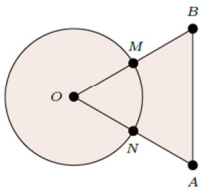
Solution Synthesis; Existing Figure Problem Synthesis

Example 1

Consider the sample problem from the paper.

Find the area of the shaded region where a circular arc of radius 7cm has been drawn with vertex O of an equilateral $\triangle OAB$, of side 12cm, as center. (CBSE 2012)



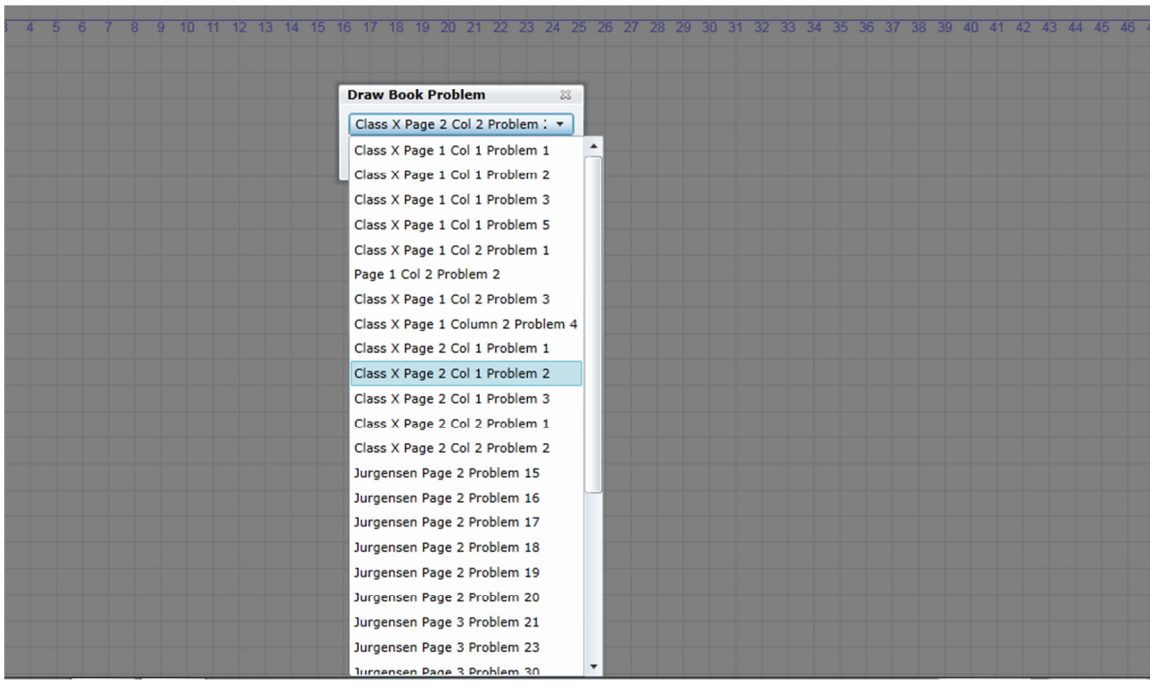
In this case, the explicit facts of Known include $\{\text{Equilateral}(\triangle OAB), OM = 7, OA = 12\}$ and the goal region g is the the entire shaded figure.
One solution may subtract the shared redundant sector:

$$A_g = \text{Circle}(O) - \text{MinorSector}(M, O, N) + \text{EqTri}(O, A, B)$$
$$= 49\pi - \frac{1}{6}49\pi + 36\sqrt{3} = \frac{245}{6}\pi + 36\sqrt{3}$$

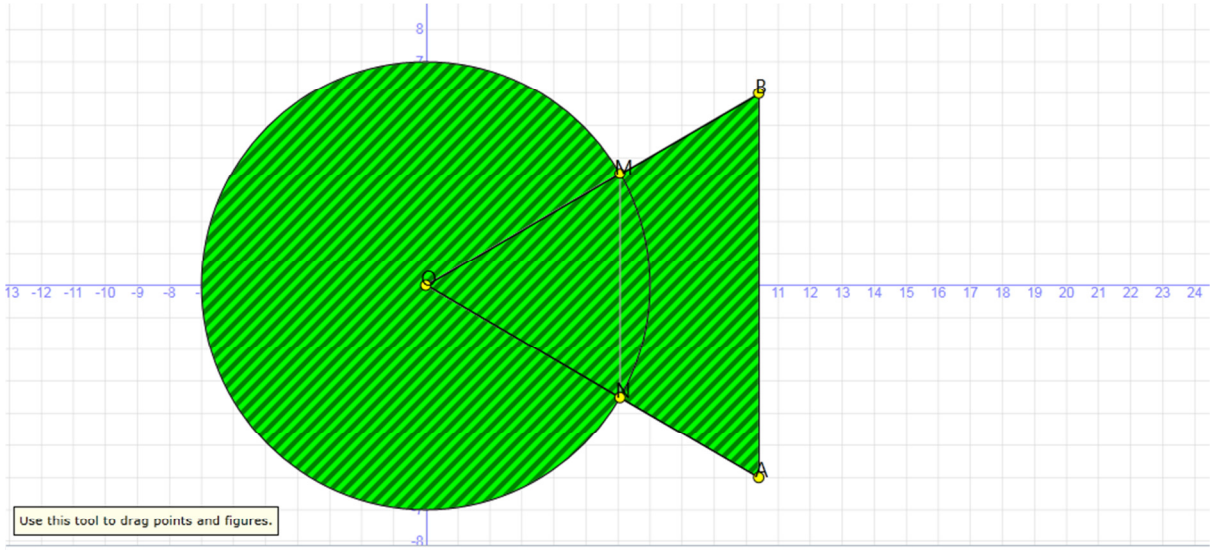
Figure 1: A sample shaded area problem.

We show a series of screenshots of our tool *GeoShader* (1) accessing the existing problem, (2) solving the problem, and (3) identifying atomic regions in the figure.

1. We select the problem from a drop-down menu.



2. The figure is analyzed, the problem is solved and the results are displayed. We note the figure is drawn to scale.

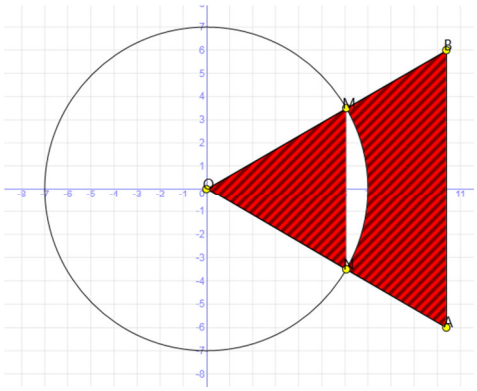


Original Problem: 190.6355 = { {Seg(MN), Arc(MN)}, Major(MON), Tri(ONM), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (Major(MON) + EqTri(ABO))
1 (128.2817): Major(MON) = Major(MON)
2 (21.2176): Tri(ONM) = Tri(ONM)
3 (153.9380): Circle(O) = Circle(O)
4 (25.6563): Minor(NOM) = Minor(NOM)
5 (62.3538): EqTri(ABO) = EqTri(ABO)
6 (132.7204): { {Seg(MN), Arc(MN)}, Major(MON) } = (Circle(O) - Tri(ONM))
7 (4.4387): { {Seg(MN), Arc(MN)} } = (Minor(NOM) - Tri(ONM))
8 (36.6975): { {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (EqTri(ABO) - Minor(NOM))
9 (41.1362): { {Seg(MN), Arc(MN)}, {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (EqTri(ABO) - Tri(ONM))
10 (149.4993): { Major(MON), Tri(ONM) } = (Major(MON) + Tri(ONM))
11 (190.6355): { {Seg(MN), Arc(MN)}, Major(MON), Tri(ONM), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (Major(MON) + EqTri(ABO))
12 (164.9792): { Major(MON), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (Major(MON) + { {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} })
13 (169.4179): { {Seg(MN), Arc(MN)}, Major(MON), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (Major(MON) + { {Seg(MN), Arc(MN)}, {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} })
14 (57.9151): { Tri(ONM), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (Tri(ONM) + { {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} })
15 (186.1968): { Major(MON), Tri(ONM), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} } = (Tri(ONM) + { Major(MON), {Arc(MN), Seg(BM), Seg(AB), Seg(NA)} })

We observe the solution in our debug window indicated by “Original Problem” noting the floating-point value equates to our prior calculations. This equation indicates a set of four atomic regions which are all shaded in green above equating to the Major Sector (MON) plus the equilateral triangle ABO.

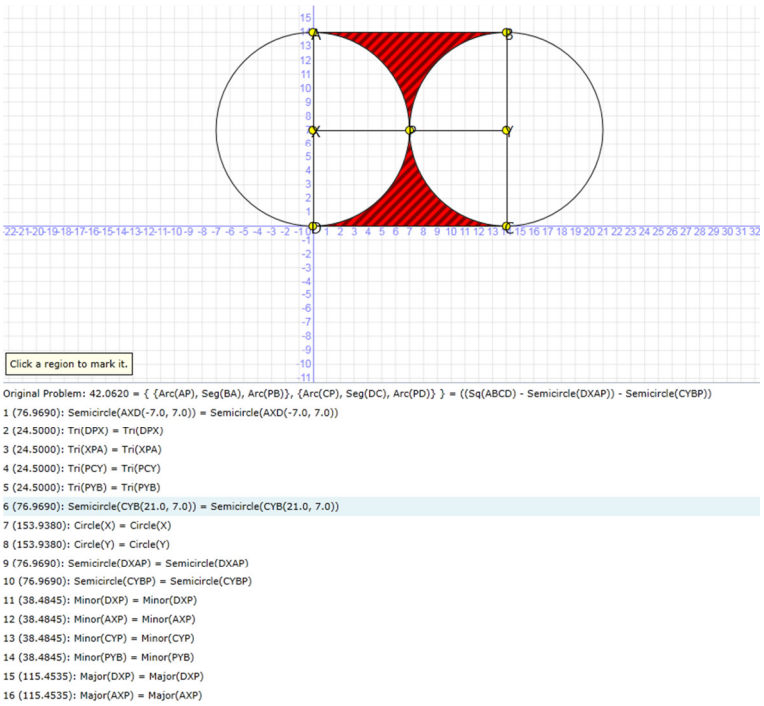
We also observe the associated expressions to solve the area of each of the 15 possible regions. Hence, this problem is a complete problem.

3. As a clear indication of the four atomic regions, we observe the shading (and lack of shading) of two of the atomic regions.



Example 2

As a demonstration of the potential complexity of a figure with respect to atomic regions, we consider another example from the paper.



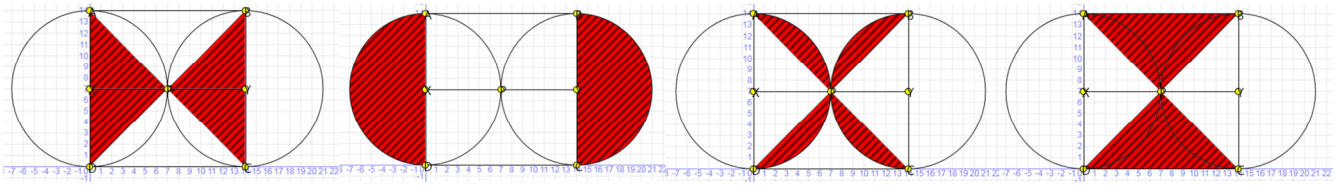
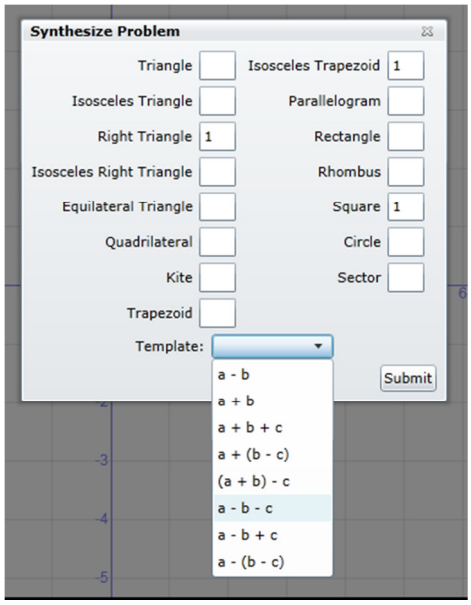


Figure Synthesis

From the user interface we dictate the general type of figure we will synthesize based on a specified set of shapes and selection of a template. In this case, we are attempting to generate some of the same figures depicted in the paper.



After submission, of the shapes and template, a sample figure is drawn with shaded regions in the interface. Below are three sample constructions.