Assigning Boy Scouts to Patrols

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MATH 480, Community Project

The Problem

We need to do a project so we can pass this class.

A Mathematical Interpretation

$1 \text{ enemy} + 1 \text{ enemy} = 0 \text{ survivors}$

The Objective Functions

1. **MinCut**. This is the traditional metric of a cut on a weighted graph and is the sum of the weights of the edges we would "cut" if we were to sever the edges between distinct patrols. More formally, for some partition I, J $I \neq J$, the MinCut is defined as:

$$MinCut(I, J) := \sum_{e=(i,j), i \in I, j \in J} c(e)$$

   We want this to be as low as possible.

2. **FriendCut**. This is the sum of the positive, or friendly edge weights within each patrol. That is, if $I_+ = \{e = (i,j) | i,j \in I, c(e) = 1\}$ is the the set of edges in patrol I with positive weight and $J_+ = \{e = (i,j) | i,j \in J, c(e) = 1\}$ is the set of edges in patrol J with positive weight, then (assuming all positive weights are 1):

$$FriendCut(I, J) := |I_+ \cup J_+|$$

   We want this to be as high as possible.

3. **EnemyCut**. This is similar to FriendCut, except we now measure the number of negative edges going from one scout to another within the same patrol. Let $I_- = \{e = (i,j) | i,j \in I, c(e) = -1\}$ be the the set of edges in patrol I with negative weight and $J_- = \{e = (i,j) | i,j \in J, c(e) = -1\}$ be the set of edges in patrol J with negative weight, then

$$EnemyCut(I, J) := |I_- \cup J_-|$$

   We want this to be as low as possible.

4. **AwkwardCut (+i)**. Same in all respects to MinCut, except for an additional penalty of i if there are two scouts, Scout A and Scout B, in the same patrol such that Scout A likes Scout B and Scout B dislikes Scout A.

$$AwkwardCut(I, J, i) := \left[\sum_{e=(k,j), k \in I, j \in J} c(e) \right] + i * |\{e_+ = (k,j), e_- = (j,k) : e_+, e_- \in I, c(e_+) = 1, c(e_-) = -1\}|$$

5. **HybridCut**. A convex combination of MinCut and FriendCut, each with equal weight (that is, half the MinCut loss plus half the FriendCut loss).

$$HybridCut(I, J) := \frac{1}{2} MinCut(I, J) + \frac{1}{2} FriendCut(I, J)$$

Our Solution

MinCut		**FriendCut**		**EnemyCut**	
Patrol 1	Patrol 2	Patrol 1	Patrol 2	Patrol 1	Patrol 2
Brandon	Christian	Brandon	Daniel	Brandon	Christian
Cameron	Daniel	Cameron	Darwin	Cameron	Jake
Colby	Jake	Christian	Jake	Colby	Jordan
Darwin	Jordan	Colby	Jordan	Daniel	Nathan
Evan	Nathan	Evan	Nathan	Darwin	Patrick
Tommy	Patrick	Tommy	Patrick	Evan	Timmy
	Timmy		Timmy	Tommy	

AwkwardCut (+1)		**AwkwardCut (+2)**		**HybridCut**	
Patrol 1	Patrol 2	Patrol 1	Patrol 2	Patrol 1	Patrol 2
Brandon	Christian	Brandon	Cameron	Brandon	Christian
Cameron	Daniel	Christian	Evan	Cameron	Daniel
Colby	Jake	Daniel	Evan	Colby	Darwin
Darwin	Jordan	Darwin	Nathan	Evan	Jake
Evan	Nathan	Jake	Timmy	Timmy	Jordan
Tommy	Patrick	Jordan	Tommy	Tommy	Nathan
	Timmy	Patrick			Patrick

Table: The partitions arrived at by minimizing each objective function

How Good Are These Solutions?

Method	**MinCut**	**FriendCut**	**EnemyCut**
MinCut	0	17	0
FriendCut	1	18	1
EnemyCut	2	15	0
AwkwardCut (+1)	0	17	0
AwkwardCut (+2)	1	18	2
HybridCut	0	18	1

Figure: The scores according to the three primary metrics.

Blocks

Block Title

You can also highlight sections of your presentation in a block, with it's own title

Theorem

There are separate environments for theorems, examples, definitions and proofs.

Example

Here is an example of an example block.

Summary

- The first main message of your talk in one or two lines.
- The second main message of your talk in one or two lines.
- Perhaps a third message, but not more than that.

- Outlook
  - Something you haven't solved.
  - Something else you haven't solved.

For Further Reading I

A. Author.
Handbook of Everything.
Some Press, 1990.

S. Someone.
On this and that.
Journal of This and That, 2(1):50–100, 2000.