A2 Question 1.5: Graphical determination of the efficient set and the Pareto front (Part 1)

We use the KKT theorem for unconstrained optimization or the level set theorem in order to identify efficient points. Here they are given by the tangential points (with equal slope -> KKT). Because we do not yet know, where the efficient set is, we start with plotting $s, r_1$ in the region $[1cm, 10cm]$, in which we suspect the efficient set to be located.

**COMMAND IN wxMaxima:**
```
contour_plot([0.333*3.145*(1+1.618+1.618^2)*vs*vr1^2, 3.145*2.618*vs*vr1+3.145*vr1^2, [vr1, 1, 10], [vs, 1, 10]],
[gnuplot_preamble,"set cntrparam levels 20;set key rmargin; set xlabel 'r1'; set ylabel 's'')];
```

Efficient set, upper part (approx.)

Zoom is required to get a better picture of the feasible subset:
See next slide

Technique Note: Volume is depicted in b/w. To achieve this I used PowerPoint. Format graphics on a copy of the image, and set colors to greylevels. Then in the other graphics set transparent color to white. Now both plots were put on top of each other. The legends were assembled using color transformations and crop tool on copies of the image. A second plot was added to zoom in the region from 1cm to 4cm, because the density of the level curves was too low.
**A2 Question 1.5: Graphical determination of the efficient set and the Pareto front (Part 2)**

**COMMAND IN wxMaxima:**

```
contour_plot([0.333*3.145*(1+1.618+1.618^2)*vs*vr1^2,3.145*2.618*vs*vr1+3.145*vr1^2,[vr1, 1, 4],[vs, 1, 4]],
[gnuplot_preamble,"set cntrparam levels 20;set key rmargin; set xlabel 'r1'; set ylabel 's''"]);
```

**Points on the Pareto front**

<table>
<thead>
<tr>
<th>f1=A (approx.)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>30</td>
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</tr>
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