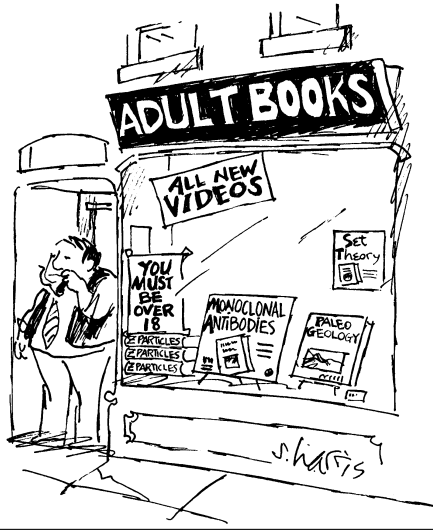


Sex, Religion, Politics



One-Slide Summary

- The **substitution model** for evaluating Scheme does not allow us to reason about mutation. In the **environment model**:
- A **name** is a **place** for storing a value. **define**, **cons** and function application **create** places. **set!** **changes** the value in a place.
- Places live in **frames**. An **environment** is a frame and a pointer to a **parent frame**. The **global environment** has no parent.
- To **evaluate** a name, **walk up** the frames until you find a definition.
- A **golden age** is a period when knowledge or quality increases rapidly.

#2

Outline

- Golden Ages
- Names and Places
- Environment Model
- Interested in random weekly emails about available CS 150 **tutoring**? Send email to the course staff (or me) to get on that list.

#3

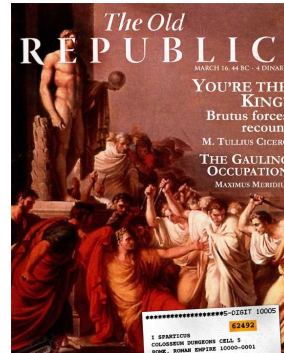
The Real Golden Rule?

Why do fields like astrophysics, medicine, biology and computer science have “endless golden ages”, but fields like ...

- rock n' roll (1962-1973, or whatever was popular when you were 16)
- music (1775-1825)
- philosophy (400BC-350BC?)
- art (1875-1925?)
- soccer (1950-1966)
- baseball (1925-1950?)
- movies (1920-1940?)

have short golden ages?

Think about it over the break!



Golden Ages or Golden Catastrophes?

Malthusian Catastrophe

Reverend Thomas Robert Malthus, *Essay on the Principle of Population*, 1798

“The great and unlooked for discoveries that have taken place of late years in natural philosophy, the increasing diffusion of general knowledge from the extension of the art of printing, the ardent and unshackled spirit of inquiry that prevails throughout the lettered and even unlettered world, ... have all concurred to lead many able men into the opinion that we were touching on a period big with the most important changes, changes that would in some measure be decisive of the future fate of mankind.”



Source: The Warren J. Samuels Portrait Collection at Duke University

Malthus' Postulates

"I think I may fairly make two postulata.

- First, that food is necessary to the existence of man.
- Secondly, that the passion between the sexes is necessary and will remain nearly in its present state.

These two laws, ever since we have had any knowledge of mankind, appear to have been fixed laws of our nature, and, as we have not hitherto seen any alteration in them, we have no right to conclude that they will ever cease to be what they now are..."

Malthus' Conclusion

"Assuming then my postulata as granted, I say, that the power of population is indefinitely greater than the power in the earth to produce subsistence for man.

Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison of the second."

Malthusian Catastrophe

- Population growth is geometric: $\Theta(k^n)$ ($k > 1$)
- Food supply growth is linear: $\Theta(n)$

What does this mean as $n \rightarrow \infty$?

Food per person = food supply / population
= $\Theta(n) / \Theta(k^n)$

As n approaches infinity, food per person approaches zero!

Liberal Arts Trivia: American Studies

- This American social activist and leading figure of the woman's movement crafted the Declaration of Sentiments. Its presentation, at the first women's rights convention in Seneca Falls, is often credited with initiating the first woman's suffrage movement in the USA. Beyond voting rights, her work addressed parental and custody rights, employment and income rights, property rights, divorce laws, and birth control.

Liberal Arts Trivia: Classics and Drama

- This ancient Greek tragedian playwright wrote Ajax, **Antigone**, Trachinian Women, **Oedipus the King**, Electra, Philoctetes and Oedipus at Colonus. He influenced the development of the drama by adding a third actor (reducing the importance of the chorus in the presentation of the plot) and putting a greater emphasis on character development.

Malthus' Fallacy



Malthus' Fallacy

He forgot how he started:

“The great and unlooked for discoveries that have taken place of late years in natural philosophy, the increasing diffusion of general knowledge from the extension of the art of printing, the ardent and unshackled spirit of inquiry that prevails throughout the lettered and even unlettered world...”

Golden Age of Food Production

- Agriculture is an “endless golden age” field: production from the same land increases as $\sim \Theta(1.02^n)$
- Increasing knowledge of farming, weather forecasting, plant domestication, genetic engineering, pest repellants, distribution channels, etc.

Growing Corn

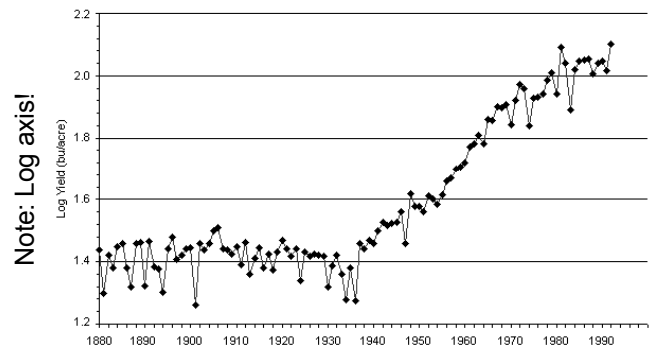


1906: < 1,000
pounds per acre

2006: 10,000
pounds per acre

Michael Pollan's *The Omnivore's Dilemma*

Corn Yield



<http://www.agbioforum.org/v2n1/v2n1a10-ruttan.htm>

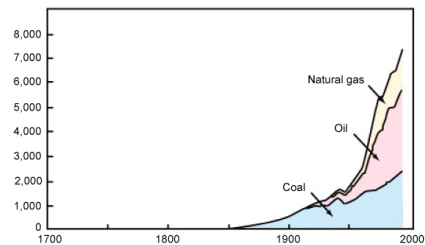
Example: Norman Borlaug

- Father of the Green Revolution
 - Nobel Peace Prize, Presidential Medal of Freedom, Congressional Gold Medal (one of five to win all three), India's Padma Vibhushan
- "At a time when doom-sayers were hopping around saying everyone was going to starve, Norman was working. He moved to Mexico and lived among the people there until he figured out how to improve the output of the farmers. So that saved a million lives. Then he packed up his family and moved to India, where in spite of a war with Pakistan, he managed to introduce new wheat strains that quadrupled their food output. So that saved another million. You get it? But he wasn't done. He did the same thing with a new rice in China. He's doing the same thing in Africa -- as much of Africa as he's allowed to visit. **When he won the Nobel Prize in 1970, they said he had saved a billion people.** That's BILLION! BUH! That's Carl Sagan BILLION with a "B"! And most of them were a different race from him. **Norman is the greatest human being, and you probably never heard of him.**"
 - Penn Jillette, on the show Penn & Teller

Upcoming Malthusian Catastrophes?

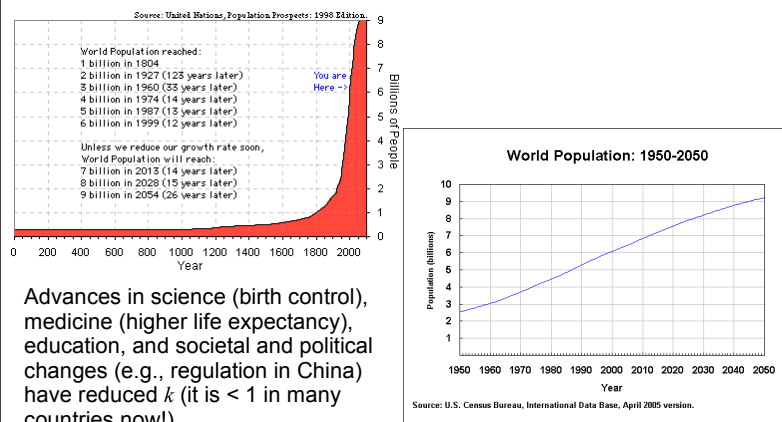
- Human consumption of fossil fuels grows as $\Theta(k^n)$ (fairly large k like 1.08?)
- Available fuel is constant (?)

Fig. 3: Trends in World Fossil Fuel Consumption (Million tons oil equivalent)



Source: Environment Agency's "White Paper on the Environment" (1998)
http://www.wp.mext.go.jp/hakusyobook/hpag200001/hpag200001_2_006.html

Malthus was wrong about #2 Also



“Cornucopian View”

- Few resources are really finite
- All scientific things seem to have endless golden ages
- (We hope) Human ingenuity and economics and politics will solve problems before they become catastrophes
 - No one will sell the last gallon of gas for \$2.35

“Kay”-sian View

The best way to predict the future is to invent it.
— Alan Kay

Charge

- When picking majors, pick a short golden age field that is about to enter its short golden age
 - This requires vision and luck!
- Play it safe by picking an endless golden age field (CS is a good choice for this!)

Liberal Arts Trivia: French Literature

- This 19th century French writer and political activist was an exponent of the Romantic movement in France. Two of his volumes of poetry, *Les Contemplations* and *La Légende des siècles* are particularly critically acclaimed, and he is sometimes called the greatest French poet. Outside of France he is perhaps best known for *Les Misérables* and *Notre-Dame de Paris*.
- Bonus points: Give Valjean's prisoner number.

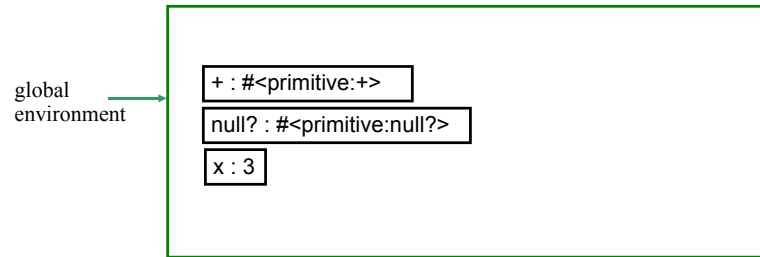
Liberal Arts Trivia: Mathematics

- This is a major area of mathematics that combines developments and concepts from set theory and geometry, such as those of dimension, space, transformation and shape. Of particular importance to this field are homoemorphisms, which can viewed as continuous functions with continuous inverses. Subfields include point-set, algebraic, and geometric.

Review: Names, Places, Mutation

- A **name** is a **place** for storing a value.
- A **define** creates a new place.
- A **cons** application creates two new places, the **car** and the **cdr**.
- A **frame** is a collection of places.
- An **environment** is a frame and a pointer to a parent environment.
- The **global environment** has no parent.
- **(set! name expr)** changes the value in the place **name** to the value of **expr**.

Environments

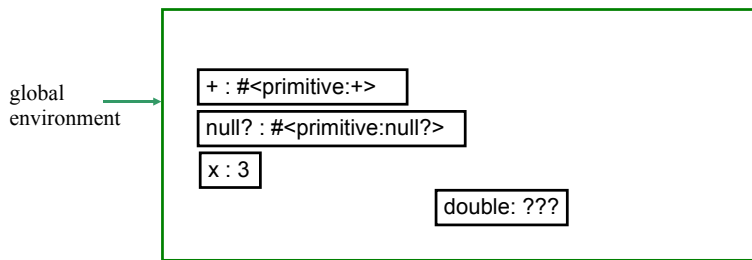


The global environment points to the outermost frame. It starts with all Scheme primitives.

```
> (define x 3)
>
```

#26

Environments & Procedures



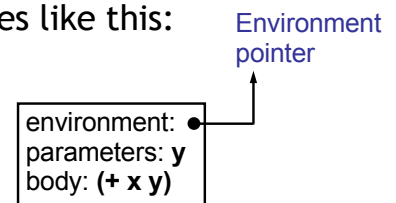
The global environment points to the outermost frame. It starts with all Scheme primitives.

```
> (define (double (lambda (x) (+ x x)))
>
```

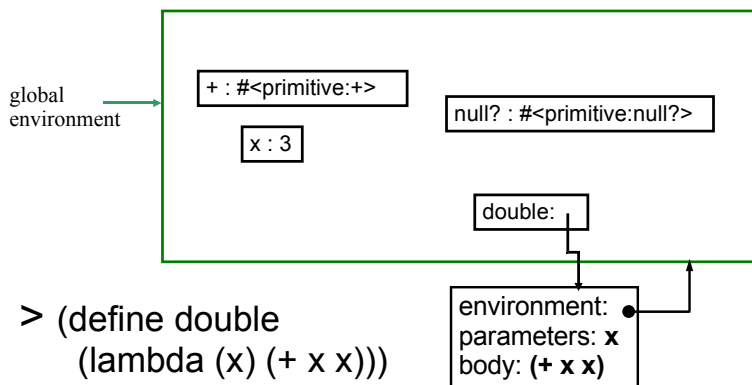
#27

How To Draw Procedures

- A procedure needs **both code and an environment**
 - Think of **make-incrementer ...** where are **x** and **y**?
 - (define (**make-incrementer** x)
 - (lambda (y) (+ x y))
- We draw pictures like this:



Procedures



```
> (define double
  (lambda (x) (+ x x)))
```

#29

Application

- Old rule: (Substitution model)

Apply Rule 2: Constructed Procedures.
To apply a constructed procedure, **evaluate** the body of the procedure with each formal parameter replaced by the corresponding actual argument expression value.

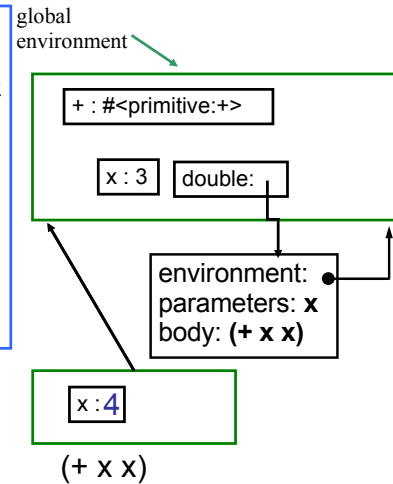
#30

New Application Rule 2:

1. **Construct a new environment**, whose parent is the environment to which the environment pointer of the applied procedure points.
2. **Create places** in that frame for each parameter containing the value of the corresponding operand expression.
3. **Evaluate the body in the new environment**. Result is the value of the application.

#31

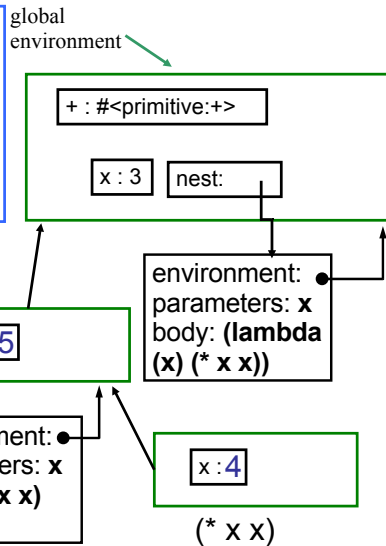
1. Construct a new environment, parent is procedure's environment pointer
2. Make places in that frame with the names of each parameter, and operand values
3. Evaluate the body in the new environment



> (double 4)
8

#32

1. Construct a new environment, parent is procedure's environment pointer
2. Make places in that frame with the names of each parameter, and operand values
3. Evaluate the body in the new environment



> (define nest
(lambda (x)
(lambda (x)
(* x x))))
> ((nest 5) 4)
16

#33

Evaluation Rule 2: Names

A *name* expression evaluates to the value associated with that name.

To find the value associated with a name, look for the name in the frame associated with the evaluation environment. If it contains a place with that name, the value of the name expression is the value in that place. If it doesn't, the value of the name expression is the value of the name expression evaluated in the parent environment if the current environment has a parent. Otherwise, the name expression evaluates to an error (the name is not defined).

#34

evaluate-name

```
(define (evaluate-name name env)
  (if (null? env) (error "Undefined name: ...")
      (if (frame-contains name (get-frame env))
          (lookup name (get-frame env))
          ;; otherwise, check with the parent
          (evaluate-name name
                          (parent-environment (get-frame
                                                env))))))
```

#35

Homework

- PS 5 due *Friday*
 - Extension granted.
- Read Course Book 9 and 10

#36