Random Vector Assignment

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Consider a triangle with vertices,

$$\mathbf{A} = \begin{pmatrix} 2 \\ 0 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} 4 \\ 1 \end{pmatrix} \quad \mathbf{C} = \begin{pmatrix} 0 \\ 4 \end{pmatrix} \tag{1}$$

I. Vectors

Parameter	Value	Description
$\mathbf{m_{AB}}$	$\begin{pmatrix} 2 \\ 1 \end{pmatrix}$	Direction vec of AB
$\mathbf{m_{BC}}$	$\begin{pmatrix} -4 \\ 3 \end{pmatrix}$	Direction vec of BC
$\mathbf{m_{CA}}$	$\begin{pmatrix} 2 \\ -4 \end{pmatrix}$	Direction vec of CA
$\|\|\mathbf{A}-\mathbf{B}\|\|$	-	Lenght of AB
$\|\|\mathbf{B}-\mathbf{C}\|\|$	5	Lenght of BC
$\|\|\mathbf{C}-\mathbf{A}\|\|$	-	Lenght of CA
rank $\begin{pmatrix} 1 & 1 & 1 \\ A & B & C \end{pmatrix}$	3	non-collinear
$\mathbf{n_{AB}}$	$\begin{pmatrix} 1 \\ -2 \end{pmatrix}$	Normal vec of AB
$\mathbf{c_{AB}}$	2	Constant in AB
$\mathbf{n_{BC}}$	$\begin{pmatrix} 3 \\ 4 \end{pmatrix}$	Normal vec of BC
$\mathbf{c_{BC}}$	16	Constant in BC
$\mathbf{n_{CA}}$	$\begin{pmatrix} -4 \\ -2 \end{pmatrix}$	Normal vec of CA
$\mathbf{c_{CA}}$	-8	Constant in CA
Area	5	Area of $\triangle ABC$
cos($\mathbf{A}$)	0	cosine of $\angle\mathbf{A}$
cos($\mathbf{B}$)	0.447	cosine of $\angle\mathbf{B}$
cos($\mathbf{C}$)	0.894	cosine of $\angle\mathbf{C}$

TABLE I
Triangle

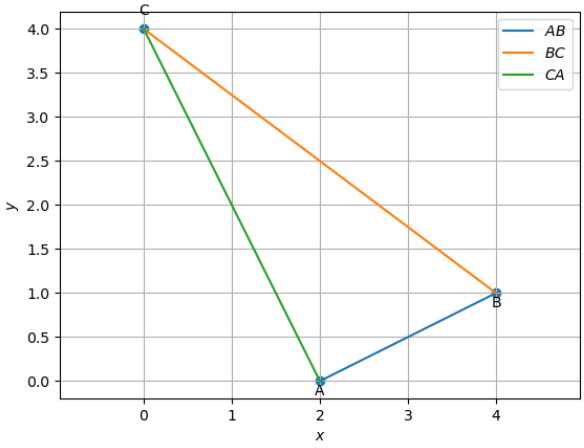

Fig. I. Triangle generated using python

II. Median

Parameter	Value	Description
D	$\begin{pmatrix}2.0\\2.5\end{pmatrix}$	Midpoint AB
E	$\begin{pmatrix}1.0\\2.0\end{pmatrix}$	Midpoint BC
F	$\begin{pmatrix}3.0\\0.5\end{pmatrix}$	Midpoint CA
$\mathbf{n_{AD}}$	$\begin{pmatrix}2.5\\0.0\end{pmatrix}$	Normal vec of AD
$\mathbf{c_{AD}}$	5	Constant of AD
$\mathbf{n_{BE}}$	$\begin{pmatrix}1.0\\3.0\end{pmatrix}$	Normal vec of BE
$\mathbf{c_{BE}}$	7	Constant of BE
$\mathbf{n_{CF}}$	$\begin{pmatrix}-3.5\\-3.0\end{pmatrix}$	Normal vec of CF
$\mathbf{c_{CF}}$	-12	Constant of CF
G	$\begin{pmatrix}2.0\\1.667\end{pmatrix}$	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
rank $\begin{pmatrix}1 & 1 & 1\\ A & D & G\end{pmatrix}$	2	**A**, **D**, **G** collinear
A − **F**	$\begin{pmatrix}-1.0\\-0.5\end{pmatrix}$	Direction vec of AF
E − **D**		Direction vec of ED

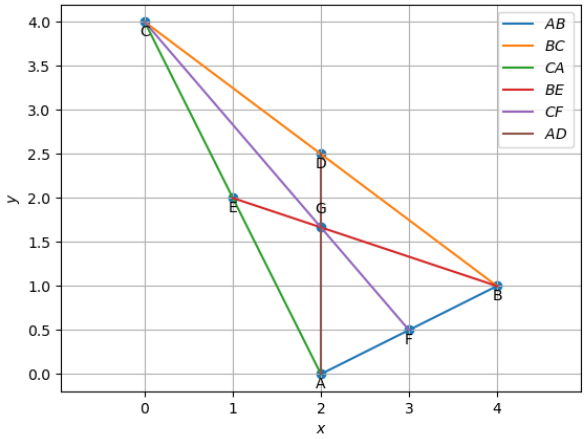

Fig. II. Medians generated using python

III. Altitude

Parameter	Value	Description
$\mathbf{D_1}$	$\begin{pmatrix}3.2\\1.6\end{pmatrix}$	altitude foot from A
$\mathbf{E_1}$	$\begin{pmatrix}2.0\\0\end{pmatrix}$	altitude foot from B
$\mathbf{F_1}$	$\begin{pmatrix}2.0\\0\end{pmatrix}$	altitude foot from C
$\mathbf{n_{AD_1}}$	$\begin{pmatrix}-4\\3\end{pmatrix}$	Normal vec of AD_1
$\mathbf{c_{AD_1}}$	-8	Constant of AD_1
$\mathbf{n_{BE_1}}$	$\begin{pmatrix}2\\-4\end{pmatrix}$	Normal vec of BE_1
$\mathbf{c_{BE_1}}$	4	Constant of BE_1
$\mathbf{n_{CF_1}}$	$\begin{pmatrix}2\\1\end{pmatrix}$	Normal vec of CF_1
$\mathbf{c_{CF_1}}$	4	Constant of CF_1
H	$\begin{pmatrix}2.0\\2.5\end{pmatrix}$	Orthocenter

TABLE III
Orthocenter

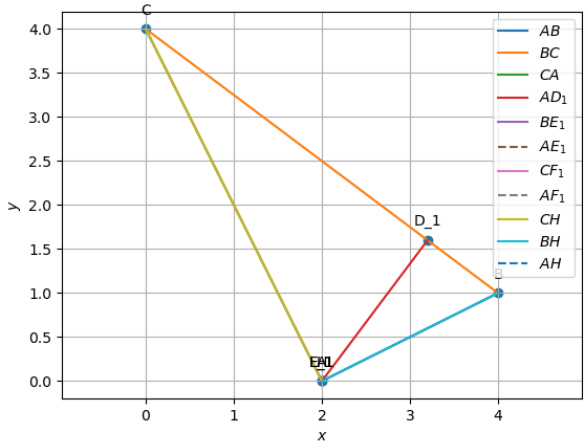

Fig. III. Altitudes generated using python

IV. Perpendicular Bisector

Parameter	Value	Description
$\mathbf{n_{OA}}$	$\begin{pmatrix} 0 \\ -2.5 \end{pmatrix}$	Direction vec of OA
$\mathbf{n_{OB}}$	$\begin{pmatrix} 2.0 \\ -1.5 \end{pmatrix}$	Direction vec of OB
$\mathbf{n_{OC}}$	$\begin{pmatrix} -2.0 \\ 1.5 \end{pmatrix}$	Direction vec of OC
$\mathbf{O}$	$\begin{pmatrix} 2 \\ 2.5 \end{pmatrix}$	Circumcenter
$\mathbf{n_{OD}}$	$\begin{pmatrix} -2 \\ -1 \end{pmatrix}$	Normal vec of OD
$\mathbf{c_{OD}}$	-6.5	Constant of OD
$\mathbf{n_{OE}}$	$\begin{pmatrix} 4 \\ -3 \end{pmatrix}$	Normal vec of OE
$\mathbf{c_{OE}}$	0.5	Constant of OE
$\mathbf{n_{OF}}$	$\begin{pmatrix} -2 \\ 4 \end{pmatrix}$	Normal vec of OF
$\mathbf{c_{OF}}$	6.0	Constant of OF
$\|\mathbf{A}-\mathbf{O}\|$	2.5	Norm of OA
$\|\mathbf{B}-\mathbf{O}\|$		Norm of OB
$\|\mathbf{C}-\mathbf{O}\|$		Norm of OC
$\mathbf{R}$		Circumradius
$\angle BAC$	90.0°	Angle $\angle BAC$
$\angle BOC$	179.99°	Angle $\angle BOC$

TABLE IV
Circumcenter

V. Angular bisector

Parameter	Value	Description
$\mathbf{n_{IA}}$	$\begin{pmatrix} 1.341 \\ -0.447 \end{pmatrix}$	Normal vec of IA
$\mathbf{c_{IA}}$	2.683	Constant vec of IA
$\mathbf{n_{IB}}$	$\begin{pmatrix} -0.152 \\ -1.694 \end{pmatrix}$	Normal vec of IB
$\mathbf{c_{IB}}$	-2.305	Constant vec of IB
$\mathbf{n_{IC}}$	$\begin{pmatrix} 1.494 \\ 1.247 \end{pmatrix}$	Normal vec of IC
$\mathbf{c_{IC}}$	4.988	Constant vec of IC
$\mathbf{I}$	$\begin{pmatrix} 2.382 \\ 1.146 \end{pmatrix}$	Incenter
$\mathbf{D_3}$	$\begin{pmatrix} 2.894 \\ 1.829 \end{pmatrix}$	POC with AB
$\mathbf{E_3}$	$\begin{pmatrix} 1.618 \\ 0.763 \end{pmatrix}$	POC with BC
$\mathbf{F_3}$	$\begin{pmatrix} 2.764 \\ 0.382 \end{pmatrix}$	POC with CA
$\|\mathbf{D_3}-\mathbf{O}\|$	0.854	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
$\angle BAI$	45°	Angle $\angle BAI$
$\angle CAI$		Angle $\angle CAI$

TABLE V
Incircle

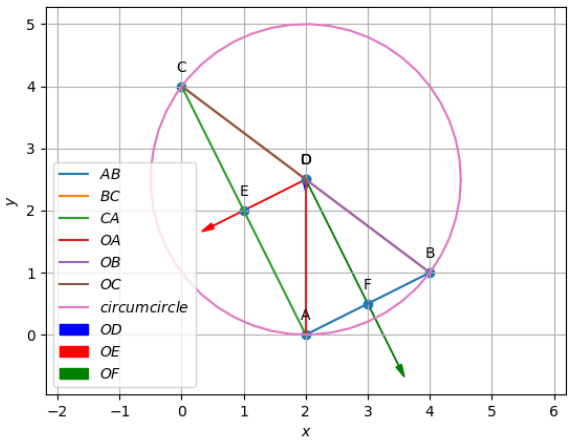

Fig. IV. Perpendicular bisectors generated using python

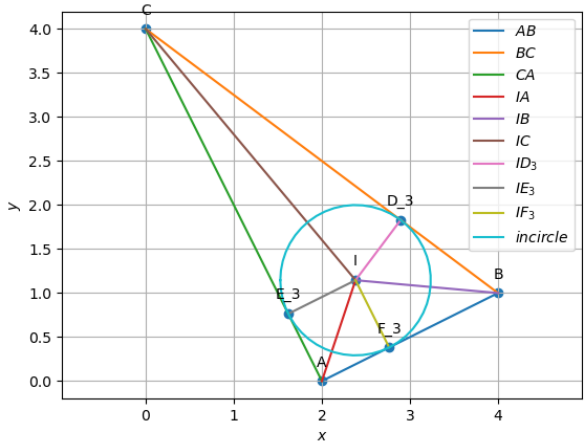

Fig. V. Incircle generated using python