MA162: Finite mathematics

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University of Kentucky

March 25, 2010

SCHEDULE:

- HW C1 is due Monday, Mar 29th, 2010.
- HW C2 is due Monday, Apr 5th, 2010.
- HW C3 is due Sunday, Apr 11th, 2010.
- Exam 3 is Monday, Apr 12th, 5:00pm-7:00pm.
- **All** alternate exam takers must signup (on mathclass.org) by April 6th.

Today we will cover 6.1: sets.

5.3: Quiz review

- How long does it take to pay off a \$1000 debt at 12% interest compounded monthly if you make regular monthly payments of \$15?

- Write down what we know:

$$\begin{aligned} P &= \$1000 \\ R &= \$15 \\ i &= 12\%/12 = 0.01 \\ n &= ? \\ A &= \begin{cases} \$1000 \cdot (1.01)^n & \text{owed} \\ \$15 \cdot ((1.01)^n - 1)/0.01 & \text{paid} \end{cases} \end{aligned}$$

- Write down an algebraic goal:
  Solve $\$1000 \cdot (1.01)^n = \$15 \cdot ((1.01)^n - 1)/0.01$ for n.

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Basic algebra

- Solve $\$1000 \cdot (1.01)^n = \$15 \cdot ((1.01)^n - 1)/0.01$ for n.
- Solving for n is going to mean solving for $(1.01)^n$ first.
- Set $x = 1.01^n$ so we remember to solve for x
- Solve $\$1000(x) = \$15(x - 1)/0.01$ for x
- $10x = 15x - 15$, $15 = 5x$, $x = 3$
- $1.01^n = 3$, $n = \log(3)/\log(1.01) \approx 110.4$ months

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5.3: Quiz review

- How long does it take to pay off \$1000 debt at 12% compounded monthly if you pay \$30 the first three months, but \$15 every month thereafter?
- Well: pay the first three months, then you are back to problem #1.
- First month: \$1000 + \$10 - \$30 = \$980
- Second month: \$980 + \$9.80 - \$30 = \$959.80
- Third month: \$959.80 + \$9.60 - \$30 = \$939.40
- Now how long does it takes to pay off \$939.40 at 12% and \$15 per month?
- Solve $\$939.40(1.01)^n = \$15((1.01^n) - 1)/0.01$ for n

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Basic algebra

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- Set $x = 1.01^n$ and solve $\$939.40(x) = \$15(x - 1)/0.01$ for x
- $x = 15/(15 - 9.394)$, so $n = \log(15/(15 - 9.394))/\log(1.01) \approx 98.9$ months
- Don't forget to actually answer the question. Number pushing cannot run a business. How much sooner do you pay off the debt?
- 99 months at \$15 a month, 3 at \$30, so 102 total, compared to the 110 from before: 8 months sooner.
- Don't forget to check your answer! Is it reasonable that making **three** double payments now will save you **eight** payments later?
- Over the course of 8 years on a high interest debt like this, yes.

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- How long does it take to pay off a \$1000 debt at 12% compounded monthly if you charge \$300 to the debt every month, but pay back \$315 every month?
- Two possibilities: either they charge you interest on the \$300 that you pay back immediatly, or they don't.
- If not, then every month you pay back \$15 net. Exactly #1
- If so, then that \$300 earns another \$3 interest, so you pay back \$12 net. A tiny change to #1, but takes 180 months at that rate. Better to pay back \$18 at least.

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- Suppose you don't pay anything for the first year (and the fees are waived; lots of department stores do this). After that, you pay back \$15 per month. How much longer does it take?
- So let the first year run, you owe $\$1000 \cdot (1.01^{12}) = \$1126.83$
- Now pay it back, solve $\$1126.83 \cdot (1.01^n) = \$15 \cdot ((1.01^n) - 1)/0.01$
- Set $x = 1.01^n$, solve $\$1126.83(x) = \$15(x - 1)/0.01$
- $x = 15/(15 - 11.2683)$,
  $n = \log(15/(15 - 11.2683))/\log(1.01) \approx 139.8$
- Not counting the first year, that is 30 extra months (and 42 total)!
- Delaying starting for one year costs you nearly three more years

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5.3: Quiz review

- Suppose you want to pay off the \$1000 debt with regular monthly payments over a single year, but it earns 12% interest. How much should you pay each month?

- Setup table as before:

$$\begin{aligned} P &= \$1000 \\ R &= ? \\ i &= 12\%/12 = 0.01 \\ n &= 12 \\ A &= \begin{cases} \$1000 \cdot (1.01)^{12} & \text{owed} \\ R \cdot ((1.01)^{12} - 1)/0.01 & \text{paid} \end{cases} \end{aligned}$$

- Write down an algebraic goal:
  Solve $\$1000 \cdot (1.01)^{12} = R \cdot ((1.01)^{12} - 1)/0.01$ for R.

- $\$1126.83 = R(12.6825)$, so $R = \$88.85$ per month

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6.1: Life before sets

- We are going to be doing some hard counting problems.
- To make it easier, we need to be able to talk about the things we are counting.
- When we counted money, or acres, or ounces of jamba juice we had variables to denote the number. $x = 5$ acres, or $y = 10$ ounces.
- If you had \$5 in one bank account and \$10 in another, you had $\$5+\$10 = \$15$ total. The numbers were all that mattered.
- Unfortunately life rarely divides nicely into separate accounts, and numbers cannot describe many of these aspects.

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- To make it easier, we need to be able to talk about the things we are counting.
- When we counted money, or acres, or ounces of jamba juice we had variables to denote the number. $x = 5$ acres, or $y = 10$ ounces.
- If you had \$5 in one bank account and \$10 in another, you had \$5+\$10 = \$15 total. The numbers were all that mattered.
- Unfortunately life rarely divides nicely into separate accounts, and numbers cannot describe many of these aspects.

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6.1: More than numbers can say

- We are going to be counting more complicated things now.
- If your friend Jimmy says you can borrow their car Monday, Tuesday, and Wednesday, then that is 3 days you've got a car.
- If your friend Timmy says you can borrow their car Tuesday, Thursday, and Friday, then that is 3 days you've got a car.
- How many days total can you borrow a car?
- Well, Monday, Tuesday, Wednesday, Thursday, Friday is five days.
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6.1: Sets to name the things we are counting

- If we let J be the days Jimmy lets us have the car, then

$$J = \{ \text{ Monday, Tuesday, Wednesday } \}$$

- If we let T be the days Timmy lets us have the car, then

$$T = \{ \text{ Tuesday, Thursday, Friday } \}$$

- The days when at least one of them let us use the car is the **union** of the two sets

$$J \cup T = \{ \text{ Monday, Tuesday, Wednesday, Thursday, Friday } \}$$

- The days when both of them let use the car is the **intersection** of the two sets

$$J \cap T = \{ \text{ Wednesday } \}$$

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6.1: More sets

- We can have sets of numbers $A = \{1, 2, 3\}$ and $B = \{3, 4, 5\}$, then:
- $A \cup B = \{1, 2, 3, 4, 5\}$
- $A \cap B = \{3\}$
- $A - B = \{1, 2\}$ is the difference, the things in A that are not in B
- We can write down sets in funny ways:
  $A = \{3, 2, 1\} = \{1, 1, 1, 1, 1, 2, 2, 3\}$
- We can describe them in words, "A is the set of positive integers whose square is a one digit number."

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6.1: Summary

- Today we learned about **sets**, **union**, **intersection**, and **difference**.
- You are now ready to complete HWC1 and HWC2
- Next week we will begin counting in earnest; it is best to be done with the interest homework before then. Both are hard, but they are not related.
- Make sure to take advantage of office hours