Ex C5/C6

- Ex C5
  1. $\forall x \neg(x \text{ 🗣} x)$
  2. $\forall x \forall y ((x \text{ 🗣} y) \rightarrow (y \text{ 🗣} x))$
  3. $\forall x \forall y \forall z (((x \text{ 🗣} y) \wedge (y \text{ 🗣} z)) \rightarrow \neg(x \text{ 🗣} z))$
     called intransitive
  4. $\forall x \exists y \exists z (y \neq z \wedge (x \text{ 🗣} y) \wedge (x \text{ 🗣} z))$
  – Smallest party?

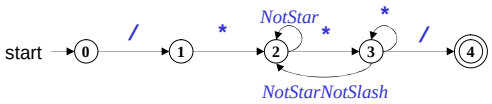
at least?
at most?
must/can have?
talking to self?

- Ex C6
  – Solutions will be posted this afternoon

Java Comments (Comp A)

- A standard C-style comment, where all of the characters between `/*` and `*/` are ignored.
- A collection including `/**/`, `/* */`, `/*a*/`, `/*b*/`, etc.

FSA



Cf. a standard C-style comment, where all of the characters between `/*` and `*/` are ignored.

Regular Expression

`/*` *NotStar*`*` `*(*)*` (*NotStarNotSlash* *NotStar*`*` `*(*)*`)`* `/`
where

- Σ = the set of acceptable characters
- *NotStar* = $\Sigma - \{*\}$
- *NotStarNotSlash* = $\Sigma - \{*, /\}$

A variant of regular expression used in Unix

```
\/ \* [^\*]* [\*]+ ( [^\/\*] [^\*]* [\*]+ )* \/
```


Compiler Compiler

- Program to build compilers
- Most compilers contain a FSA to deal with string patterns, e.g., FP numbers, variable names, comments, etc.
- A compiler compiler will need some specification to build a FSA.

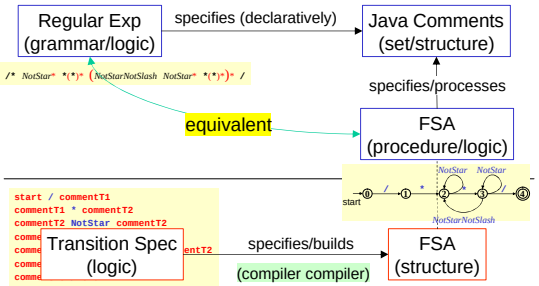
FSA Transitions

Transition spec: State × Input → State

```
1.  start / commentT1
2.  commentT1 * commentT2
3.  commentT2 NotStar commentT2
4.  commentT2 * commentT3
5.  commentT3 NotStarNotSlash commentT2
6.  commentT3 * commentT3
7.  commentT3 / end
```

Taken from a spec file actually used for constructing a mini Java compiler

Logic-Structure Connection



FSA Variations

- Deterministic
  - At most one transition for each pair of state and input
  - Transition ⇒ Function
- Nondeterministic
  - Possibly multiple transitions for each pair of state and input
  - Transition ⇒ Relation
- Make deterministic for practical purposes

Preview

Poker

Scenario

- In Las Vegas, playing poker with $1M at stake
- Your hand: Flush (e.g., all ♦)
- Your guess of an opponent's hand: Full house (e.g., 7♣, 7♦, 7♥, 8♠, 8♦)
- Forgot which one is stronger, but (strategically) could not ask
- So, decided to compute which one is less likely (lower probability) ...

Unit C6: Counting/Probability

Today

- Apply probability and counting ideas to analyze poker hands

Probability

- One in 1,000,000
- 10 winning tickets among 1,000,000
- Probability of an event =

Probability?

$$\frac{\text{the number of possibilities for the event}}{\text{the number of all the possibilities}}$$

An event may involve multiple cases.

Flush

- Deck of 52 cards
  - 13 numbers (A, 2, ..., 10, J, Q, K) for four suit (♣, ♦, ♥, ♠)
- A hand in poker (this type): 5 cards
- Number of different hands of Flush (F)
- Number of all possible hands (P)
- Probability = F / P

Permutation

- The number of different *ordering* of r objects taken from n objects
  - Notation: $P(n, r)$
- Computation

  $P(n, r) = n \times (n-1) \times ... \times (n-r+1) = n!/(n-r)!$
- Example
  - Number of 3-letter words (from lower-case alphabet):

    $P(26, 3) = 26 \times 25 \times 24 = 15{,}600$

Combination

- The number of different *choices* of r objects taken from n objects
  - Notation: $C(n, r)$
- Computation

  $C(n, r) = P(n, r) / r! = n!/(r!\,(n-r)!)$
- Example
  - Number of sets with cardinality 3 (from lower-case alphabet):

    $C(26, 3) = (26 \times 25 \times 24) / (3 \times 2 \times 1) = 2{,}600$

Group Exercise 1

- Explain how to compute the number of all possible hands consisting of 5 cards (from the standard deck of 52 cards).
  - No need to actually calculate. You can just give a formula.

How serious will you be if you may win or lose $1M?

Group Exercise 2

A. Explain how to compute the number of Flush hands (from the standard deck of 52 cards).
   A. No need to actually calculate. You can just give a formula.

B. Explain how to compute the probability of Flush

Probability Basics

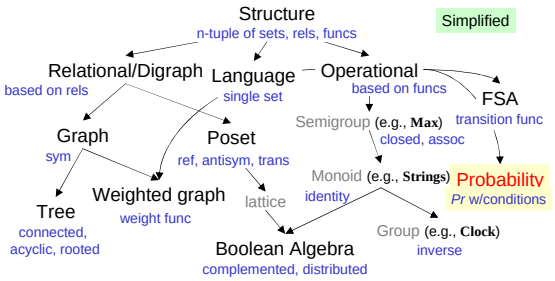
- Sample space, Ω: Set of all possible outcomes
- Event: $A \subseteq \Omega$ why subset, not member?
- Probability measure (a function) on Ω: $Pr(A)$ has a real value and some other properties (next slide)

Probability as Structure

Probability = $(\Omega, Pr, \mathbf{R})$

- Ω: Sample space (a non-empty set)
- $\mathbf{R}$: set of real numbers
- Pr: _____ (type)
- **Probability** must satisfy the following conditions
  - $Pr(\Omega) = 1$
  - $A \subseteq \Omega \Rightarrow Pr(A) \geq 0$
  - $Pr(A \cup B) = Pr(A) + Pr(B)$ for disjoint A and B

Organization of Structures



Multiplication Principle

- Suppose that two events occur *in sequence*, where the first event has n possibilities and the second, m. The number of possibilities for the sequence is $n \times m$.
- Examples
  - Choose 5 numbers, then choose a suit
  - Coin tossing single time vs. k times
  - Choice of 5 appetizers and 9 main dishes: 45

Addition Principle

- Consider two *disjoint* sets of objects, where the first set has n elements and the second, m. The number of objects in the two set is $n + m$.
- Example
  - Consider 2 cats and 2 humans (and no hybrids). Then, there are 4 objects.
- Implication to probability: additive as well

Section Summary

- Probability
  - As an operational structure with special conditions
- Counting
  - Permutation (order relevant)
  - Combination (order irrelevant)
- Principles
  - Additive: independent events
  - Multiplicative: sequential events

Group Exercise 3

Rank the following hands

- Flush (e.g., ♦2, ♦4, ♦5, ♦8, ♦9)
- Four of kinds? cards (e.g., ♣2, ♦2, ♥2, ♠2, *another*)
- Full house (e.g., ♣2, ♦2, ♥2, ♠7, ♣7)
- Straight (e.g., ♣2, ♦3, ♥4, ♠5, ♣6)

No review/upgrade period

Module C Evaluation Workshop

- Fri., Nov. 14, class time (next class meeting)
- Review the relevant part of the syllabus and the on-line handbook
- Re-use your manila folder or large envelope
- Complete and bring "Take-Home Exercise Self-Evaluation Form" (distributed today) along with exercises
- Exercise C5 will be checked on Tue. Solutions available that day.
- Complete and bring "Module C Comprehensive Exercises" (available on-line)
- Group evaluation sessions (open book): 20 min × 3
- "Comprehensive Exercise Self-Evaluation Forms" will be distributed that day (no need to print in advance)
- Submit all materials at the end of the s
- Mini Project Phase 2 due on Tue., No

New criteria; Preview on-line
Note: critical analysis includes positive aspects as well