Inna Williams
Computer Problems
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Section 3.1

###
Problem 1
****
a. Apply the following world population figures to estimate the 1980 population, using (a) the
straight line through the 1970 and 1990 estimates; Compare with the 1980
estimate of 4452584592.
###

```
>   with(plots):with(CurveFitting);
```
$[ArrayInterpolation, BSpline, BSplineCurve, Interactive, LeastSquares, Lowess,$ **(1)**
    $PolynomialInterpolation, RationalInterpolation, Spline, ThieleInterpolation]$

```
>  population_data_1980 := 4452584592
```
$$population\_data\_1980 := 4452584592 \qquad \textbf{(2)}$$

```
> interpolated_2_population_data := [[1970, 3707475887], [1990, 5281653820]]:
    p1 := plot(interpolated_2_population_data, style = point, color = black):
    display(p1)
```
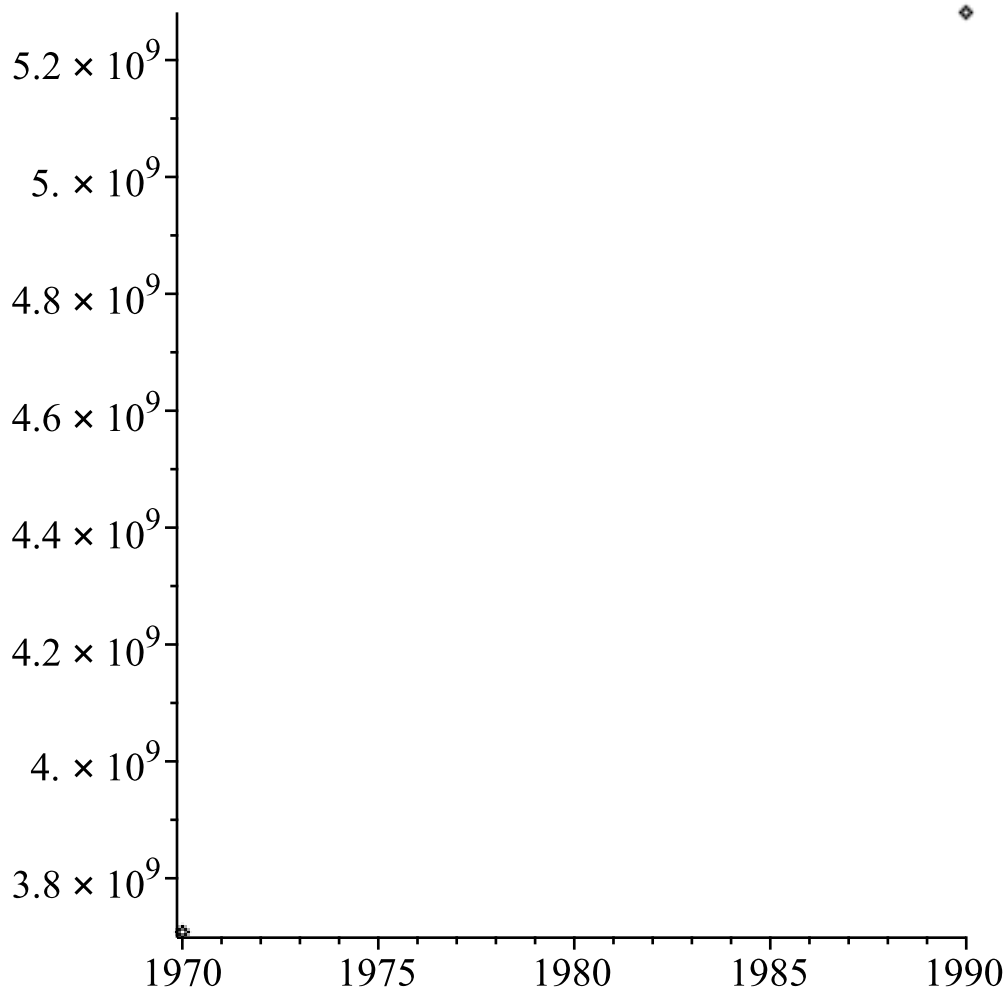
5.2×10^9

$5. \times 10^9$

4.8×10^9

4.6×10^9

4.4×10^9

4.2×10^9

$4. \times 10^9$

3.8×10^9

1970   1975   1980   1985   1990

> `poly:=x→PolynomialInterpolation(`*interpolated_2_population_data,*
   x)

$$poly := x \mapsto PolynomialInterpolation(interpolated\_2\_population\_data, x) \qquad \textbf{(3)}$$

> `interpolated_2_population_data_1980 := evalf(poly(1980))`

$$interpolated\_2\_population\_data\_1980 := 4.494564854 \, 10^9 \qquad \textbf{(4)}$$

> `absolute_error_2_1980 := abs(population_data_1980 -`
   `interpolated_2_population_data_1980)`
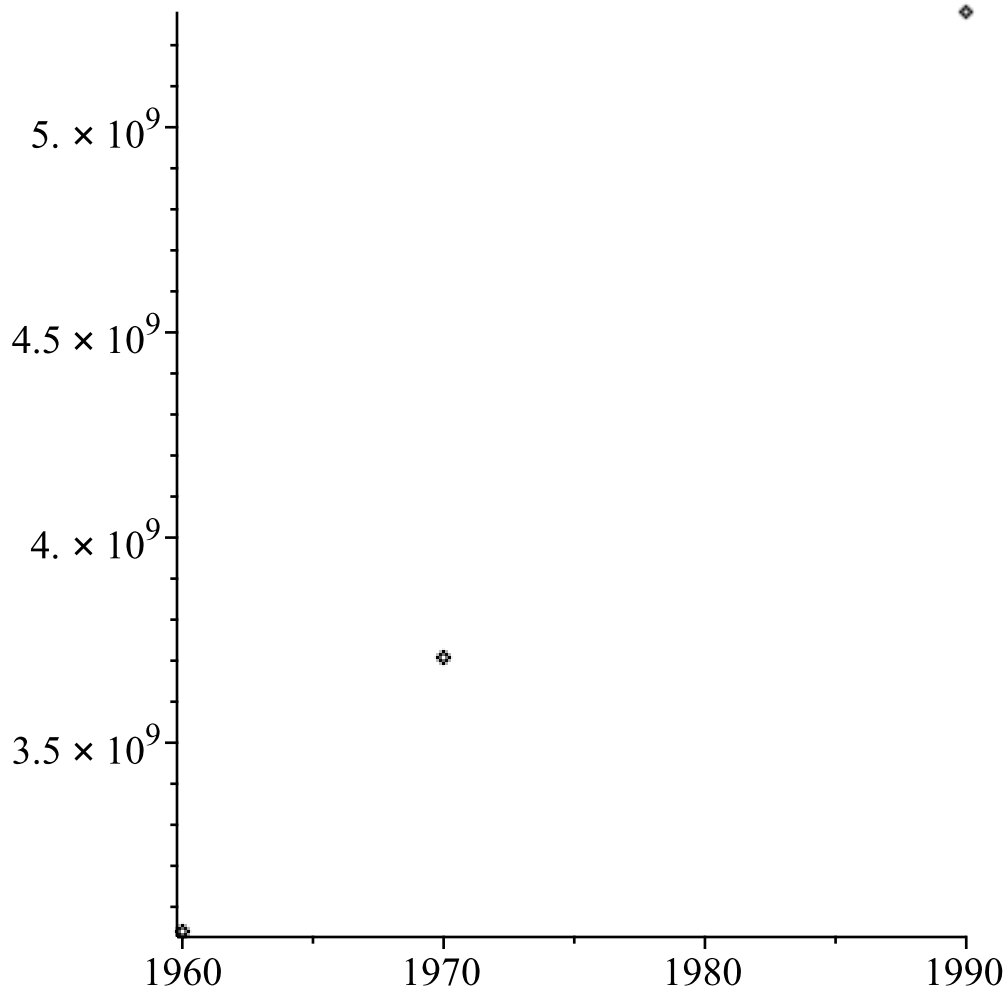
$$absolute\_error\_2\_1980 := 4.1980262 \, 10^7 \qquad \textbf{(5)}$$

> `relative_error_2_1980 := evalf(100 * absolute_error_2_1980 /`
   `population_data_1980)`

$$relative\_error\_2\_1980 := 0.9428290723 \qquad \textbf{(6)}$$

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b.Apply the following world population figures to estimate the 1980 population, using
 (b) the parabola through the 1960, 1970, and
1990 estimates; Compare with the 1980 estimate of 4452584592

> $interpolated\_3\_population\_data := \left[\left[1960, 3039585530\right], \left[1970, 3707475887\right], \left[1990,\right.\right.$
  $\left.\left.5281653820\right]\right]:$ **p1** $:=$ **plot**$\left(interpolated\_3\_population\_data, \text{style} = \text{point}, \text{color} = \text{black}\right):$
  display$\left(\text{p1}\right)$

> **poly** $:=$ **x→PolynomialInterpolation**$\left(interpolated\_3\_population\_data, \text{x}\right)$

$$poly := x \mapsto PolynomialInterpolation(interpolated\_3\_population\_data, x) \qquad \textbf{(7)}$$

> **interpolated_3_population_data_1980 := evalf(poly(1980))**

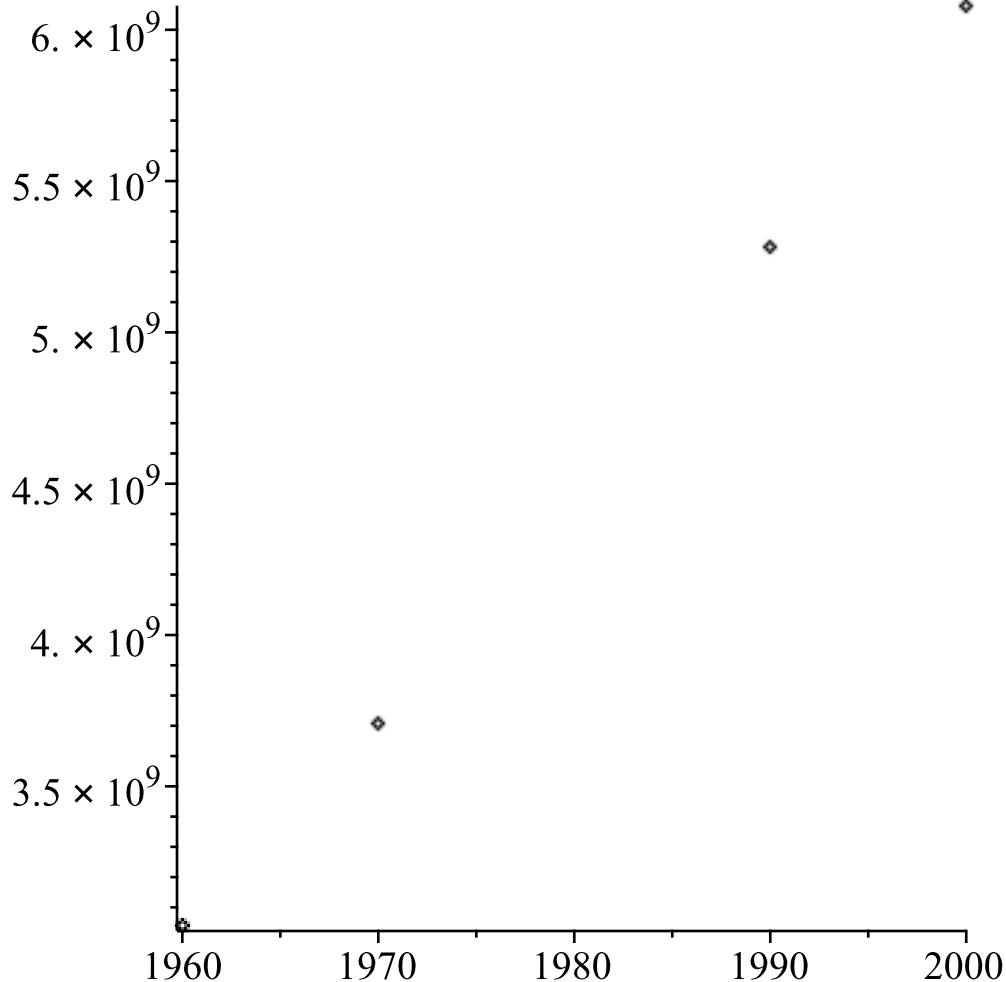$$interpolated\_3\_population\_data\_1980 := 4.454831984 \, 10^{9} \qquad \textbf{(8)}$$

> **absolute_error_3_1980 := abs(population_data_1980 -**
  interpolated_3_population_data_1980)

$$absolute\_error\_3\_1980 := 2.247392 \, 10^{6} \qquad \textbf{(9)}$$

> **relative_error_3_1980 := evalf(100 * absolute_error_3_1980 /**
  population_data_1980)

$$relative\_error\_3\_1980 := 0.05047387542 \qquad \textbf{(10)}$$

##

c. Apply the following world population figures to estimate the 1980 population, using (a) the straight line through the 1970 and 1990 estimates; (c) the cubic curve through all four data points. Compare with the 1980 estimate of 4452584592.

> $interpolated\_4\_population\_data := \big[\,[\mathbf{1960,\ 3039585530}],\,[\mathbf{1970,\ 3707475887}],$
> $[\mathbf{1990,\ 5281653820}],\,[2000,\,6079603571]\,\big] : \mathbf{p1} :=$
> $\mathbf{plot}(interpolated\_4\_population\_data, \mathbf{style=point}, \mathbf{color=black}) :$
> $\mathbf{display}(\mathbf{p1})$

> $\mathbf{poly} := \mathbf{x \rightarrow PolynomialInterpolation}(interpolated\_4\_population\_data, \mathbf{x})$
> $\qquad poly := x \mapsto PolynomialInterpolation(interpolated\_4\_population\_data, x)$ **(11)**

> `interpolated_4_population_data_1980 := evalf(poly(1980))`
> $\qquad\qquad interpolated\_4\_population\_data\_1980 := 4.472888288\,10^9$ **(12)**

> `absolute_error_4_1980 := abs(population_data_1980 -`
> `interpolated_4_population_data_1980)`
> $\qquad\qquad absolute\_error\_4\_1980 := 2.0303696\,10^7$ **(13)**

> `relative_error_4_1980 := evalf(100 * absolute_error_4_1980 /`
> `population_data_1980)`
> $\qquad\qquad relative\_error\_4\_1980 := 0.4559979846$ **(14)**

##

Answer · (a) · (b) · (c):

estimate of **1980**	= 4452584592
straight line through the 1970 and 1990 estimates	= 4494564854
the parabola through the 1960, 1970, and 1990 estimates	= 4454831984
the cubic curve through all four data points	= 4472888288

The best approximation is the parabola through the 1960, 1970, and 1990 estimates
with absolute error = 2247392 and relative error = 0.05 %

The second best approximation is the cubic curve through all four data points estimates
with absolute error = 20303696 and relative error = 0.46 %

The worse is the the straight line through the 1970 and 1990 estimates
with absolute error = 41980262 and relative error = **0.94 %**

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