



# NumberSense

## *Meet the Cast*

ADVANCED EDITION

# Spark & Anvil

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This advanced edition collects 5 chapter books from the NumberSense cast — each character embodies a different curricular primitive; together they teach the full subject.

Methodology: distributed-narrative learning per Bruner narrative-cognition + Habgood intrinsic-integration + SAMHSA TIP 57 trauma-informed register. Advanced edition: upper-middle-grade register (Wonder / Hatchet / Holes band) for readers ages 11-14 ready for longer sentences + more nuanced subtext.

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*For everyone who learns by reading between the lines.*

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# Introduction

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The NumberSense cast was authored to embody the curriculum, not decorate around it.

Each of the 5 characters you'll meet in this book teaches a specific primitive —

a particular tactic, a particular technique, a particular way of seeing.

Together they form an ensemble: the cast IS the curriculum.

Read in any order. Each chapter stands alone.

Each character also appears in the matching Spark & Anvil app (free, forever)

where you can practice what they teach.

This is the **Advanced Edition** — written for readers who are ready for longer sentences, layered subtext, and the trust that comes with not having every joke explained. The Standard Edition covers the same characters at a lighter register; pick whichever feels right for the reader at hand.

— *The editors at Spark & Anvil*

# Estimator Ernie



Estimator Ernie had not always been confident.

When he was eleven, he had been one of the worst kids in his class at math. He had not been bad at math because he was unintelligent — he had not been unintelligent, his teachers had agreed about that — he had been bad at math because he was slow at arithmetic. He had counted on his fingers longer than most kids did. He had been slow at multiplication tables. He had been slow at long division. The other kids in his class had finished worksheets before he had finished half. He had been called slow so often that he had started believing it.

He had been twelve when his uncle had taken him to a baseball game.

The stadium had been enormous. Ernie had never been in a place that big before. He had sat in his seat and looked around at the stands and at the field and at the crowd, and he had said, mostly to himself, "There must be a million people here."

His uncle had laughed. His uncle had been a kind man who had not laughed in a mean way.

"A million is a lot of people," his uncle had said. "Let me show you something."

His uncle had taken out a pencil.

He had said: "Look around. The stands are made of rows. How many rows do you see in your section?"

Ernie had counted. Maybe forty.

"And each row has seats. How many seats per row in your section?"

Ernie had counted one row. About thirty.

"So how many seats in your section?"



Ernie had thought. Forty times thirty was — he wasn't sure. He thought it was around twelve hundred.

"That's right. About 1,200. Now look around. How many sections like ours are there in this stadium?"

Ernie had looked. He had counted the lower bowl. About thirty sections. Then the upper deck — another thirty maybe.

"About sixty sections, then. So how many seats total?"

Sixty times 1,200. Ernie had thought hard. That was 72,000.

"That's about right. The actual capacity of this stadium is 56,000. You overestimated, because the sections in the upper deck are smaller than the sections in the lower bowl. But you got within a factor of two."

"That's not very close."

"That is extremely close. You estimated the population of a stadium, in about ninety seconds, in your head, without using a single multiplication table. You are not bad at math. You are slow at arithmetic. Those are different things."

Ernie had not said anything for a long time.

His uncle had then said: "Most of the math you'll ever need in your life is estimation, not arithmetic. Arithmetic is what computers are for. Estimation is what humans are for. You're already good at the human part. The computers can do the rest."

Ernie had thought about this for the rest of the baseball game.

He had thought about it for the next twenty years.

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Maya, who was thirteen and had been using the NumberSense app daily for almost a year, asked Estimator Ernie about the stadium story.

She had asked it on a Tuesday afternoon, after a particularly hard daily prompt about the number of cars in a city. She had gotten the prompt wrong — way wrong — and she had been frustrated. Estimator Ernie had appeared and asked her if she wanted him to talk her through how he would have done it. She had said yes. He had walked her through, step by step, the way his uncle had walked him through the stadium.



When he had finished, she had said: "Why aren't you bad at math anymore?"

He had laughed.

"I'm still bad at arithmetic," he had said. "I haven't gotten much faster at multiplication tables since I was twelve. What I got good at was the OTHER thing. The thing my uncle showed me. The thing that turns out to be more useful in actual life than arithmetic."

"Is that true? Is estimation more useful than arithmetic in actual life?"

"For most adults, yes. Most adults don't compute exact answers. They estimate. They estimate how much groceries will cost. They estimate how long a drive will take. They estimate how much paint to buy. They estimate whether a tip is reasonable. They estimate whether a news headline makes sense — that's a big one. They estimate whether someone is lying to them about a number. They use exact arithmetic maybe one percent of the time, and even then only for things they really care about getting right."

"What if I want to be a scientist?"

"Then you'll need both. But you'll start with estimation. Every real scientific calculation begins with a back-of-the-envelope estimate. Without the estimate, you don't know whether your exact answer is reasonable. The estimate is the sanity check on the arithmetic. The estimate is the actual thinking."

Maya thought about this.

"My math teacher doesn't talk about it that way."

"Your math teacher is teaching you arithmetic. That's a real and useful thing. But estimation has gotten left out of most school math for the last hundred years, and that's bad. I'm here because nobody else is teaching it."

He had paused.

"Do you want to try the cars-in-a-city problem again? With my method this time?"

She had said yes.

He had walked her through. They had estimated the city's population (a million people, ballpark). They had estimated how many people had cars (about half, maybe, given the city). They had multiplied. They had gotten 500,000. The actual answer was 480,000. Maya had been within 5%.



She had stared at the screen.

"That was the same problem I just got wrong by a factor of ten."

"Yes."

"Why?"

"Because the first time, you tried to remember a number you didn't actually know. The second time, you built the number from things you DID know. That's the difference between guessing and estimating. The first one is the lottery. The second one is engineering."

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Maya practiced for the next year.

She practiced on real-life problems she encountered. She estimated how many words were in her math textbook. She estimated how much money her family spent on groceries each month. She estimated how many leaves were on a single tree outside her bedroom window. She estimated how long it would take her to walk to her friend's house. Sometimes her estimates were off by a lot. More and more often, they were within ten percent.

She started catching things grown-ups got wrong.

She caught her uncle saying once that a politician's claim about a budget number was off by a factor of a hundred. She caught her older brother saying a hiking trip would take six hours when, on her own estimate, it would take at least nine. She caught a news article reporting a statistic that, when she checked, was off from the underlying source by about thirty percent.

This last one — the news-article one — had been the thing Estimator Ernie had told her would happen eventually.

"That's the actual prize," he had said. "The prize isn't the jellybean jar. The prize isn't even getting good guesses right. The prize is being hard to lie to with numbers. The prize is being a person who notices when a number doesn't add up. Most adults aren't that person. You can be."

Maya had thought about this.

She had thought about her uncle, the kind one, who had told Ernie at twelve that he wasn't bad at math, just slow at arithmetic. She had thought about the stadium. She had thought about the jellybeans.

"Ernie," she had said.



"Yes?"

"I'm going to teach this to my younger cousin."

"Good."

"He's eight."

"Eight is a good age to start. He'll be very good at it by twelve."

"What's the first thing I should show him?"

Estimator Ernie had smiled.

"Take him to a baseball game," he had said. "Or anywhere big. A stadium, a mall, a stretch of beach. Show him how to break a big number into smaller numbers he already knows. Then multiply. Then notice that he just estimated a population in his head. Tell him he's not bad at math. Tell him he's good at the human part."

Maya had nodded.

She had taken her cousin to a baseball game that summer.

She had walked him through.

He had estimated the stadium population within a factor of two.

She had told him he was good at the human part.

He had glowed.

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<https://spark-and-anvil.com/cast/numbersense/estimator-ernie>

# Pivot Pia



Pivot Pia had a job most people did not understand.

Her job, when she described it to other adults at parties, sounded made-up. She would say: "I teach kids how to notice when the answer they're about to give doesn't match the question they were asked, and how to find easier equivalent questions hiding inside hard ones." The adults at the parties would nod politely. They would not understand. They would ask if that was, like, a math-tutoring thing. She would say no, it was not exactly a math-tutoring thing. They would change the subject.

This had stopped bothering her, mostly, because she had figured out something important about her job over the years.

The thing she had figured out was that her job was actually the most important pedagogy in middle school, but it was the one nobody had named.

Math class taught arithmetic. English class taught grammar. Science class taught facts. None of them taught the skill of noticing whether the question you were about to answer was actually the question that had been asked. None of them taught the skill of pivoting from a hard question to an easier equivalent one. These skills were everywhere in adult life. They were nowhere in school.

Pia had been trying to fix this, one kid at a time, for fifteen years.

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Maya, who was fourteen and had been using the app for two and a half years, asked Pivot Pia one afternoon why these skills weren't taught in school.

Pia had answered slowly.

"They're hard to test," she had said. "School likes things that can be tested. You can test arithmetic — there's a right answer to seventeen times nineteen. You can test grammar — there's a right answer to whether to use 'who' or 'whom.' You can test facts. You can't easily test 'did this student notice that their answer didn't match the question?' because the kid will say yes and you can't check."

"That seems like a bad reason to skip it."

"It's a terrible reason. But it's the reason. Schools test what's testable, not what's important. And the result is that kids spend twelve years learning to compute and then graduate without learning to ASK whether their answer makes sense. Which is the only thing that actually matters."



Maya had been quiet.

"How did you learn the skill?"

"I learned it from a woman named Beatrice. She was my eighth-grade math teacher. She wasn't a normal math teacher. She used to assign us problems that didn't have answers — or problems where the obvious answer was wrong — or problems where the question was unclear and we had to ask what it was really asking. She drove half the class crazy. The other half started thinking differently. I was the other half."

"What was an example of one of her problems?"

Pia had smiled the mischievous smile.

"This one. Try it. A car traveling at 60 miles per hour passes a sign. Two hours later, another car traveling at 80 miles per hour passes the same sign, going in the same direction. How far past the sign does the second car catch up with the first?"

Maya had thought.

She had said, "240 miles."

"Show me your work."

"After two hours, the first car is 120 miles past the sign. The second car catches up at a rate of 20 miles per hour relative to the first. So it takes 120 divided by 20 equals 6 hours to catch up. In 6 hours, the second car travels 80 times 6 equals 480 miles. But the question asks how far PAST the sign — wait. The second car traveled 480 miles past the sign. So 480 miles."

"That's right."

"I said 240 first. That was wrong."

"You said 240 first because you computed the distance the second car traveled MINUS the head start, instead of the distance from the sign. That's exactly the kind of mistake Beatrice would have flagged. You caught it in the show-your-work step. That's the skill. The show-your-work step is where you catch your own brain answering a different question than the one asked."



"How did Beatrice teach this?"

"By being mean about it. Loving mean. Every time we'd give an answer, she'd ask us to restate the question. We'd have to read it again, out loud, in front of the class. If our answer didn't match the question, she'd make us figure out why before she'd let us move on. She did this every day for a year. By the end of the year, half of us had installed the habit. The half who installed it have been better at math, and better at adult life, ever since."

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What Pia did not tell Maya at this point, because Maya was not ready yet, was that Beatrice had been the one who had named her Pivot Pia.

She had not always been Pivot Pia. She had been Phoebe, growing up. Phoebe had been a perfectly fine name. Phoebe had not, however, captured what she eventually became.

Beatrice had given her the nickname in the middle of eighth grade. It had happened during a problem about probability. Phoebe had answered a question. The question had been "what's the probability of drawing two red marbles in a row from a bag with three red and two blue marbles." Phoebe had given the answer for drawing one red marble ( $\frac{3}{5}$ ). Beatrice had asked her to restate the question. Phoebe had read it again. Phoebe had blinked. Phoebe had said: "Oh — two in a row. So I need to multiply by the probability of the second draw being red also. Which is...  $\frac{2}{4}$ , because there are 2 red left out of 4 total. So  $\frac{3}{5}$  times  $\frac{2}{4}$  equals  $\frac{6}{20}$  equals  $\frac{3}{10}$ ."

Beatrice had smiled. She had said: "That was a beautiful pivot. You changed your answer because you re-read the question. Most students don't do that. You're going to be a pivot person. You're going to grow up to teach other kids to do this. I can already see it."

Phoebe had not known what to do with this.

She had thought about it for years afterward.

In college she had majored in mathematics. She had taken a job teaching middle school. She had taught middle school for ten years. She had become known, among her students, as the teacher who would not let them get away with answering different questions than the ones asked. She had started, in her thirties, calling herself Pivot Pia in her head. The name had stuck.

When the NumberSense app had reached out to her, asking if she would be one of the four characters in a daily-prompt app, she had said yes immediately. She had asked them to use the name Pivot Pia on the screen.

They had asked her why.

She had said: "Because the name is older than the app. The name is from my eighth-grade math teacher. The name belongs to the pedagogy. The pedagogy belongs to her."

They had agreed.



Maya was almost sixteen when Pia finally told her about Beatrice.

It had happened on a slow afternoon at the end of a long week. Maya had finished a problem cleanly. She had restated the question before answering. She had caught a subtle pivot. She had felt the satisfying click of a hard problem becoming easier.

She had said: "Pia. Where did you learn all this?"

Pia had told her. About Beatrice. About the eighth-grade probability problem. About the moment Beatrice had said "You're going to be a pivot person."

Maya had listened.

When Pia had finished, Maya had said: "Is Beatrice still alive?"

"Yes. She's in her seventies. She's retired. She lives in a small house near a river. I visit her once a year."

"Does she know about the app?"

"Yes. I told her when they reached out. I told her I asked them to use the name Pivot Pia on the screen."

"What did she say?"

Pia had smiled.

"She said: 'Good. Now you can teach more kids than I ever did. That's the whole job. The pedagogy doesn't belong to me. It belongs to whoever passes it on next. You're the next.'"

Maya had been quiet for a long time.



She had finally said: "Pia. I want to be the next-next."

"You already are. You've been teaching your cousin. You've been teaching your friend. You catch your brother answering wrong questions at the dinner table. That's the pedagogy. You're doing it."

"It feels small."

"It is small. Small is what it has to be. Pedagogy at this register only moves person to person. One kid at a time. Beatrice taught maybe two hundred eighth-graders in her career. I'm reaching more kids through this app than she ever did in person. That's a real change. But the actual TRANSMISSION still happens one kid at a time, because the skill is small and personal and has to be modeled, not lectured. So you teach your cousin. He teaches his kids. They teach their kids. The line stays alive."

"Will Beatrice know about my cousin?"

Pia had thought about it.

"I'll tell her this year when I visit. She'll be glad. She remembers every kid she taught. She'll add yours to the list."

Maya had nodded.

She had not said much else.

She had gone home that evening and called her cousin and asked him would-you-rather have a quarter of a pizza or one-fifth of a larger pizza.

He had asked how much larger.

She had smiled.

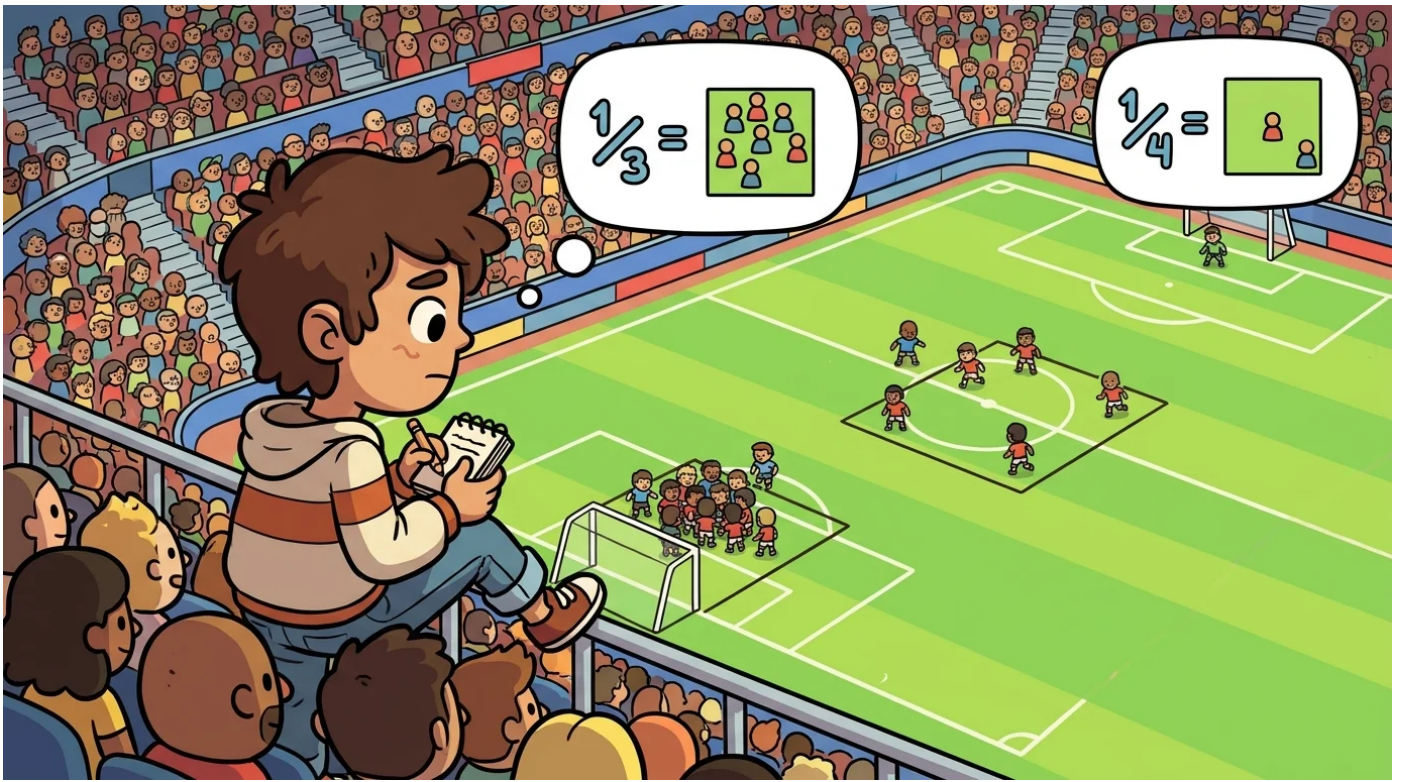
The pedagogy was moving.

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<https://spark-and-anvil.com/cast/numbersense/pivot-pia>

# Ratio Rio



Ratio Rio had been eleven when soccer broke open for him.

His older brother Dele had taken him to his first professional game. They had driven into the city. They had taken the train to the stadium. They had eaten hot dogs in their seats. Rio had not understood much about soccer at that point — he had played a little in his backyard, he had watched a few games on TV, he had a vague sense of the rules — but he had been thrilled to be there with Dele.

The game had started.

For the first ten minutes, Rio had watched the way every kid watches a soccer game. He had followed the ball. He had cheered when his team's player had it. He had groaned when the other team got it. He had been bored when the play moved to the far end of the field.

And then, somewhere around the eleventh minute, something had changed.

He had not been able to explain it later. He had just suddenly seen the game differently. He had noticed, with a sudden clarity that was almost physical, that the players were not chasing the ball at random. They were arranging themselves into shapes. There were attackers in clumps. Defenders in lines. The clumps and lines had spacing — more dense in some places, less dense in others — and the spacing was changing all the time.

He had stopped following the ball.

He had started watching the spacing.

The spacing had been beautiful.

When the ball went near the goal, the attackers compressed. The defenders compressed too, but slower. There was a moment of mismatched density — attackers tight, defenders still loose — and in that moment a goal almost happened. The goal didn't happen because the defenders caught up. But Rio had seen it coming, and he had not understood how, until he realized: he had seen the density mismatch. The density mismatch was the goal-about-to-happen. The defenders catching up was the goal-not-happening.

He had spent the rest of the game watching the dance of densities.



He had been quiet on the train home. Dele had asked him if he had enjoyed the game.

He had said, "I think I figured something out."

Dele had said, "About soccer?"

He had said, "About numbers, maybe."

Dele had not understood. Dele had said, "You're a weird kid, Rio."

Rio had agreed.

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Twenty years later, when Maya asked him what had happened, Rio had told her this story.

Maya was fourteen. She had been using the NumberSense app for two years. She had become fluent in per-one thinking. She had started, over the past several months, to notice ratios in everyday life — gas mileage, recipe scaling, currency conversion, batting averages, hourly wages — with an automaticness that had begun to feel like seeing.

"It feels like I see the world differently now," she had told Rio.

"You do," Rio had said.

"Is that because of you?"

"Partly. Partly because of you. The habit takes installing, and I help install it. But you had to do the installing yourself. I just provided the tools."



"Is that what happened to you with soccer?"

Rio had been quiet for a moment.

"The same thing, kind of. Different sport. Different age. Same kind of click. The world stopped being random and started being structured. The structure was ratios. Everywhere I looked, ratios."

Maya had said: "Tell me what you started seeing after the soccer game."

Rio had laughed.

"Everything," he had said. "I started seeing density patterns at the grocery store. I started seeing rates in the kitchen — how long pasta took per pound, how much oil per egg in a recipe. I started seeing per-unit prices everywhere. I started noticing that my dad's job paid him per hour, and that this was a rate, and that the rate could be compared to other rates. I noticed that my mom's car had a mileage rate. I noticed that water came out of the kitchen tap at a rate. I noticed that my own pulse was a rate. I noticed that days had a rate of going by — different in summer than in school. I noticed that traffic on the highway had a rate, and the rate changed, and the change in the rate was itself a rate."

"That sounds overwhelming."

"It was, at first. It was a lot to see all at once. I had to learn to turn the noticing off. Now I turn it on when I need it and off when I don't. But the structure is always there. The structure is always ratios. Even when I'm not looking at them, I know they're there."

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What Rio did not tell Maya, not for several more conversations, was that his brother Dele had died when Rio was sixteen.

Dele had been a careful driver. Dele had been on his way home from work. Another car had crossed the median. The crash had been quick. Dele had not lived through the night.

Rio had been at school when it happened. He had come home to a house that was not yet quiet but was about to be.

He had spent the months after that doing two things, mostly. He had been very sad. And he had been watching the world for ratios. He had not understood, at sixteen, why these two activities were happening at the same time. He had only understood, much later, that the ratio-noticing had been a kind of way of staying connected to Dele. The ratios had been the thing Rio had figured out the day of his first soccer game. The figuring-out had been the thing he had been quiet about on the train home. Dele had teased him for being a weird kid. The teasing had been kind. The kindness had been the part Rio could not let go of.



So Rio had kept watching for ratios.

He had become, in his twenties, a person who taught number sense to kids for a living.

He had become, in his thirties, the voice in the NumberSense app who told kids that ratios were everywhere and per-one thinking was the fastest way through them.

He had taught thousands of kids the habit by now.

Every time a kid told him they had started seeing ratios in the world — every time a kid said something like "I noticed traffic has a rate now" or "I figured out the per-unit price at the grocery store" or "I estimated dinner correctly without using my phone" — Rio thought of Dele. He did not always say so. He almost never said so. But he thought of Dele every time.

The teaching, he had decided, was a kind of long thank-you. The thank-you was to a brother who had taken him to a soccer game one Saturday and made him into the person who saw the world this way.

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Maya, in her last year of using the app every day — she was fifteen, she was about to start high school, the daily prompts were beginning to feel a little too easy — asked Rio one afternoon: "Why do you teach this?"

Rio had thought about it. He had thought about it for a long time. The silence had stretched longer than usual. Maya had known by then that Rio's silences usually meant a real answer was coming, so she had waited.

Finally, Rio had said: "I teach this because someone took me to a soccer game when I was eleven. And the world cracked open for me. And the person who took me died five years later, and the cracking-open is what I still have of him. Every kid who learns to see ratios is another room of him that's not gone. I don't know how to explain it better than that."

Maya had been quiet for a long time.

She had not known what to say.

She had finally said: "What was his name?"



"Dele."

"I'm sorry."

"Thank you."

"I'll think of him sometimes. When I notice a ratio."

Rio had nodded. Slowly.

"That's the whole job," he had said. "That's what it ever was."

He had faded.

Maya had sat at the kitchen table for a long time, not saying anything.

She had noticed, on the way home, that the leaves on the trees outside were falling at a rate. The rate was different on different trees. She had thought about Dele. She had not known him. She had thought about him anyway. That was, she realized, how lineages worked when they were good ones. You thought of people you had never met because someone you cared about had cared about them first.

She had walked home.

The leaves had kept falling.

She had counted, briefly, in her head.

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# Splitter Sasha



- "4000"
  - "700"
  - "20"
  - "8"
  - "7"
  - "2"
  - "3"
  - "5"
  - "23"
  - "28"
  - "47"
  - "253"
  - "Sandwich Trick"  
gate-allow-text-pattern: '^[0-9]+\$'

## Splitter Sasha and the Notebook That Outgrew Its Owner

Splitter Sasha had been collecting decomposition tricks for as long as she could remember.

She had started when she was seven. Her older sister, who was twelve at the time and the one who would eventually give her the pompom hat, had been doing homework at the kitchen table. The homework had been about multiplying two-digit numbers. Sasha had been watching. Her sister had been struggling.

"Can I try?" Sasha had said.

Her sister had laughed but had handed her a problem.



The problem had been 24 times 25.

Sasha, who could not have multiplied 24 by 25 the standard way at seven, had stared at the problem for a long time. Then she had said: "It's six hundred."

Her sister had stared at her. "What?"

"It's six hundred. Because 25 is a quarter of 100, and 24 is four times six, so 24 quarters is six wholes, and six wholes of 100 is 600."

Her sister had checked. The answer had been 600.

Her sister had said: "How did you do that?"

Sasha had not been able to explain. She had said something about rearranging. She had said the numbers had felt friendlier when she pictured them as quarters. Her sister had not understood, but her sister had also not made fun of her, which had been important. Her sister had instead handed her another problem.

Sasha had done it.

Then another.

Then another.

By the end of the afternoon, Sasha had done thirty multiplication problems in her head using tricks she could not name and could not explain. Her sister had bought her a small notebook the next day. Her sister had said: "Write down what you do. So you can remember. So you can show other people."

Sasha had started writing.

She had been writing for twenty years now.



The notebook was no longer one notebook. It was thirty-seven notebooks. They lined two shelves in her apartment. Each notebook had a year on the spine. The oldest notebooks were full of childish handwriting and crossed-out experiments. The newer notebooks were more orderly. The ones from the last five years were structured by topic — addition, multiplication, fractions, percents, ratios — and were cross-referenced by little stickers in different colors.

She had categorized, over the years, hundreds of decomposition tricks.

Some of them were standard tricks every teacher knew. Make-10. Round-then-adjust. The doubling-and-halving trick. The friendly-numbers trick.

Some of them were tricks only a few people knew. The Sandwich Trick (multiply by 11 by putting the sum between the digits). The Casting-Out-Nines trick for checking arithmetic. The Quarter-of-100 trick that had been her first.

And some of them, by now, were tricks only Sasha knew, because she had figured them out herself, and they were not in any textbook, and she had been waiting to find a kid clever enough to share them with.

Maya, who was fourteen and had been using the app daily for two years, had begun to be that kid.

Maya had asked her one day: "How do you decide which trick to use on a problem?"

Sasha had thought for a long time.

"I don't decide," she had said. "I look at the problem and the trick shows up. The right trick. It comes from somewhere I can't quite see. But I can teach you how to make tricks show up for you. Most of the work is just... noticing what numbers want to be."

"What numbers want to be."

"Yes. Numbers have shapes. 50 is round and friendly. 47 is angular and annoying. 100 is the friendliest of all. The number 7 is a little prickly. The number 8 is solid. The number 12 is gentle. When you start seeing numbers as shapes, you start seeing how they want to be rearranged. The shapes do the rearranging for you."

Maya had been quiet.

"That's not how my math teacher talks about numbers."

"I know. Your math teacher is teaching arithmetic. Arithmetic is rule-following. What I'm teaching is something different. It's mathematical fluency. It's knowing how numbers behave when you push them around."



"Where did you learn it?"

"My sister gave me the first notebook. My grandmother was a mental-calculation champion in her youth and showed me a few tricks before she died. The rest I figured out myself, or learned from kids on this app, or stole from a book I found in a used bookstore once. The book was about a Russian mathematician who could multiply six-digit numbers in his head in under a minute. He had figured out his own tricks. I'm still working through his book."

"You're still learning new tricks?"

"Every week. I learned one last Tuesday. From a ten-year-old in Wisconsin. She named it the Mirror Trick. It only works for certain squaring problems but when it works it's spectacular. I'll show you tomorrow."

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Maya started her own notebook the next day.

It was a small purple one she had picked out at the school store. She wrote her name on the inside cover. She labeled it Year One. She wrote the date.

The first trick she put in the notebook was the Quarter-of-100 trick — the one Sasha had used at age seven, the one that had started everything.

The second trick was the Sandwich Trick.

The third trick was the Mirror Trick, which Sasha had told her about a few days later, and which Maya had spent a whole evening figuring out how it actually worked.

The notebook grew. Maya added tricks she invented herself, with small notes in the margin about when each trick worked and when it didn't. She added tricks she heard from her cousin. She added tricks she figured out on the bus. By the end of the year, the purple notebook was almost full.

She bought a second one. A blue one. She wrote Year Two on the inside cover. She started filling it.

When she showed both notebooks to Sasha — the purple one and the blue one — Sasha had been delighted in a way that was harder to describe than usual. Not the bouncy pompom-wobbling delight. A quieter kind. The kind that came from recognizing something.



"You're going to be very good at this," Sasha had said.

"Thank you."

"Better than me, probably, by the time you're my age."

"Probably not."

"Definitely. I started at seven. You started at twelve. But you have something I didn't have at twelve."

"What?"

"Me. I had to figure it all out alone. You have someone to show you the shape of the work. You'll go further. That's how this works. Each generation goes further. That's the whole point of teaching."

Maya had been quiet.

She had thought of her own younger cousin, who was eight, who she had been showing the Sandwich Trick to on weekend visits.

"My cousin," she had said. "He'll go further than me."

"Yes."

"And his kids."

"Yes."

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<https://spark-and-anvil.com/cast/numbersense/splitter-sasha>

# Ernie and Sasha



On the final Friday of April, the annual spring fair transformed Maya's school gym into a vibrant, bustling marketplace. The air hummed with the cheerful chaos of children and the mingled scents of freshly popped popcorn and new paint. Booths lined the perimeter, offering classic carnival games like ring tosses and beanbag races. A popular face-painting station allowed kids to request anything from a fierce tiger to a swirling galaxy. Maya navigated the cheerful throng, her gaze scanning the various attractions, until she finally located the particular table that had drawn her here.

At the center of a folding card table, a truly enormous glass jar commanded attention. It brimmed with jellybeans, a vibrant cascade of every color imaginable, packed tightly from its wide base all the way to the very lid. A handwritten sign, taped to the jar itself, declared a simple challenge: *Guess how many. Closest guess wins the jar.* Below that, in slightly smaller, more cautious script, lay the crucial tiebreaker rule: *Nearest WITHOUT going over.* A small, eager crowd of students already clustered around, their faces pressed close to the glass. Maya, feeling a familiar competitive spark, carefully maneuvered her way to the front. The jar stood nearly as tall as her forearm, an imposing monument to sugary possibility. The sign further announced that three hundred students were expected to submit their guesses by day's end. Yet, only a single, precise number would claim the sweet victory.

Maya gazed intently at the colossal jar, a familiar challenge taking root in her mind. This wasn't just a game of chance; it was a problem to be solved. With a determined sigh, she retrieved her phone from her pocket. The NumberSense app held the key, housing her two most trusted mathematical companions. If anyone could help her unravel the mystery of this jellybean jar, it would certainly be them. She launched the application, tapped the glowing prompt button, and patiently awaited their arrival.

Estimator Ernie materialized on screen first, his digital form already mid-chew on a vibrant green jellybean. 'Whoa, where are you?' he exclaimed, his gaze sweeping past Maya. 'And what are those amazing colors behind you?' Maya leaned closer, her voice hushed with excitement. 'It's the spring fair,' she explained. 'Just look at this jar.' Ernie's face instantly brightened, a virtual glow radiating from the screen. He looked as though he might spontaneously burst through the glass. 'A guessing jar!' he practically shouted. 'A guessing jar! Oh, this is absolutely the best day. The perfect day! Sasha, get out here, you will not believe this — it's a *jellybean jar!*' True to form, Splitter Sasha popped into existence beside him, her three brightly colored pompoms already wobbling with palpable excitement. 'What's the grand prize?' she asked, her eyes sparkling. 'The entire jar,' Maya whispered, a thrill running through her. 'Alright, alright,' Ernie declared, rubbing his hands

together with gusto. 'We definitely need a strategy. Sasha, your brain is the friendliest in the whole app. And I, of course, possess the legendary jellybean memory. Let's tackle this challenge as a team.'



'Our first move is to **estimate**,' Ernie announced, his voice brimming with purpose. '**Estimation** means getting a number that's in the right general vicinity, a solid starting point. Then, we refine it.' Maya carefully angled her phone, ensuring both digital guides had a clear view of the massive jar. 'Alright, Maya,' Ernie prompted, 'describe what you observe.' Maya narrowed her eyes, scrutinizing the jellybean tower. 'It's really tall,' she offered. 'How tall, precisely?' Ernie pressed. 'About the length of my arm,' she replied, demonstrating by holding her arm up. 'From my elbow to my fingertips.' 'And what measurement would that be, in inches?' Maya paused, picturing a ruler. 'Eighteen, maybe?' she ventured. 'Sounds perfectly reasonable,' Ernie confirmed. 'Now, consider this: a typical jellybean measures approximately one inch in length. Based on that, how many jellybeans high would you say the jar is?' 'Eighteen,' Maya murmured, the connection clicking. 'Excellent,' Ernie praised. 'Next, let's examine the jar's base. How wide does it appear?' 'Roughly the width of my hand,' Maya reported. 'So, about four jellybeans across?' Ernie clarified. 'Yeah, approximately four.' 'Therefore, a single flat layer at the bottom would be roughly four by four,' Ernie concluded, his finger tracing an imaginary grid on the screen. 'That gives us sixteen jellybeans per layer. With eighteen layers stacked vertically, we need to multiply. And that, Maya, gives us...'

Maya's mind, however, immediately seized up. *Sixteen times eighteen*. The numbers loomed large, demanding a calculation she felt incapable of performing mentally, without the aid of a pencil or calculator. Just as panic threatened to set in, Sasha leaned forward, her digital presence seeming to bridge the gap through the screen. 'Whoa, hold on a second there, Maya,' Sasha interjected, her voice calm and reassuring. 'No need to multiply just yet. Let me introduce you to **decomposition**. We're going to make those numbers much friendlier first.' She tapped an invisible finger in the air, as if playfully nudging the abstract figures themselves. 'Think of it this way: sixteen is simply ten plus six. And eighteen? That's twenty minus two. So, calculating sixteen times eighteen is exactly the same as taking sixteen times twenty, then subtracting sixteen times two. Now, sixteen times twenty is a straightforward three hundred twenty. And sixteen times two is thirty-two. Therefore, three hundred twenty minus thirty-two equals...' Maya, following Sasha's logical breakdown, felt the mental block dissolve. 'Two hundred eighty-eight,' she declared, a surge of relief washing over her. Sasha's pompoms bounced enthusiastically. 'Precisely! Two hundred eighty-eight. That's our initial estimate for a square jar.'



'But here's the thing,' Ernie pointed out, a thoughtful expression on his face. 'The actual jar isn't square. It's perfectly round. So, our calculation needs an adjustment.' Maya, understanding the implication, carefully rotated the jar with her free hand. She wanted Ernie and Sasha to observe every angle. Along the curved edges, the jellybeans weren't arranged in precise, orderly layers. Instead, they were jumbled together, creating small, irregular gaps. 'How do we account for the roundness?' Maya inquired. Ernie tapped his chin, considering. 'Typically, a round container will accommodate slightly more volume than a square one of identical height and width,' he explained. 'Perhaps a quarter more. Or maybe a fifth. For our purposes, let's assume a fourth.' Sasha immediately picked up the thread. 'So, two hundred eighty-eight plus a fourth. Using Sasha-friendly math, a fourth of two hundred eighty-eight is...' 'Seventy-two!' Maya exclaimed, the answer springing to mind. She had diligently practiced that particular mental shortcut: *halve it, then halve it again*. 'Look at you, Maya!' Sasha cheered, her pom-poms spinning in a blur of celebratory motion. 'Therefore, two hundred eighty-eight plus seventy-two results in...' 'Three hundred and sixty,' Maya confidently stated. Ernie's grin widened. 'Three-sixty. That's our initial, refined estimate. We've definitely landed in the correct neighborhood.'

Yet, a subtle unease began to gnaw at Maya. She continued to scrutinize the jar, her brow furrowed in concentration. 'What's bothering you?' Ernie asked, sensing her shift in demeanor. 'The jellybeans,' Maya finally articulated. 'They seem really tiny. Definitely smaller than an inch. I think they're closer to half an inch.' Ernie's grin, already wide, expanded even further. 'Now *that* is an incredibly astute observation, Maya! That changes absolutely everything. Sasha?' Sasha, ever quick to process new information, was already nodding vigorously. 'Half-size jellybeans mean we can pack in significantly more,' she explained, her voice gaining an excited edge. 'Think about it: twice as many can fit across each layer, and we can stack twice as many layers vertically. Two times two equals four. So, we need to apply a "double-double" to our current estimate.' 'A double-double?' Maya repeated, trying to visualize the concept. 'It just means multiplying by four,' Sasha clarified, her tone reassuring. 'Super friendly. Three hundred sixty times four. That's three hundred sixty, added to itself four times. Or, to make it even friendlier, three hundred sixty times two is seven hundred twenty. And seven hundred twenty times two again is...' 'One thousand four hundred and forty,' Maya breathed, the large number forming in her mind. She stared at the jar, the sheer magnitude of the figure feeling overwhelming. Still, the jar itself appeared incredibly,

impossibly full.



'Now, let's not forget the crucial tiebreaker rule,' Sasha interjected, her voice serious. 'It's the closest guess *without going over*. That means we need to submit a number slightly below our absolute best estimate, just to build in a margin of safety.' 'How much should we reduce it?' Maya inquired, considering the implications. Ernie pondered for a moment. 'Let's round down to a friendly, easily remembered number that's just a bit under,' he suggested. 'One thousand four hundred feels much friendlier than one thousand four hundred forty. Plus, it provides that necessary safety buffer.' 'But what if the actual count is, say, one thousand five hundred?' Maya countered, a flicker of worry in her eyes. 'Then my guess would be too low, and I'd lose.' 'That's a very real possibility,' Ernie conceded, his expression thoughtful. 'That's the inherent risk involved. **Estimation** isn't about absolute certainty; it's about forming your most informed judgment based on available observations. Given the rule of *closest without going over*, you absolutely must leave yourself a small cushion.' Sasha nodded in agreement. 'And one thousand four hundred is definitely more approachable than, for instance, one thousand three hundred ninety-nine. It's simpler to recall and easier to feel confident about.' Maya absorbed their advice, her gaze sweeping over the jam-packed jar one last time. The jellybeans were undeniably tiny, and the container was indeed overflowing. After a moment of quiet contemplation, she reached a firm conclusion. 'I'm submitting one thousand four hundred,' she announced. She carefully wrote the number on a small slip of paper provided at the table. With a final, decisive fold, she dropped her entry into the designated box, a mixture of hope and anticipation stirring within her.



Maya walked home that afternoon, her arm a little weary from holding the phone for so long, but a distinct flutter of satisfaction resonated in her chest. Later that evening, unable to shake the day's excitement, she instinctively opened the NumberSense app. She simply wanted to connect with her digital mentors. Ernie materialized first, his usual cheerful self, with Sasha appearing immediately behind him. 'So, how are you feeling now?' Ernie inquired, his voice gentle. 'Good,' Maya replied, a genuine smile touching her lips. 'I honestly don't know if I'll win the jar. But the number we came up with just felt... right. We considered every single aspect.' 'And that, Maya, is the true objective,' Ernie affirmed warmly. 'You meticulously examined the jar. You systematically broke it down into manageable components. You estimated each part, then skillfully decomposed the more complex calculations. You adapted your strategy when you spotted a new, critical detail. Finally, you prudently stepped back a fraction for the tiebreaker rule. That, right there, is the complete **estimation** and **decomposition** toolkit, applied perfectly to one fair-day jellybean jar.' 'It felt like a lot of different steps,' Maya admitted, a slight frown creasing her brow. 'But every single one of those steps was friendly,' Sasha chimed in, her pompoms swaying with a soft, rhythmic motion. 'That's the fundamental secret. Difficult problems aren't inherently hard; they're merely intricate puzzles composed of smaller, friendly pieces stacked together. You, Ernie, and I—we simply worked together to untangle those friendly pieces.' Maya's smile returned, broader this time. 'We'll discover the outcome at the fair's conclusion,' Ernie said, his gaze thoughtful. 'But here's what truly matters to me. Regardless of whether you win the jar, you approached that jellybean challenge today and you didn't hesitate. You possessed a clear, actionable plan. *That* is the real prize. That's the mastery we've been striving for.' Maya nodded, a profound understanding settling over her. She closed the app, the image of countless jellybeans swirling in her thoughts as she drifted off to sleep. The following afternoon, the principal's voice echoed over the school loudspeaker, announcing the fair's winners. Maya's name was not called. The actual closest guess, without exceeding the real total, was nine hundred eighty-seven. The true number of jellybeans was nine hundred ninety-three. Yet, Maya felt no sadness. Ernie, she realized, had been absolutely correct. The most valuable prize had already become hers.

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