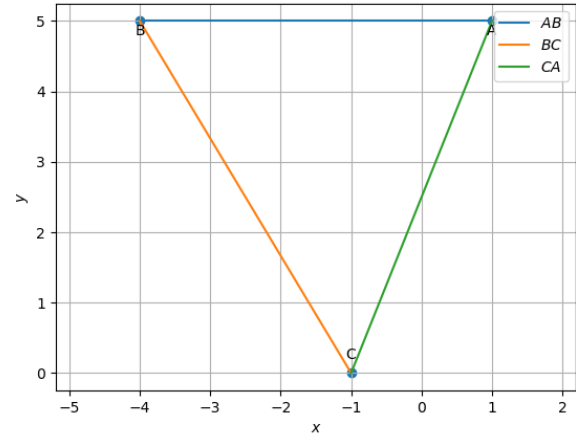


Fig. I. Triangle generated using python

## II. MEDIAN

Parameter	Value	Description
<b>D</b>	$\begin{pmatrix} -2.5 \\ 2.5 \end{pmatrix}$	Midpoint $AB$
<b>E</b>	$\begin{pmatrix} 0.0 \\ 2.5 \end{pmatrix}$	Midpoint $BC$
<b>F</b>	$\begin{pmatrix} -1.5 \\ -5.0 \end{pmatrix}$	Midpoint $CA$
$\mathbf{n}_{AD}$	$\begin{pmatrix} -2.5 \\ 3.5 \end{pmatrix}$	Normal vec of $AD$
$\mathbf{c}_{AD}$	15	Constant of $AD$
$\mathbf{n}_{BE}$	$\begin{pmatrix} -2.5 \\ -4.0 \end{pmatrix}$	Normal vec of $BE$
$\mathbf{c}_{BE}$	-10	Constant of $BE$
$\mathbf{n}_{CF}$	$\begin{pmatrix} -5.0 \\ 0.5 \end{pmatrix}$	Normal vec of $CF$
$\mathbf{c}_{CF}$	-5	Constant of $CF$
<b>G</b>	$\begin{pmatrix} -1.333 \\ 3.333 \end{pmatrix}$	Centroid
$\frac{BG}{GE}$	2	Ratio of $BG$ and $GE$
$\frac{CG}{GF}$		Ratio of $CG$ and $GF$
$\frac{CG}{GF}$		Ratio of $CG$ and $GF$
$\text{rank} \begin{pmatrix} 1 & 1 & 1 \\ A & D & G \end{pmatrix}$	2	<b>A, D, G</b> collinear
<b>A – F</b>	$\begin{pmatrix} 2.5 \\ 0.0 \end{pmatrix}$	Direction vec of $AF$
<b>E – D</b>		Direction vec of $ED$

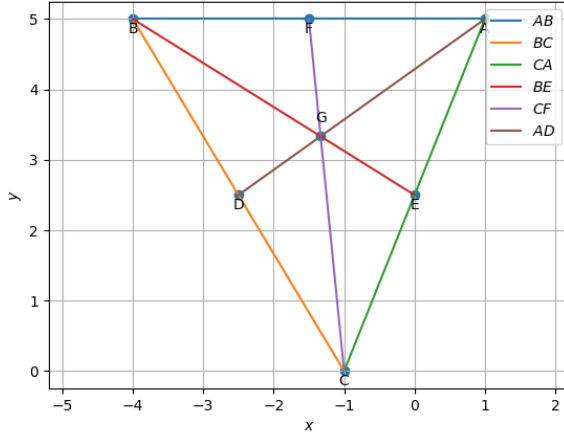


Fig. II. Medians generated using python

## III. ALTITUDE

Parameter	Value	Description
<b>D<sub>1</sub></b>	$\begin{pmatrix} -2.676 \\ 2.794 \end{pmatrix}$	altitude foot from $A$
<b>E<sub>1</sub></b>	$\begin{pmatrix} 0.310 \\ 3.276 \end{pmatrix}$	altitude foot from $B$
<b>F<sub>1</sub></b>	$\begin{pmatrix} -1 \\ 5 \end{pmatrix}$	altitude foot from $C$
$\mathbf{n}_{AD_1}$	$\begin{pmatrix} 3 \\ -5 \end{pmatrix}$	Normal vec of $AD_1$
$\mathbf{c}_{AD_1}$	-22	Constant of $AD_1$
$\mathbf{n}_{BE_1}$	$\begin{pmatrix} 2 \\ 5 \end{pmatrix}$	Normal vec of $BE_1$
$\mathbf{c}_{BE_1}$	17	Constant of $BE_1$
$\mathbf{n}_{CF_1}$	$\begin{pmatrix} -5 \\ 0 \end{pmatrix}$	Normal vec of $CF_1$
$\mathbf{c}_{CF_1}$	5	Constant of $CF_1$
<b>H</b>	$\begin{pmatrix} -1 \\ 3.8 \end{pmatrix}$	Orthocenter

TABLE III  
ORTHOCENTER

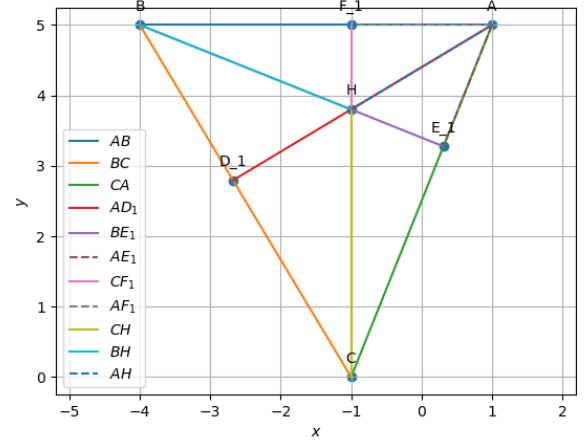


Fig. III. Altitudes generated using python

## IV. PERPENDICULAR BISECTOR

Parameter	Value	Description
$\mathbf{n}_{OA}$	$\begin{pmatrix} 2.5 \\ 1.9 \end{pmatrix}$	Direction vec of $OA$
$\mathbf{n}_{OB}$	$\begin{pmatrix} -2.5 \\ 1.9 \end{pmatrix}$	Direction vec of $OB$
$\mathbf{n}_{OC}$	$\begin{pmatrix} 0.5 \\ -3.1 \end{pmatrix}$	Direction vec of $OC$
$\mathbf{O}$	$\begin{pmatrix} -1.5 \\ 3.1 \end{pmatrix}$	Circumcenter
$\mathbf{n}_{OD}$	$\begin{pmatrix} 5 \\ 0 \end{pmatrix}$	Normal vec of $OD$
$\mathbf{c}_{OD}$	-7.5	Constant of $OD$
$\mathbf{n}_{OE}$	$\begin{pmatrix} -3 \\ 5 \end{pmatrix}$	Normal vec of $OE$
$\mathbf{c}_{OE}$	20	Constant of $OE$
$\mathbf{n}_{OF}$	$\begin{pmatrix} -2 \\ -5 \end{pmatrix}$	Normal vec of $OF$
$\mathbf{c}_{OF}$	-12.5	Constant of $OF$
$\ A - O\ $	3.140	Norm of $OA$
$\ B - O\ $		Norm of $OB$
$\ C - O\ $		Norm of $OC$
$\mathbf{R}$		Circumradius
$\angle BAC$	$68.1986^\circ$	Angle $\angle BAC$
$\angle BOC$	$136.3972^\circ$	Angle $\angle BOC$

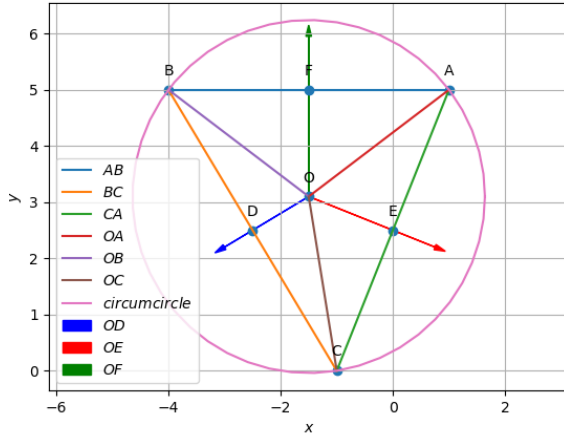
TABLE IV  
CIRCUMCENTER

Fig. IV. Perpendicular bisectors generated using python

## V. ANGULAR BISECTOR

Parameter	Value	Description
$\mathbf{n}_{IA}$	$\begin{pmatrix} -0.928 \\ 1.371 \end{pmatrix}$	Normal vec of $IA$
$\mathbf{c}_{IA}$	5.928	Constant vec of $IA$
$\mathbf{n}_{IB}$	$\begin{pmatrix} 0.857 \\ 1.514 \end{pmatrix}$	Normal vec of $IB$
$\mathbf{c}_{IB}$	4.142	Constant vec of $IB$
$\mathbf{n}_{IC}$	$\begin{pmatrix} -1.786 \\ -0.143 \end{pmatrix}$	Normal vec of $IC$
$\mathbf{c}_{IC}$	1.786	Constant vec of $IC$
$\mathbf{I}$	$\begin{pmatrix} -1.277 \\ 3.458 \end{pmatrix}$	Incenter
$\mathbf{D}_3$	$\begin{pmatrix} -2.599 \\ 2.665 \end{pmatrix}$	POC with $AB$
$\mathbf{E}_3$	$\begin{pmatrix} 0.154 \\ 2.886 \end{pmatrix}$	POC with $BC$
$\mathbf{F}_3$	$\begin{pmatrix} -1.277 \\ 5.000 \end{pmatrix}$	POC with $CA$
$\ \mathbf{D}_3 - \mathbf{O}\ $	1.542	Norm of $OD_3$
$\ \mathbf{E}_3 - \mathbf{O}\ $		Norm of $OE_3$
$\ \mathbf{F}_3 - \mathbf{O}\ $		Norm of $OF_3$
$\mathbf{r}$		Inradius
$\angle BAI$	$34.1^\circ$	Angle $\angle BAI$
$\angle CAI$		Angle $\angle CAI$

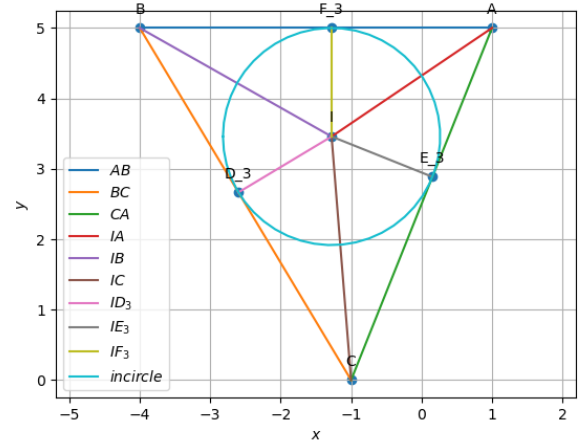
TABLE V  
INCIRCLE

Fig. V. Incircle generated using python